Talking Bits

An investigation into the nature of digital communication technology and its impact on society

Thomsen, Michael

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Michael Thomsen

Table of Contents

Acknowledgements

This thesis has been a long time coming, and many people have helped it along its winding path. Above all I have to thank my wife, Annika, and my kids for their extraordinary patience and understanding. How they have managed to put up with my endless nights of reading, browsing and writing is beyond me. My advisor, Lise Kofoed, has helped lift the text from a hotchpotch of trivia and tediousness to a proper thesis through repeated reviews and sound advice. And several friends including Bodil Jönsson, Henrik Ravn, Terkel Skårup, Bjarne Tveskov, Louise Koch, Joost Elffers and Howard Rheingold have offered invaluable advice and feedback. I owe you one, guys!

The cover image stems from (Black 2006)

Michael Thomsen

Copenhagen, January 17th, 2010

Preface

I started my career in computers as a thief. In 1979 I was hired into the technical department of a Danish software company, and after a crash course in assembly language programming I was put to work decoding chips in order to solve problems in them or modify them for other purposes. Laboriously unraveling the mysteries of operating systems and driver routines through a mixture of automatic and hand decoding I would probe into the minds of programmers from MOSTEK, Q1, DEC, CP/M and elsewhere. It was fascinating to discover that I could recognize the art of individuals in their code, and I slowly started to feel part of an invisible community of kindred spirits. I felt somewhat like a thief, but I also quickly realized that writing code from scratch in most cases was a waste of time when I had all this excellent stuff from others lying around in a digital form, readily available for copying and modification. Although I was unable to share my code with my colleagues in the United States I was becoming a part of a hacker community and adopting the hacker mindset, which for me grew out of the computer itself rather than of the free spirit of academia or the revolutionary spirit of computer clubs.

I count myself lucky to have entered the world of computers through its smallest constituent parts. Personal computers never became black boxes to me, and I quickly realized that the only magic in computers was the magic of digital computation – of the bit. Encountering application programmers I was amazed to discover their lack of understanding of the basic fact that digital systems were inherently just logical constructs made by people and that there was for instance no such thing as unbreakable security or fail-safe copy protection systems.

In the mid-80s I was studying computer science and doing PC communications for a living. I discovered the world of open source software through the Kermit protocol and was truly excited by the existence of a community devoted to making my previous thievery not only legal, but also commendable, and I tried to adopt the same attitude in my own work. When I

encountered the Internet I realized its power and the obvious limitations of the point-to-point communication I was developing as a freelance programmer. The revelation came gradually, but since my first encounter with Usenet news groups I have become ever increasingly devoted to open source, open content and open communication.

From the perspective of the bit and the information package, computers and computer communications look very different than from the vantage points of the desktop metaphor, cultural analysis, or marketing strategies, and over the years I have become increasingly frustrated with the lack of appreciation of the technological character and true scope of the digital revolution. During the 80s and the early 90s the problem was a simple one of widespread blindness, but as the World Wide Web caught on, suddenly the whole world of business seemed to wake up, and every marketing manager became an Internet expert overnight, many of them without understanding the true nature of what they were getting into. They saw new business possibilities through direct consumer access, but I saw them as a threat to the creative and global potential of computation and many-to-many communication.

Fortunately the burst of the bubble in 2001 showed the nakedness of the emperor, and the ups and downs of those years turned out to be just ripples on the surface of a larger wave, but we have yet to see whether we can exploit the true potential of digital information, computation and communication. We are still very much living in a mass media society, and the big question is whether we will be able to clear our eyes of the mass-medial mud to see and seize the opportunities that lie ahead.

This is the question that motivated me to start my research for this thesis. I wanted to find a way to understand and explain the importance and potential impact of digital communication, and I believed that the explanation could be found by examining the fundamental characteristics of the technology itself. My journey took me far and wide – some would probably say too far – and the result is a complex web of cultural, political, economic and technological deliberations, but I hope and believe that it can contribute to a better understanding of our present situation and provide some guidelines for

constructive action towards our digital future. I have enjoyed my explorations and hope you will find them inspiring and perhaps illuminating.

Introduction

'Rapidly we approach the final extension of man – the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media'

Marshall McLuhan[1]

When Marshall McLuhan wrote these words in 1961 computers were hardly on his mind. His concern was mainly with the mass media of television and radio, and his vision was of a global village, where everyone would be aware of what was happening around the globe. Like a true prophet he saw a connected future, but for some reason he saw it in the wrong media. Mass media do not create a global village, because a village depends entirely on two-way communication, and the world of television has turned out to be one of cultural imperialism and increasing centralization of power. Yet, the technology that could prove McLuhan right was already well under way in 1961, and today we are facing a global upheaval, which makes his books seem more visionary than ever.

After 5000 years of dead non-malleable text and 500 years of increasingly lop-sided communication through mass media we have now developed a technology that allows us to bring information back to life and communication back to dialog. Digital information is infinitely copyable, freely modifiable and brought to a level of symbolic generalization that allows us to express ourselves in a multitude of ways affecting all our senses. Digital computation allows us to add work to and create multiple representations of information and thus turn it into a living, dynamic entity, and digital communication finally brings the promise of true many-to-many communication, where everyone can join a global or local conversation in real time or over centuries. In short, digital media bring the power of creativity and communication back to the people.

The way we think, relate to each other and organize our societies is intrinsically dependent upon our communication technologies, and I intend to

show that digital technology is bringing more fundamental changes to our communication landscape than any other invention made during the last 4000 years. When viewed together, digital information, computation and communication are such a powerful force that they will inevitably cause fundamental changes to virtually every aspect of society – much like the printing press did, but even more profoundly. Print brought us the mass media society - digital media will bring it to an end.

We are children of the past, and we face everything with the mindset of what has been and what we are used to. When encountering something truly new we thus tend to go through a progression of reactions. First we might ignore it like a toothache in the hope that it will just go away. When that doesn't happen we try to explain it in terms of what we know and are familiar with. Sometimes we succeed and happily bypass what could have been a major change in our lives, but when no proper explanation offers itself, some of us react with active resistance, while others just dive in and immerse themselves in the unknown in the hope that all will be revealed in due time. We proclaim the revolution, yet we are unable to explain it or even grasp its scope or possible consequences. After blindly diving through murky waters and suffering the consequences we some day emerge to discover that we have ended up on a foreign shore – in all likelihood already occupied by someone else, who for some reason or other found the waters easier to navigate. It may even be a hostile shore that makes us long for home, but all we can do is blame ourselves that we did not plan ahead a little better. There is usually no way back.

With digital technology most of us seem (but only seem) to have gone beyond denial and active resistance. We are eagerly embracing computers and the Internet, and the revolution has been proclaimed more times than we might have wished for. Nevertheless we tend to explain and treat digital media like a mere extension of the mass media we have been living with for the last centuries, and by doing so we risk failing to understand and utilize the true potential of the technology

We seem to address the changes in a very piecemeal fashion, explaining every new phenomenon like email, the web, blogging or Web 2.0 almost like

an isolated event. By doing so we fail to grasp the profound changes that are happening right now and even more so the opportunities and pitfalls that lie ahead of us. The consequence is that we walk blindly or backwards into an unknown future. Instead of basing our development on a real understanding of our newfound technology and its potential we innovate and adapt in the no-mans land between old mass media culture and a digital future. We understand the technology itself, and innovators have a field day exploring the new opportunities, but the consequences to society are only discovered when they have become reality.

Yet, the spoils go to those who best understand and embrace the qualitatively new, and those who rush blindly into the future do so at their own peril. The crash of the digital economy at the turn of the millennium should serve as a warning of things to come. At that time only money was lost, but, as this thesis will demonstrate, much more important things are at stake in the decades to come.

My main quest has been to investigate, what we can do to walk forwards rather than backwards into the future, and the underlying question of the thesis is thus the following:

> ***Is there a way for us to understand digital technology from the perspective of the future rather than the past?***

I believe there is, and I think the solution is to be found in the juncture between the theory of communication technology and the history of its impact on society and culture.

Consequently this thesis introduces a theoretical framework, which describes some specific, fundamental aspects of communication technology; and then applies this framework in an exploration of the history of communication technology and its effect on our lives.

The historical account provides an explanation of what constitutes qualitative change, which in turn allows us to get a clearer grasp of digital technology and create a more informed roadmap for our digital future.

Obviously, our future is not determined by technology and our use of it alone, and only the technological determinist would venture to make predictions

based on technology. Knowledge, technology and culture are developed in a complex web of interdependencies, and it is fool-hearted to try to be determinist one way or the other. I agree with the sociologist Adrian Johns[2] that we cannot view any technology as 'sui generis", because it both arises out of and is implemented in a cultural and social context, but I nevertheless claim that whereas implementation and use of a given technology may vary greatly they will always depend on its basic characteristics. Technologies are not invented, developed or deployed unless the conditions are right and someone perceives a need, but all technologies have fundamental properties that determine what can and cannot be done with them. By examining the basic structure, the DNA if you will, of a given technology we can therefore discover its potentials and limits and perhaps say something about its possible effects on society.

Technology is today more important for competitiveness than ever before. As convincingly argued by Jared Diamond in 'Guns, Germs and Steel'[3], geography has played a major role in the history of progress, but today the most important raw material for progress is our mind, and although we of course continue to depend on access to water and raw materials, our communication and transportation technologies at least in principle allow those with the best skills and ideas to prosper independently of where they happen to be located. The Fertile Crescent in the Middle East was crucial in the development of Western Civilization, but today our seeds of social, cultural and economic progress grow in a different kind of soil.

I see technology as an enabler in the complex web of cognitive and societal development. Technology in itself cannot change society or thinking, but given the right circumstances it can act as a powerful catalyst for change. What we make of the future is very much dependent on our ability to rethink and recreate our society in ways that can bring out the full, positive, and productive use of the technologies we invent. My hope is that this thesis can lead to an understanding of digital communication that can help unleash its potential as the powerful enabler I believe it is.

So, to sum it all up, what I intend to unfold and discuss on the following pages are the following claims:

Claim 1. That we can find important clues to the development of past and future cultures in the fundamental properties of their communication technologies.

Claim 2. That digital technology represents the most important qualitative development in communication technology at least since the advent of writing.

Claim 3. That the fundamental properties of digital technology will promote a society and culture, which is radically different from the one we have developed in the Western World since the advent of the printing press and, in fact, bears close resemblance to oral society, albeit on a much grander scale.

The argument is divided into six parts:

In order to investigate these claims the thesis discusses all major communication technologies from three perspectives as seen in Figure 1.

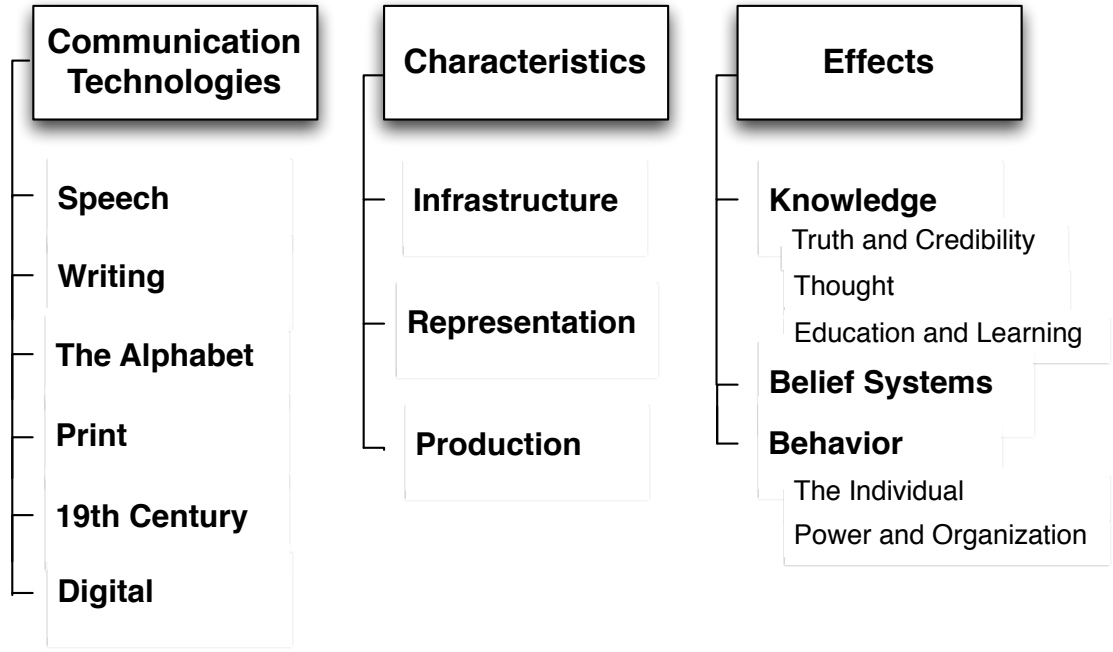

Figure 1. Structural aspects of the thesis

In **Section 1** the stage is set through a brief examination of digital technology and the tell-tale signs of an emerging digital culture.

Section 2 introduces the theoretical framework that breaks communication technology into its constituent parts. The framework does not cover all

aspects of communication and communication technologies in their broadest sense, but allows us to identify and highlight their central aspects.

Section 3 provides a sweeping overview of the development of communication technologies since the advent of speech and examines each technology using the framework presented in Section 2.

Section 4 addresses Claim 1 above by examining the impact of the various communication technologies on key aspects of human culture and shows how important cultural developments can be related to specific aspects of the theoretical framework

Section 5 examines digital communication technology in terms of the framework in order to address Claim 2

Section 6 finally discusses the potential impact of digital media upon society to address Claim 3.

The thesis concludes with a discussion of the above claims in view of the findings.

Research Method

This thesis is an attempt to deal with an emerging phenomenon. The approach I have chosen is to form a hypothesis about the relationship between some central properties of a given communication technology and its impact on society and culture. The hypothesis is tested on historical data and then used to look for signs in present day development and speculate about possible futures.

The hypothesis and the historical examination are straight-forward and traditional research, but to examine a reality that is in the early stages of formation is difficult from a research perspective, as there is only a limited body of knowledge to build upon. And when one is dealing with a phenomenon, which is in the process of changing our view of knowledge, validity and research itself, a choice has to be made. The conservative approach would be to stand firmly in the existing research paradigm and only accept the sources that concur with it, but in my view that would prevent a proper embracing and thus understanding of the phenomenon itself.

The internet is both the subject and one of the main information sources of this thesis. As a source of information it is incredibly rich, but the information is produced, modified, distributed and validated in ways that are far beyond the scope handled by existing academic standards. It will take us decades if not centuries to develop new standards of classification and validation, and our knowledge institutions will have to battle for the position and relevance. It is a time for experimentation with new ways of knowledge creation and knowledge sharing, and, lacking proper standards, we have to rely on our experience and critical sense. When exploring new territory you cannot expect the roads to be paved.

Using web resources, for instance, is not considered proper academic style in all circles, but I feel that discounting the considerable and competent work done by millions of web users, irrespective of their academic credentials, would be outright foolish and certainly not in line with my thesis. I have done my best to ensure the validity of my sources, and, where possible, I have used sources that are likely to be continuously validated and updated by a community of capable users.

The thesis is to a very large degree based on my personal experience and acquaintance with cutting edge people and developments over the last 30 years, and many of the observations and reflections on the following pages should be seen as those of an experienced practitioner rather than a traditional academic.

This thesis is very broad in its scope and touches upon a large number of disciplines including sociology, computer science, linguistics, history, religious studies and the history of science. The research questions, however, are actually of a technological nature. The entire thesis is an investigation into the logic of communication technology rather than the nature of society, and its perspective on society and culture is clearly technological. Claiming that this perspective provides anything like an exhaustive explanation of cultural development would amount to technological determinism, but I have no such intention. In fact, quite the opposite. Perhaps the most important observation motivating this thesis is, that our development is and has always been crucially affected by our ability and readiness to understand and embrace the

possibilities afforded by the technologies we have developed, rather than by the technologies themselves.

To underscore the technological focus of this thesis I have chosen to use the term 'communication technology' as the common concept for all the enhancements of communication developed in or by humans. The obvious choice might have been the term 'media', but media is used ambiguously, sometimes describing the means of communications, sometimes the substance through which information travels, and sometimes the sources of information. Technology is also an ambiguous term, but in its everyday use it comes much closer to the subject of this thesis. One of the definitions in Merriam- Webster holds, that technology is: *'a manner of accomplishing a task especially using technical processes, methods, or knowledge*'[4]. Using this definition we can define thus communication technology as ' a manner of accomplishing communication tasks using technical processes, methods or knowledge', which concurs nicely with the subject of this thesis and does not limit the inquiry to physical, technological constructs, but can include mental or partially mental constructs such as speech and coding schemes.

With this definition in mind we can embark on the investigation into technology and culture!

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[1] McLuhan 1961, p. 4

[2] Johns 1998, p. 19

[3] Diamond 1998

[4] Merriam-Webster Online Dictionary, http://www.merriam-webster.com/dictionary/technology, July 2009

Section 1
An Emerging Digital Culture?

This section examines the character and history of digital technology and goes on to explore signs of, how digital communication is affecting society today. The purpose of the section is to set the stage for the later exploration by demonstrating that society is experiencing the early stages of some fundamental shifts in the way we produce, share and consume information in a wide variety of forms and contexts.

1.1 Going Digital

> *'Creative, interactive communication requires a plastic or moldable medium that can be modeled, a dynamic medium in which premises will flow into consequences, and above all a common medium that can be contributed to and experimented with by all.'*
>
> J.C.R.Licklider[1]

The history of the computer is a history of information, computation and communication, and we must examine each of these aspects in turn in order to understand the full scope of the changes we are facing.

1.1.1 Digital Information and Computation

In a sense the invention of the computer represents the completion of a journey started with tokens used for counting 8000 years ago in Mesopotamia. As we will see later, writing grew out of counting, but since then the two have lived fairly separate lives in their own realms with writing shaping humanities and mathematics shaping science, and it was only around the end of the 19th Century that the two would finally find each other again. This meeting was a prerequisite for the development of the computer, since computation, as we know it today, is a matter of logic processing rather than simple calculation.

Computation is based on a number of inventions, each with its own history:

Binary Representation

First of all, since the basic logical unit of the computer is a bit, which can have only the values 0 and 1, the fundamental representation of data in a computer must be binary. Various early and later attempts at coding the alphabet for communication have resembled a binary notation, but the first to formally show that any number can be represented in a binary fashion was Godfried Wilhelm Leibniz.[2], who is considered the last universalist and a co-inventor with Newton of differential calculus. Leibniz had a life-long interest in the unifying ideas of nature and came to see the numbers 0 and 1 as the simplest expression of all things. In 1679 he developed a binary calculus from his 1666 notion that *"the truth of any proposition in any field of human inquiry could be*

determined by simple calculation"[3], and when he later encountered the binary logic of the Chinese I Ching hexagrams he felt increasingly confident in his theories[4]. He nevertheless never devoted his full attention to binary calculus, and after his death it faded into obscurity. Nevertheless Leibniz is still considered one of the fathers of computer science in addition to his many other contributions to a variety of fields. He did for computing what the alphabet did for language, and he created the symbolic representation that would become the basis for description of all things digital ranging from computation to representation in all types of digital media.

Symbolic Logic[5]

Logic originated as a branch of philosophy dealing with the art of reasoning, and its history goes at least back to Aristotle, who wrote 6 treaties on logic assembled in the so-called Organon[6]. His writings were very influential in Ancient Greece and all through the Middle Ages, but it was not until the 17th Century that logic became formal through exposition to mathematical theories.

The first person to create a symbolic logic for argumentation outside of mathematics was – once again – Leibniz, but it seems that his contribution never came to have any influence on developments, and the person today credited with the initial development of symbolic logic was the Englishman George Boole, who in 1854 introduced his Boolean Logic[7]. Although Boole was unaware of Leibniz' work on formal logic and of his binary calculus, his logic strongly resembles the work of Leibniz, and it lends itself well to binary computing, since it only deals with two logical states: True or false.

Boolean logic makes it possible to represent and treat logical statements in a binary fashion and thus establishes the second part of the foundation for digital computation.

Algorithmic Processes

Binary representation and symbolic logic solve the problems of representation and logic decision making, but they do not solve the problem of actually performing computational processes. This is the realm of systematic procedures or algorithms, and like so many other fields it dates back to the Ancient Greeks, to Euclid who around 300 BC in his '*Elements*'[8] described

what has become known as Euclid's Algorithm, which devices a simple procedure to find the greatest common divisor for two natural numbers.

The term 'algorithm' stems from the 9th Century Persian mathematician al-Kwarizmi[9], but the more formal definition of the concept must be ascribed to the British mathematician, Alan Turing[10], who in 1936 described a universal machine, the Turing Machine, and proved that it would be able to calculate any computable function, i.e. perform any algorithm. He had thus, albeit only in theory, created the mother of all computers (in that it could in principle do what any other computing machine can do), and he had done it with recourse only to binary representation, Boolean logic and an ability to carry out simple instructions. So, finally, with the Turing machine in 1936 the theoretical foundation for the computer was complete, and only the actual implementation was missing.

The Computer[11]

The computer has many predecessors including the abacus and calculating machines invented by people like Blaise Pascal in 1642 and Leibniz in 1794, but the first computer incorporating any kind of automated, procedural logic did not appear until the 19th Century and was in one way the result of a hoax.[12] Around 1820 the English mathematician and inventor Charles Babbage played the famous Mechanical Turk, a purported chess automaton. Even though he occluded that it was a hoax (which of course it was), it inspired him to start working on his own mechanical calculation machine[13], and in 1821 he designed his first calculator based on punch cards. He kept refining his designs until his death in 1871, and although he never built it, he completed the drawings for the first general purpose calculating machine, called the Analytical Engine. Babbage utilized the fact that many mathematical calculations consist of many repetitions of the same operation and the Analytical Engine is the first example of an automatic, programmable machine based on algorithmic thinking. It contained a central processing unit, a storage unit, and input-output units, and the principles described by him to a large degree are replicated in the computers we use today.[14] Building proper computers based on the Victorian age technology was, however, a fairly

impractical affair, and it was only in the age of electronics that computers as we know them today became feasible.

Most theoretical work on computation had taken place in Europe, but when it came to actual implementation and application the United States would rapidly take the lead, which it has kept to this day[15].

The first working, electronic computers were built during the 1940s, and, as has been the case with many other technologies, the modern-day computer was developed as a result of military needs in wartime. During the first few years of their existence computers were mainly used in scientific and military contexts, but as computers became cheaper and more powerful, they gradually entered the factory floor and the office. The invention of the transistor in the late 1950s made it possible to build much smaller and more powerful computers, enabling the introduction of minicomputers in the mid-60s, but very few people before the 70s dreamed of the computer becoming a personal or household tool. Computers were largely seen as number crunchers with limited applicability, and in a world where information was power there was little incentive to put this power in the hands of ordinary people. The dominating computer corporations like IBM and NCR served only organizations, and it would take a combination of ideology, amateur enthusiasm and entrepreneurship to bring the computer to the masses.

The story of the personal computer is one of the classics of innovation[16]. It is a story of business-driven entrepreneurs, revolutionary idealists, blind industry and unintended consequences. It is a story of a few individuals and groups, but one that has had enormous consequences for the tools that most of us use in our everyday life.

In the mid-70s IBM was completely dominating the computer market with its mainframe systems that required large investments and were certainly not accessible to the common man. IBM had come to be seen by many as the epitome of the corporate beast monopolizing a technology that could and should belong to everyone[17]. And a few people had started to take matters into their own hands.

Driven by the desire to bring computation to the masses and beat the big corporations Lee Felsenstein and Ed Roberts were working independently in

San Francisco and Alberquerque to create cheap, versatile computers[18]. Ed Roberts was the more entrepreneurial of the two and was certainly partly driven by monetary concerns, whereas Lee Felsenstein was largely motivated by an idealistic urge to liberate the people through technology. Roberts was the first to actually create a functional machine, while Felsenstein was instrumental in bringing together the Homebrew Computer Club from which great things would eventually spring.

The Altair 8800 created by Ed Roberts was announced in Popular Electronics in January of 1975, and on March 5th, 1975 the first meeting of the Homebrew Computer Club in San Francisco took place with the attendance of a motley crew of

> *'professionals too passionate to leave computing at their jobs, amateurs transfixed by the possibilities of technology, and techno-cultural guerrillas devoted to overthrowing an oppressive society in which government, business, and especially IBM had relegated computers to a despised Priesthood'*[19]

The club members were very eager to get their hands on the Altair 8800, but Ed Roberts had delivery problems, and frustration quickly grew. Meanwhile Roberts had teamed up with Paul Allen and Bill Gates who had created a BASIC[20] interpreter. The club members had heard about the interpreter, but had been unable to obtain it for the Altair, so it is not hard to imagine their frustration when the Altair team showed up in Palo Alto in June of 1975 with an Altair 8800 running BASIC, but no interpreter available for others to use. Some of the locals responded in true hacker style and simply appropriated a copy of the tape containing the code for the interpreter. The next day copies were distributed at the Home Brew Computer Club meeting, and from there they rapidly spread to the community at large, thus spawning an animosity that would become a dominating feature in the PC world for the next 25 years. Bill Gates, who may have been technically proficient, but was not a disciple of hacker ethics, became furious and wrote a letter to the hacker community accusing it of thievery[21]. His and Paul Allen's deal with Ed Roberts was for royalty on each copy sold, and he didn't see any reason why software should not cost money just like hardware – a view that certainly set him apart from the hacker community on both coasts, and which would have a profound effect on the development of Microsoft. For a large part of the community Bill

Gates and Microsoft became the corporate and proprietary beast of the PC world that was little better than IBM and the other big companies dominating the computer industry[22].

Microsoft bashing became a popular pastime at conferences and in IT departments around the world – and certainly not entirely without reason[23]. A company's soul and culture is largely determined by its founders during its early days. It is visible in its products as well as in its strategies and actions at all levels. Microsoft was built on Harvard rather than MIT ideals and the company managed to turn software into an extremely profitable business by completely ignoring the fact that software is perhaps best served by being as freely and openly distributed as possible. They thus played their role in the development of proprietary thinking in the digital domain and in all likelihood delayed the mainstreaming of open source software for many years.[24]

The Home Brew Computer Club would breed a very different kind of company. One of the participants in the first club meeting was Steve Wozniak, at that time an employee at Hewlett-Packard. He had long been wanting to build a microcomputer, and during 1975 he designed and developed the computer, which would become the Apple I, when he and his friend, Steve Jobs from Atari, joined forces to form the Apple Computer Company in April of 1976. When IBM finally caught on to the revolution around 1980, Apple had already launched the Apple II, which was, in fact, in many ways more advanced than the IBM PC. Incidentally both Steve Wozniack and Steve Jobs initially tried to sell the Apple idea to their respective companies, but without success.

Meanwhile Bill Gates was contacted by IBM, which had decided to produce their own personal computer. Gates did not have an operating system, but eventually bought a system called QDOS and renamed it MS-DOS and thus started on the path to creating the biggest software company in the World and making closed rather than open software the model for the industry.

According to Pia Heikkila,[25] IBM was forced by the popularity of the Apple computers to start their secret project "Chess" to create a personal computer:

> *'Ken Batty, marketing director of IBM's PC division, explained the rationale behind the decision.*

"Our mainframe customers kept on coming back to us saying they were using a small machines called Apple for their computing tasks and had spreadsheets and simple calculation programmes on them. So in a face of competition, we panicked and decided to bring out our own design," he said."[26]

The introduction of an open system to the mass market had an effect that must have been quite a surprise and perhaps shock to IBM. First of all the company expected to sell around 250,000 computers in the first three years, but sold more than 3 million[27], and secondly a wealth of applications started appearing from all over, and a number of competitors entered the market with IBM-compatible PCs.[28] Within a very short time computation became available to the masses, and the revolution of computation was unstoppable.

So, whereas the computer grew out of military and universities, the revolution that brought the computer to our homes and desktops was to a large degree created by idealistic enthusiasts, many of whom were motivated by the desire to fight corporate America and what they perceived as fake democracy. These were people who had grown up in post-war America with growth, prosperity and liberal parents and had lived through civil unrest, Vietnam War demonstrations and the hippie movement. Out of it had grown a strange mix of socialists, anarchists, libertarians and techno-freaks who joined forces to liberate the people through computation and communication and many of whom went on to become extremely wealthy digirati in the 90s.

With the development of the stand-alone computer two major leaps had been made in information technology: Binary representation and procedural computation based in binary logic. A new tool for manipulating information had been created, but it had yet to become a communication technology. In order for digital media to appear a means of digital communication would need to be devised.

1.1.2 Digital Communication

Since the first computers were exceedingly large and expensive, but provided calculation services that were often in demand somewhere far away, the need for communication of digital information was quickly recognized, and naturally the military was again instrumental in developments. Having been caught off

guard with way too little processing and communication power for the information needed in both World War I and World War II, the United States military was determined not to fall behind again. At the beginning of the 1950's the Cold War was being used as a rationale for increasing military spending, and the apparent threat of a direct attack on the United States from Russia led to the initiation in 1954 of the so-called SAGE (Semi-Automatic Ground Environment) project[29], which was to become one of the most ambitious engineering projects of the 20th Century. The aim of the project was to track flights over the United States territory by connecting radar and defense stations scattered around the country. The system, when fully operational in 1963, connected 24 air defense centers and 3 air defense combat stations and incorporated more than 100 air defense mechanisms. Four private companies cut their teeth on the project, and they pioneered some of the most important features of the emerging computer industry, e.g. the use of phone lines for data communication using modems that convert digital signals to analog and vice versa.

IBM was the first to bring the networking experience from the SAGE project to the commercial market. As early as 1957 the company joined forces with American Airlines to create the SABRE (Semi-Automated Business-Related Environment) airline reservation system[30]. When it was brought into operation in 1964, it connected airline offices in more than 50 cities to two IBM mainframe computers via the telephone system and handled around 84,000 calls per day.

The basic networking principles of both these and other systems at the time were, however, based on either centralized or decentralized topologies that made them vulnerable to local failures (see Figure 2), especially at the central computing sites through which all information had to pass. What was needed was a decentralized solution with a network topology that would secure a working infrastructure, even if major parts of the network went down due to power failure or enemy attack.

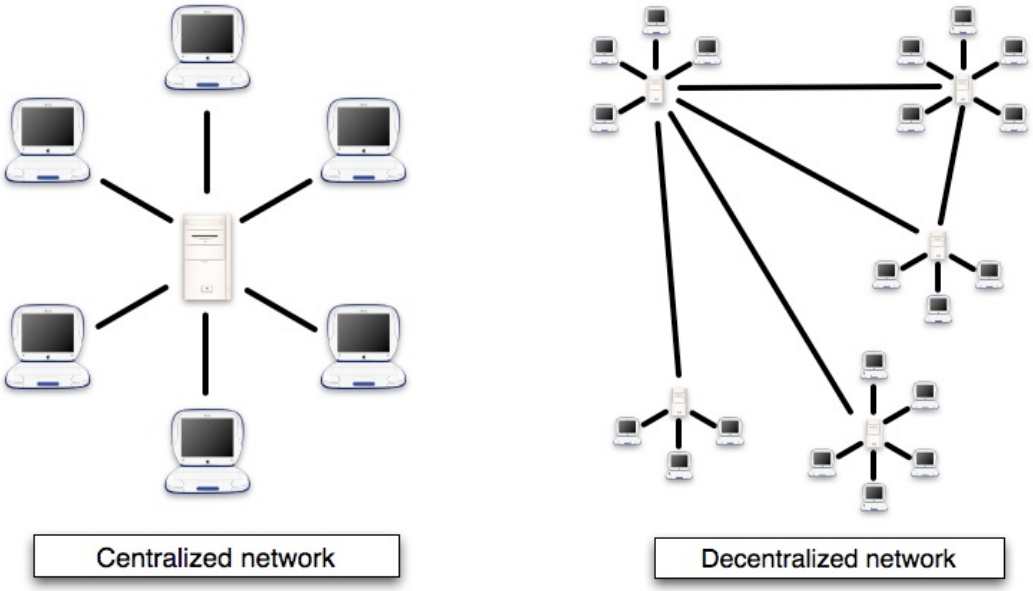

Figure 2.Traditional network topologies. Both types are vulnerable to attacks, because of the centralized hubs and single connections.

The solution to this problem was, however, already being developed – apparently almost simultaneously in several places.

In 1960 an engineer named Paul Baran was working for Hughes on the SAGE system[31]. This was at the height of the Cold War, and everyone was deeply worried about what turned out to be non-existing Russian nuclear missiles supposedly able to hit mainland US. Baran had worked with simulations of the effects of nuclear attacks and knew how devastating they could be, so he started to think about how to build a reliable command structure. Encountering the theories of neural networks, and especially those of Warren McCulloch, he realized that the topology of the brain had exactly the kind of redundancy he was looking for[32].

In order to gain more freedom in his work, Baran moved to the RAND Corporation, and here he was actually presented with the problem of command and control communications. He naturally jumped at the opportunity and soon he and his colleagues were experimenting with different network topologies. They realized that existing AM radio networks were only suited for broadcasting, and that the telephone system, which was at the time completely controlled by a not very cooperative AT&T, was extremely vulnerable due to its hierarchical, decentralized structure in addition to being

analog and thus unsuited for accurate message relaying and asynchronous communication.

The solution they came up with was to build a so-called distributed digital network in which information was split up into packages that would find their own way to the receiver. By building a certain, and actually not very great, amount of redundancy as well as some basic error detection and correction into the network, they created an incredibly resilient and reliable system.[33]

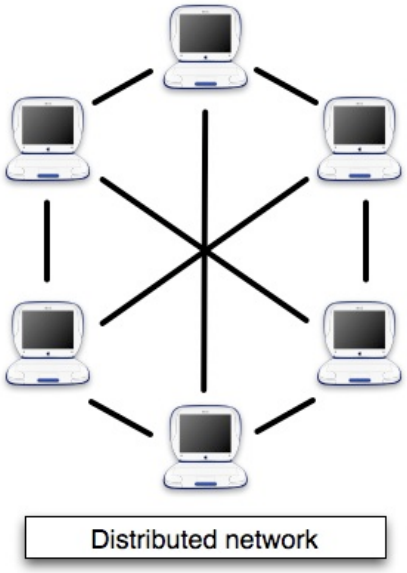

Figure 3. Distributed network. Just three connections from each node create a very high resilience.

Packet switching in a distributed network is beyond doubt the core of the genius of the Internet, but it may be a bit hard to see why at first glance. The most important aspect is that no connections are established in a packet switched network, which of course means that no connections can be broken. When information is sent from one node in the network to another, it is split up into small, numbered packages that are sent off one by one with their destination address attached. As they pass through nodes in the system they simply ask for the fastest route to their destination and follow it to the next node. Since routing maps are continually updated each package may find its own unique path through the network, and if certain parts are disrupted or slow down, packages will just route around them. In practice this means that

even if more than 80% of a truly distributed network with three or more connections per node breaks down, the remaining nodes will still be able to communicate.

Obviously, a network with this kind of resilience is highly interesting for military command structures, but at the same time it is extremely hard to control or censure. As John Perry Barlow remarks, the Internet treats censorship as a malfunction and simply routs around it. A distributed network has no center and thus no central authority or central point of control. You do not simply invade a country and take over its internet like you would take over its television stations, and the global character of the net prevents local areas from effectively upholding their own legal system concerning publication and access to information.[34]

Interestingly, Paul Baran was really never interested in systems for controlling warfare and command structures. Researchers at Rand had been studying how to end wars, and Baran's belief that abundant and reliable communication was key to this sent him off on a quest to build a network with higher communication capacity than anyone would ever need.

Unfortunately – and this is a story we could probably have heard from many of the inventors of previous communication breakthroughs – the people who had the power to actually create the network were still stuck in an analog world and simply could not understand the ideas presented by Baran and his colleagues. His first opponents were AT&T, who in addition to not understanding the proposal saw no idea in creating competition for themselves, and they were able to stall Baran for 4 years, before Rand finally convinced the Air Force to continue without AT&T. The strategy almost worked, but when the matter was then turned over to the Defense Communications Agency, which was as clueless as AT&T, Paul Baran realized that the project would fail and stall packet switched networking for at least ten years. He told this to his superiors, and the whole project was scrapped.[35]

Amazingly, all the results from the project were published for everyone to see.[36] The rationale, presumably even in the highest military circles, was that

if the Soviets built the system, they would have a better command and control structure, which would reduce the risk of nuclear war. Some brilliant and enlightened engineers understood that open communication is the key to peace, and a system originally intended for providing the Americans with second-strike capability was turned into a system to prevent war! The system they designed, but were prevented from building, was completely in line with their philosophy of communication.

There are some very important lessons to be learned from the story of Paul Baran and packet switched networking, and I believe that history has proven him and his colleagues right. To further underline this, I have included below the last three questions and answers from an interview he gave to Steward Brand and the Wired Magazine in 2003:

> *'Steward Brand: Do you ever wish you owned a patent on packet switching?*
>
> *Paul Baran: No. First of all, 17 years went by very quickly. Secondly, it would've gotten in the way of people using it. That was one of the objectives: to broaden the access.*
>
> *SB: What's your sense of when you first thought that this thing you were working on was going to take over the world?*
>
> *PB: Around December '66, I presented a paper at the American Marketing Association called "Marketing in the Year 2000." I didn't talk about packet switching, but I described push-and-pull communications and how we're going to do our shopping via a television set and a virtual department store. If you want to buy a drill, you click on Hardware and that shows Tools and you click on that and go deeper. In the end, if you have two drills you're interested in, then you hit your Consumers Union button, and their evaluation goes up on the screen. Pretty much what WebTV is. Some in the audience were furious. They said, "People don't go shopping to buy things. They go there because of the enjoyment. You don't understand women." I could see a few people going for it, but most of them were shaking their heads.*
>
> *SB: In 1966 you were foreseeing the way networks would be distributed, and you were starting to see applications. What stuff that emerged from '66 to the present surprised you?*
>
> *PB: Playing with the Arpanet as a user, fairly early on. The number of users was very small, but the rate of increase made it obvious what was going to happen. It*

was just a matter of time. No one is ever as shocked and surprised as when the inevitable occurs.'[37]

In spite of Paul Baran's negative experience with the military, it was a military institution, ARPA (Advanced Research Project Agency), which would eventually initiate the construction of the distributed, packet-switched network[38]. ARPA, unlike the Defense Communications Agency, was not part of military operations, but was focused on basic research, which of course gave it more freedom to explore uncharted territory. It had been created in response to the Soviet launch of the Sputnik in 1957, and one of its assignments was to study the use of computers in military command and control structures. In 1962 another SAGE alumni, J.C.R. Licklider (quoted at the beginning of this chapter), was hired to head this area of research, and his appointment would prove to be decisive in future development. Licklider was much more interested in the computer as a tool for communication than merely as a device for arithmetic calculation, and, as shown by the following quote from his article 'The Computer as a Communication Device', he did not share the mass media concept of communication that is still so prevalent today.

'We want to emphasize something beyond its one-way transfer: the increasing significance of the jointly constructive, the mutually reinforcing aspect of communication—the part that transcends "now we both know a fact that only one of us knew before." When minds interact, new ideas emerge. We want to talk about the creative aspect of communication.'[39]

He had grand visions of a global network with distributed computation and gave his group the nickname Intergalactic Computer Network, but he did not have any concrete ideas of how to implement it. He did, however, have a knack for leadership and for spreading his visions to his colleagues. Within a short time his department was working with 12 universities, and he instilled in all his colleagues a spirit of collaboration and openness. In a memo to the group written in 1963 he described his vision for a network of computers and urged collaboration on standards for networking, and when he shortly thereafter left ARPA, he made sure that his vision was passed on to his successors.[40]

Just like Baran, Licklider was facing traditionalist views, but in his case the main adversaries were the computer industry and the research centers rather than the telephone companies and the military. Most of his surroundings saw the computer as an arithmetic engine, and his superiors at ARPA were always questioning why ARPA should deal with computer networking issues, thinking that the computer industry would do it if it was worth doing.[41]

Ivan Sutherland, who succeeded Licklider in 1964, was more interested in computer graphics (and is considered to be one of the founding fathers of the field). He did not, however, discontinue the work on computer networks, but gave the task to Lawrence Roberts, a researcher at MIT. Roberts joined forces with Thomas Marill to build one of the first digital networks, and when Robert Taylor was hired into Sutherland's position in 1966, he convinced Roberts to join ARPA. At a conference in 1967 Roberts met Donald Davies from the British National Physical Laboratories (NPL), who had independently developed packet switching, and from whom he adopted the term. At about the same time he was made aware of Paul Baran's work and met with Baran, and there is still some controversy as to who actually created the packet switching concept that would become the basis for the Internet.

Robert Taylor had in 1966 received a one million dollar grant for the development of a computer network. Under the leadership of Larry Roberts the ARPANET was finally implemented, and in the fall of 1969 it came alive in a network of four computers. The fundamental building blocks for the network were now in place, and only one major piece was missing in the creation of the network of networks known to us today as the Internet. The ARPANET provided the basic, semi-distributed network structure, but its Network Control Program (NCP) did not possess the openness and efficiency needed for inter-networking with other networks. In 1973 Bob Kahn and Vincent Cerf designed a new protocol called TCP, which would later be split into TCP and IP, but still forms the basis for the vast majority of communication on the Internet.

The rest, as they say, is history. Numerous networking issues of course still remained to be solved; protocols, tools and applications had to be developed, other networks integrated etc, etc, but the fundamental pieces for a resilient, (at least partly) distributed, digital network had been created, and thus the

foundation for global many-to-many communication, collaboration and digital resource sharing had been laid. A number of the different developments will be discussed in later sections, but for the purposes of describing the foundations of digital communications the story so far ends with the advent of the ARPANET and its subsequent connection to other networks through TCP/IP. What is, however, important, is the fact that the Internet has managed to maintain its distributed and democratic structure, both in terms of technology and in terms of governance. The original spirit of the Internet has to a large degree prevailed in areas such as protocol development, domain name control and conflict resolution, and vigilant defenders of free speech on the net like the Electronic Frontier Foundation have several times succeeded in stopping government bodies from curtailing developments. In spite of the obvious commercial and political interests in controlling the Internet, it fundamentally remains a technology outside centralized control, and today the net has arguably grown to a size and ubiquity that puts it beyond control of any political or economic entity. We owe this extraordinary situation to the work of numerous dedicated people, but above all we owe it to the visionaries of the mid-60s who laid the technological and cultural foundation for open, distributed and highly resilient networks. In the interplay between culture and technology the earliest developers created the genetic makeup of the Internet and to a large degree set the stage for the culture and values that have developed around it.

The World-Wide Web

From the vantage point of 2008 one might expect a prominent place reserved here for the development of the World Wide Web. Yet, although it is true that it was the web that brought the Internet into most private homes, and that the web has had a tremendous impact on society, it represents no truly qualitative development in digital communications. Nevertheless the web and its history provide an interesting perspective on the interplay between old and new in times of transition, and of course a history of digital communication would be incomplete without the story of how the Internet finally broke through to the masses.

We have seen how both the PC and the Internet grew out of at least the fringes of academic environments, and the same applies to the web. The inventor of the Web is the Englishman. Tim Berners-Lee, and his book, *Weaving the Web*[42], reads like a textbook example of skunk-works innovation – and its perils.

In 1990 Berners-Lee was working at the European particle physics research center, CERN. As the son of one of the computer pioneers, Berners-Lee was very early on confronted with the question of how the computer's way of storing and retrieving information could be made to resemble that of the dynamic human brain rather than a file cabinet, and it led him to focus on links rather than entities. He writes:

> *'In an extreme view the World can be seen as only connections, nothing else. We think of a dictionary as a repository of meaning, but it defines words only in terms of other words. I liked the idea that a piece of information is really only defined by what it's related to and how it's related. There really is little else to meaning.'*[43]

Working at CERN, first as a consultant in 1980 and later in a fellowship, he was confronted with a chaotic and innovative organization with a multitude of incompatible computers and software systems. In his fellowship he was actually hired to create 'data acquisition and control' programs for research experiments, but over the years he saw an increasing need for networking all the related information in this dynamic and non-hierarchical place. When the Internet finally arrived at CERN, Berners-Lee saw an opportunity to create a network-based version of the hypertext program he had been dreaming about, and in 1990 he finally got approval from his superiors at CERN to go ahead with the project.

During the course of the next eight months he and his colleagues developed the basis of the Web we know today. They created the HypertText Transmission Protocol (http) to exchange web documents over the Internet, the HyperText Markup Language (HTML) for formatting web pages, and the Universal Resource Identifiers (URI) that would allow a link to address any kind of internal or external resource directly and ensure the decentralized structure of the web. At the same time they did a considerable amount of internal and external lobbying for the new system.

Berners-Lee had a vision of a global web, but he was very aware of the fringe character of his project within CERN. No one at CERN had asked him to create a worldwide web, and he continuously had to think of the specific internal value of the system and its possible threats to existing structures. He had sold the project as a new way of organizing existing information (in fact the first widely used data on the system was the internal phone book), and one result was the development of browsers that did not have editing capabilities. This was, in fact, counter to Berners-Lee's vision of '*a system in which sharing what you knew or thought should be as easy as learning what someone else knew*'[44], and we are still living with the consequences! From the perspective of today one cannot help but be amazed at the degree to which such early design decisions can come to affect the lives of millions of people. The consequences range from the small things like living with the www, html, http, and URL acronyms to the truly momentous fact that the web even today is infinitely easier to browse than to publish in.

The Web was based in a visionary and very internet-true idea. Few people other than Berners-Lee seemed able to grasp the scope of the idea, but at CERN it was possible (though not easy) to bring it to life. However, being developed as a skunk works project within an established organization with existing systems and ways of doing things, the web was forced into compromises and conformity with older documentation systems based in type setting. In fact, in spite of its noble vision, the web in more ways than one came to represent a retroactive development, driving the Internet back in the direction of mass media.

This conservative approach may, however, have been one of the primary reasons for the success of the web, because it helped bring two alien worlds closer to each other. And other early decisions were crucial for the continuation of the growth and development of the web. The decision to make the system completely decentralized allowed the grass root growth, and the requirement to make it able to access absolutely any type of file and information allowed it to rapidly grow beyond the bounds of HTML and incorporate both existing data and new features. Even the focus on information retrieval was probably more in line with the perceived needs of

people at the time than a creation of a full, intuitive editor for web pages. The web is under continuous development and change, and it may end up being a true many-to-many communication tool, but for now it represents the apex of the struggle for dominance and survival of the old mass-media paradigm, and it is very important to bear in mind that the Internet was and is much more than the World Wide Web.

So, from a slow start in the world of science, computers and digital communication were propelled by hot and cold wars into the hands of governments and large corporations and spread to the general public by a strange mixture of rebels, businessmen and entrepreneurs. Within a period of less that 60 years computers have become an indispensable part of society and changed from giant number crunchers hidden away in processing centers to a global network of communicating, computational artifacts ranging from supercomputers to smart thermostats and present in virtually every aspect of daily life. Things have moved with an unprecedented speed, and one might be tempted to think that the digital revolution has come and gone. But how does it look if we take a larger perspective?

1.2 Change in the Making

In 1510, 60 years after the invention of the printing press, book printers were still trying to emulate hand-written books, piracy in the form of illicit copying of books was rampant, and copyright was still two centuries off[45]. Governments and church were scrambling to figure out how to deal with this new phenomenon, which had not only multiplied the number of books in Europe, but made literature available in local languages and outside of political or religious control. Society was barely beginning to adjust to or even recognize the changes: The Reformation was still years off, no proper school system had developed, the Catholic Church had yet to instigate its infamous index and the Spanish Inquisition, and even the notion of authorship was only in its earliest days. Book printing was in its infancy, and no one would at this time have been able to predict the vast political, cultural and economic changes that Western society would experience as a consequence of this new technology. Yet, the struggle was on, and there was no turning back.

Today, 60 years after the first computers were created, we are in a very similar situation – only this time the technological disruption is at a much more fundamental level than in the 16th Century, and we are just beginning to glimpse the potential consequences. Change is inevitable, but where it will lead and who will benefit is certainly an open question. What we do know is that the struggle is heating up, and that quite powerful forces are being mobilized on all sides. Just like 500 years ago governments and organizations alike are ambivalent in their embrace of the new technology; on the one hand attracted by the new opportunities, but on the other hand worried and confused over the threats of disruption and subversion posed by many-to-many communication.

When witnessing the encounter between tradition and a completely new mindset it can be very difficult to tell which is which. What may look like a revolution from one side may very well seem revisionary from the other, and trying to consolidate the two views can be impossible. And in the case of digital communication it is particularly difficult, since digital technology changes every aspect of how we deal with information and communication.

1.2.1 Emerging Patterns of Communication

We are still in the early days of especially Internet development, but a number of increasingly successful systems are beginning to demonstrate the power of digital communication. Some of them are quite rudimentary, and we must expect some much more sophisticated solutions to appear as our mindset and technologies mature, but we can pick up some clues from existing systems.

Getting Information and Other Stuff

A little more than a decade with the World Wide Web has fundamentally changed the way we obtain information. Newspapers, phone books, encyclopedias, brochures, dictionaries – virtually all information sources are loosing their physical presence and being transformed to co-exist in one large information pool accessible from anywhere and with an ease that was unthinkable for most people just ten years ago. And not just information is affected. An important reason why we go to stores is to browse and get

information about physical products that we intend to buy. We are accustomed to this and therefore still tend to see it as an important social function, but the ease of purchase, the wealth of product information from customers and companies alike and the very competitive prices on the net make it impossible to ignore. As a consequence our identity as a shopping creature is transforming and the whole retail sector is undergoing drastic changes. People who have broadband access to the Internet find themselves less and less dependent upon other sources of information. The news on the net are newer and more facetted than those in their newspaper or on television, Google provides instant answers to just about any question, Amazon has many times more books than the local book store and at a cheaper price, online auctions can provide anything from baby beds to recreational islands, and why go to a travel agent, when you can book flight, hotel and car at discount prices from your living room?

Some Internet initiatives merely mimic normal stores and information providers, but little by little new models have emerged and shown their superiority to existing ones:

Search Engines

Given the vast amount of unstructured information on the web it was inevitable that search engines would be subject to great academic and commercial interest, and the winner so far, Google, is becoming a force that no one can afford to ignore. Entire books and theses are being written about Google and its effects on the net, so I will keep it simple here and just note, that Google uses the power of communication and computation to change the way we find information.

When the printing press emerged, a whole new set of ways to structure and retrieve information was needed. Alphabetic ordering, subject classification, and indices were all created to facilitate structure and search, and we have been living with them since. So if we wanted to find information before the age of computers and internet we would have to think in terms of subject and be very analytical in our approach. We would then have to find the appropriate book and look up the answer.

Today we simply type our question into the Google command line and usually we are provided with thousands of, often conflicting, answers. Alphabetic ordering makes little sense in this environment, and even category structuring as in e.g. Yahoo is rapidly loosing its relevance. We simply don't need categories when we can get the answer to our question directly, but we are discovering that we probably need a new set of rules and tools to help us make sense of the anarchy out there. Like the publishers and other book people of 1510 we need to come up with models that can somehow encapsulate the new world and help its most valuable aspects to survive and prosper.

So far, Google seems to be on the way to becoming the behemoth of information search. The mission of Google is *"to organize the world's information and make it universally accessible and useful"*[46], and the company is incredibly successful in doing just that – and making money at the same time. Having acquired a dominating position in the area of text search, Google has turned to images, videos, automatic translation, geographically based search (not to mention its wide range on non-search related services), and there are no signs that the company will run out of good ideas any time soon.

Within a period of less than five years Google went from being completely ignored by the business world to being an indispensable element of their marketing strategy. Google and other search engines have managed to put product and user rather than company and sales channel at the center, and the struggle to appear at the top of relevant searches is now so intense that search optimization companies are among the highest paid consultants in the IT business.[47]

The battle for keyword search space points to a fundamental issue with computational communication. During the good old days of classified adds in the newspaper getting mentioned first was simply a question of being first in the alphabet, but with Internet search engines it becomes a matter of understanding and exploiting algorithms. Companies and individuals have a natural interest in appearing as high as possible on the lists, while search engines (at least presumably) wish to provide the most relevant answer

possible to a query, so all parties engage in a never-ending struggle to outwit one another.

Another issue is that of accumulation of information. Imagine the power wielded by someone who knows every question asked, when it is asked, and by whom, and you are only beginning to grasp the power of Google. Obviously the entity that organizes all information in the World and has full control over access is in a very powerful and potentially destructive position, and one cannot help conjuring up images of George Orwell's Big Brother as done in a 2007 report researchers from Graz University[48]. It may very well be, that the founders of Google have only good and pure intentions, but the road to hell is paved with good intentions, and it takes little imagination to envision the situation where for instance the US government uses national security interest to gain access to detailed information about user behavior.

Fortunately, nothing happens on the Internet without someone else having an opinion on it, and Google is under continued surveillance by the likes of google-watch.org, which pursues every likely and unlikely theory of abuse.

Retail Shopping

In retail, attention is moving from the store to the product. Traditionally you go to your favorite shoe store to buy shoes. You might shop around, and you may even find your shoe of choice cheaper somewhere else, but usually you will just pick a store, browse around and end up making your purchase there. Internet services like Kelkoo reverse the shopping process by allowing you to search for a product across many sales channels – basically in exactly the same way that search engines provide you with information across information providers. Real-world shopping malls are still used for browsing products, but increasingly people just find what they want in the shops and then buy it from the cheapest retailer on the net. There is no way that the shops can compete with a virtual store that holds no stock and is run almost without personnel, and although our shopping habits die hard, the entire retail sector is starting to feel the pressure. Net-based retail business is still in its infancy and has a long way to go to reach the kind of service we have a right to expect, but consumers are buying everything from gadgets to real estate,

trading across borders and continents, and generally getting a better deal. According to the US Census, e-commerce in the third quarter of 2008 accounted for more than 3% of the entire retail sales with a turnover of more than 34 billion dollars in the States[49].

It could have been very different: In 1994 I got my first taste of interactive television with 'Main Street' from GTE. Generally a completely useless service for someone who already had Internet experience and access at home, 'Main Street' provided a great example of what a proprietary Internet could have been like. The ads for the service said that you could be your own travel agent and find great bargains on travel on 'Main Street', but the service invariably came up with the American Airlines full fair price as the first and cheapest choice. I could save more than 50% in 5 minutes by calling a back street bureau in town! Needless to say such services have had little success since the web kicked in. There have been many of these attempts to use old paradigms in the new, digital environment, but like Neanderthals faced with the Cro Magnon they have been doomed from the beginning.

This does not mean that large corporations will not come to dominate retail business on the net. Like in the physical world the net is seeing an ever increasing consolidation, and there are times when it seems that the net will come to resemble the real world of free market capitalism with all it entails of big corporations, monopolies and usurpation. As the net becomes a market place, the original idealistic internet spirit of sharing and openness seems to recede in favor of dog eats dog, but fortunately we are still in the early days of electronic commerce, and the outcome is far from certain.

Business to Business

Even worse off than traditional retail business is the traditional wholesale industry, which is rapidly being replaced by software solutions that allow manufacturers and retailers to deal directly with each other and even integrate their whole supply chain system. This, in fact, is the area where we see some of the most innovative developments with the most immediate consequences. The competitiveness in the world of commerce is forcing the players to utilize digital communication to its full extent to optimize their logistics, and the result

is that the distinction between competitors and collaborators is becoming increasingly blurry.

Online auctions

A traditional auction takes place in real time and one has to be present personally or by proxy to bid. An auction is a social event and being able to examine the merchandise and feel the mood of the crowd is considered an important part of the purchasing experience. At the turn of the millennium it was basically inconceivable to the average auctioneer or auction attendee that things could be otherwise, and upstarts like EBay were considered to be in a completely different league and pose no threat whatsoever to serious auction houses. Today the traditional players are all scrambling to catch up and finding that online trading provides completely new opportunities and customers.

Online auctions typically last days rather than minutes. There is no auctioneer pushing things along, and prospective bidders can examine other offerings at their leisure. In most cases the auction site provides no evaluation or price estimate of the item up for sale, and anyone can put items on the list. The role and revenue model of the auction firm as a middle man remains the same, but the process and environment are entirely different and allow a much greater and more varied part of the population to participate.

Sharing Information

Finding information smells a lot like mass media society with its choice of channels, and we must look to our ability to share information with others to see indications of a true revolution in the making. You might say, that the web is all about sharing information, but publishing on the web is considerably more difficult than browsing it. Creating and publishing a web site is, of course, neither rocket science nor very expensive, and millions of private citizens have created their own sites that are read by anything from zero to thousands of people. In my research for this thesis I have for instance made extensive use Lawrence K. Lo's excellent web site ancientscripts.com, and several other private sites have found their way into this book. The truly

distributed and democratic nature of the web makes it the first large example of many-to-many communication over time, but it has come to be more and more dominated by commercial operations that can afford to keep up with the rapid development of search engines and other technologies and thus cause more personal contributions to disappear into the deeper recesses of the network. Luckily the spirit of the digital idealists seems to prevail, and private web sites within special interest areas continue to flourish and provide information that matches or surpasses the best encyclopedia in accuracy and currency.

Email, Usenet and Blogs

Obviously email is and has always been one of the mainstays of the net. As the name suggests email is modeled over normal mail and was created for people to send messages to each other, but the fact that you can as easily send a mail to thousands of people as to one makes email a very powerful tool for sharing information. Movements are created, rumors spread, scams flourish, and emergency relief is organized through email, making it both a blessing and a curse of the digital age. The most important aspect of email is probably that it enables us to keep in daily touch with a vastly greater number of people wherever they may be, and one might hope that it stays that way. Since email is a push technology that tends to demand attention, time and response, it serves us best as basically a one-to-one communication tool rather than a many-to-many information sharing application. So in spite of it being widely used for information dissemination I will leave it and other one-to-one communication tools like chat rooms and instant messaging for now and turn my attention to more proper sharing tools.

Where email is person-oriented, Usenet newsgroups were created to facilitate public communication about specific subject matters[50]. Newsgroups reside in a distributed system of servers that keep each other updated at all times and thus create a distributed storage system with great redundancy and resilience. Users can subscribe to and publish in groups that are organized in a fairly dynamic hierarchy of subject matters, and they can also create their own groups. Newsgroups thus provide a place to find people who share your

interests, keep up with the latest developments in a field, have public discussions, and acquire help from specialists. The self-organizing character of Usenet makes it a chaotic and anarchistic service with newsgroups about the most absurd subject matters, frequent violent disagreements (called flaming wars), and widespread spamming. Some groups are kept in control by a moderator, and over the years various systems for organizing the immense amounts of information have been developed, but Usenet is perhaps past its prime and in the process of being overtaken by other technologies. Nevertheless, traffic has been increasing steadily since the early beginnings in 1979 and is today a whooping 2 terabytes per day.

To some degree Usenet newsgroups have been replaced by web-based discussion forums that are very similar to newsgroups in structure, but often require community membership. Recently these forums have become an integral part of suites of web applications developed for collaborative work. A number of intranet applications for shared files, calendars, news, task lists etc make it possible for groups of people to share and collaborate flexibly over distance and time and are becoming part of everyday life for project workers around the world.

On the more personal side people have been writing diaries and keeping logs on the web almost since day one. Web logging as a separate activity came into existence in 1999 when the term blogging[51] was coined and the first blogging tools were published. Since then blogging and its sibling, Twitter, have become favorite pastimes for a growing community of devotees around the World and an increasingly important factor in both politics and media coverage. In 1999 blogging gained fame, when bloggers started a process that led to the fall of US Senate Majority Leader, Trent Lott. In a speech at the 100th birthday of 1948 presidential candidate and segregationist Strom Thurmond, Lott said that if Thurmond had become president the United States could have avoided a number of its current problems – a remark that could be seen as advocating racist policies. Mass media did not pick up on the story, but political bloggers started gathering evidence of other racist remarks by Lott and fairly rapidly raised a so-called blogstorm, which eventually forced Lott to resign.

Blogs enable ordinary people to give their own view of e.g. current events, and they have turned out to be an extremely effective tool for exposing frauds or creating movements. The following three examples show, how blogs and similar systems can and will influence business, politics and consumer power.

In 2002 journalists and avid bloggers Dan Gilmor and Doc Searls were in the audience when Qwest CEO, Joe Nachio, spoke self-pityingly about the woes of his company and its crashing stock[52]. Since the conference hall was equipped with wireless Internet access Gilmor and Searls were able to blog live, and the audience was able to read their comments while listening to the speaker. Gilmor and Searls criticized Nachio for lamenting his company's problems while he was apparently cashing in by selling stock, and within minutes a lawyer from Florida had sent both of them a Yahoo link showing that Nachio had earned 200 million dollars recently by selling out of his stock. They both wrote this in their blog and the mood in the hall very quickly turned hostile towards the hapless executive.

When the CBS show 60 Minutes in 2004 showed documents purportedly proving bad conduct by President George W. Bush, Jr in the military, bloggers almost immediately questioned the validity of the documents. Within days they had raised up a media storm, which eventually caused CBS to apologize and fire the producer of the show[53].

The Kryptonite story is interesting from several different perspectives[54]. Kryptonite bicycle locks from Cambridge, Massachusetts, has long been famous for their strength and durability, but already in 1992 the British magazine, Bicycle News, published an article describing how tubular locks like a number of those sold by Kryptonite could be opened using a simple, deformable plastic tube like for instance a Bic pen. No one seemed to pay much attention to the article, but when Chris Brennan published the 12 year old news on bicycleforum.net, the story was quickly picked up by, in particular, bloggers, who put up videos and personal accounts of the Kryptonite weakness. Within days the Kryptonite Company was forced to react and offer an exchange of all the faulty locks, but even though they reacted quickly they were unable to prevent a class action lawsuit filed in September 2004. The result was that lock owners were offered a free exchange of their lock and up

to 3000 dollars if they could prove that their bike had been stolen due to the lock deficiency. The lawyer made 690,000 dollars, and Jim Gardner, who runs bicycleforum.com, had to put up 1000 dollars from his own pocket to pay for the increased load on his web site.[55] Clearly the legal profession is not one of the first to be threatened due to digital media!

There are many more stories about the increasing role of blogs in politics and commerce, and they clearly show both the advantages and the perils of journalism without editors. Sites like daypop.com and Slashdot.org that monitor the blogsphere to find the most written about subjects and the most read stories contribute to making sense of a seemingly chaotic news stream, but also to amplifying popularity of specific items to a degree that is often not warranted by their importance.

Peer-to-peer Systems[56]

Where email resembles the postal system and blogging is somewhat like massive mass media, the so-called peer-to-peer (P2P) systems (of which Usenet is in fact considered the first) simply facilitate the sharing of information between large numbers of users. The P2P craze started with the development of Napster in 1999, which may seem strange to some, since Napster was in a sense less peer-to-peer in nature than the web itself, because it relied on central servers to keep lists of available files – something that Berners-Lee had carefully avoided. But Napster first of all added a search function with templates for specific category searches and made it extremely easy for people to share files. Sharing was already fairly easy in for instance FTP servers, but in Napster a file in your shared space immediately became part of the overall selection for everyone else. Apart from this, Napster was obviously the right thing at the right time, and it will no doubt in the future stand as the first true challenge from the net to established industry.

The fact that Napster was based on a centralized indexing system allowed the, by now seriously worried, recording industry to pursue the company for copyright violation, and eventually Napster disappeared – only to be replaced by Gnutella, Fasttrack, and Bittorrent which are truly distributed systems that allow people to access files on each other's computers over the net without

use of any intermediary databases or indices. They pose a more serious threat, because they cannot be closed down, and only individual users can be pursued for copyright infringement. With somewhere around 10 million simultaneous users at any time of the day on sites like piratebay.org chasing each one down is obviously quite a task, and the media have been conspicuously silent about some of these services for some time now!

The only recourse for the recording industry was to go after the distributors of client software, claiming that they not only enabled, but also encouraged copyright infringement. The largest of the client software providers was Kazaa, a small Scandinavian company, which had the unique experience of turning down a lucrative purchase offer only to be tangled up in interminable court cases.

From Information Sharing to Collaborative Creation

A number of applications lie on the borderline between information sharing and collaborative creation. Sites like Slashdot and Daypop at least partly qualify as examples of collaborative creation and constitute a very interesting alternative to news agencies and newspapers. Emerging trends, stories or scandals, especially in the technology sector, very quickly find their way to these sites, and once a sufficiently interesting story has hit one of the main sites there is virtually no way of stopping it.

Early experiments with collaborative filtering have made their way into mainstream sites. In 1994 Pattie Maes[57] and her research group at MIT Media Lab created HOMR (Helpful Online Music Resource), a system that allowed people to register the CD collections and their most recent purchases. Based on this information HOMR was able to let users know what other people with similar preferences and buying habits were currently buying, helping them to make purchase decisions and form communities of interest. Pattie Maes later funded Firefly to commercialize the technology, and the company was eventually bought by Microsoft[58]. The advantages of this type of systems were obvious, and it was not long before commercial operators started creating their own versions. The most famous example is Amazon, where every search and purchase is registered, and on the basis of this

information alone the system is able to give remarkably accurate recommendations and special offers to its users. In fact so good, that most people do not bother to enter a personal profile into the system to improve its performance.

Collaborative Creation

In the spring of 2000 I consulted with the editor of the Swedish National Encyclopedia, which was trying to figure out how to deal with the digital distribution and presentation of their data. When I suggested that they should simply make it freely available on the Internet with an engine that allowed everyone to make their own contribution, he was completely flabbergasted. The encyclopedia was written and reviewed by the best academics in the field, and of course there was no way that ordinary people could make constructive contributions. Apart from that, 95% of all encyclopedia searches were for facts, so the opinions of layman would have little meaning. He in no way felt that a first hand account by a Malmö harbor worker of the escape of Jews from Denmark to Sweden during the Second World War[59] might be more interesting and perhaps even truer to reality than the carefully researched facts from a historian working 50 years after the events. My proposal of course went nowhere.

This is by no means an isolated incident. The idea that only some people are capable of telling others the correct story about an event, a technology, a place or a person has been with us for centuries, and it does not seem to be willing to die without putting up a fight. We have divided our work places into layers of leaders and workers, our schools into teachers and students, and our societies into politicians, bureaucrats and citizens, At every stage and virtually every activity in life have we become accustomed to leaving decisions to the experts in the belief that they know better than us. And no one is more certain of it than the expert. Her expertise is her identity, and there is no doubt in her mind that knowledge can only be created by experts or groups of experts. As a colleague of mine, who was supposedly an art expert (interactive art – no less) remarked to me: ‘But Michael; if you allow everyone to make art we will just get bad art!’ So it is no wonder that when information

sharing started to become collaborative creation on a large and public scale, the experts were quick to remind us that it would never work.

Most co-creation projects have been created as non-profit initiatives in the spirit of the hackers and Internet pioneers we have met earlier, and the most widely known example of collaborative, digital innovation and production is of course open source software with Linux as the most prominent example. Although the term 'open source' did not appear until 1998[60] the open source movement has its roots in the hacker movement of the 60s and 70s, and its success is the first real testimony to the viability and superiority of both small- and large-scale collaborative development.

There are two important elements in the open source idea: The first is that software should be free of cost, and the first major example is the collaboration between a number of universities in the 1970s to create a version of the UNIX operating system free of AT&T corporate control and profit requirements. The second and vastly more important element states that open source software should not only be free to use, but open and free to modify. This principle was first stated by the Free Software Foundation in the GNU Public License of 1989[61], and it remains the cornerstone of the fight against the limitations to software development imposed by secrecy, copyright, patenting and other proprietary practices. Linux today is a serious competitor to other operating systems, especially in the server market, and Apple for instance has based its latest operating system OS X on a free Unix core and made large parts of its systems available as open source. Recently IBM has embraced the open source movement and, as a gesture, the company has released 500 of its thousands of patents to free usage by the open source community. Even Microsoft has launched its own open source initiatives.

The open source community continues to develop in size and sophistication, and its interaction with the traditional business systems is as clear an example of the struggle between old and new as you can get. The conflict goes all the way back to the fights between Bill Gates and the Homebrew Computer Club described on page 18, and it is still about the same thing: How do you make a living off of something when it is free? Opinions vary widely within the

community, and novel solutions in more or less conformity with the various open source licenses pop up at regular intervals[62]. It is a precarious balance, but survival seems to be ensured, because it turns out people are willing to pay for convenience. You cannot charge for open source software, but you can charge for the packaging, the manual, the hotline and applications built on top of open source software, much in the same way that you may not be able to charge for entry into a public park, but you can charge for the ice cream and the entertainment.

Now, one might think that open source software is simply an ideological idea spawned by an anarchistic community. But whereas it is certainly a cultural construct, I believe that it was inevitable due to the character of software. Programs to a large degree are built as layers of modules like LEGO bricks, where each module performs a more or less specific function. But, unlike LEGO bricks, software modules can be freely copied and modified to fit slightly different needs, and there is no incentive to build completely new modules from scratch when 80% of the work is already done and can be used without loss to the original developer. In this sense software programs are very similar to ideas, and we might apply the same arguments to software as those applied to ideas by people like Thomas Jefferson[63].

What applies to software applies to every form of digital information, and we should see the open software community as the vanguard of a whole new culture of sharing and co-creation in the digital domain. And the place to start is of course with knowledge.

The founder of Wikipedia.org, Jimmy Wales, dreamt of a world in which every single person on the planet is given free access to the sum of all human knowledge, and his deeply idealistic project is well on the way to proving encyclopedia and newspaper editors around the World wrong[64]. The idea behind Wikipedia.org is really quite simple. Created in 2001 it is a global encyclopedia and dictionary that can be accessed and modified by anyone, which means that no entry is sacred. If you are not satisfied with the presented information you simply change it, and the only censure in existence is against outright destructive behavior. Nevertheless the Wikipedia is rapidly turning out to be a serious competitor to the large encyclopedias, and in

October 2008 more than 10 million articles in more than 250 languages had been posted. The graph below shows, how Wikipedia, like other successful community sites, grew exponentially for the first five years, and now is experiencing a steady, linear growth.

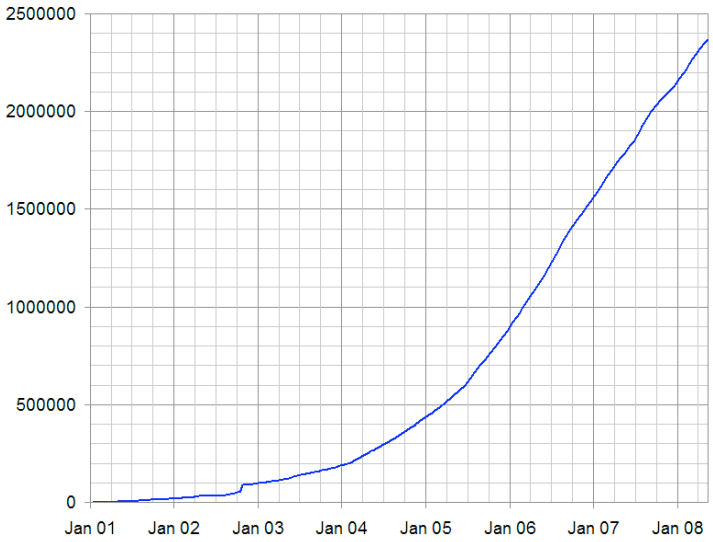

Figure 4. English-language Wikipedia Article Count - Jan 2001-Jan 2008[65]

Wikipedia.org demonstrates several important principles. First of all it shows the amazing energy, commitment and enthusiasm that people all over the World display when given the chance to contribute. Secondly it shows that a culture of quality and constructive interaction can emerge as a self-organized system with virtually no top down control and only a simple principle of interaction. And thirdly it indicates that our notion of authorship may be rapidly eroding.

Wikipedia is an excellent, yet simple example of collaborative creation, but in terms of many-to-many communication and proper exploitation of the net it has several flaws. First of all it does not provide any direct communication between users, and secondly all Wikipedia data are stored in a central database. This means that a central authority at least in principle retains control over all information and communication in the system. A certain degree of, albeit seemingly quite benevolent, censorship is exercised, and the system is vulnerable to breakdowns as seen in October 2004, when the system was running extremely slowly due to 3 servers being down.

In a world of overabundant and ever increasing amounts of information the main issue is not finding information, but finding the right information in the right quality – a problem not yet solved in current file sharing systems. In a world of mass media, the information we receive is to a large degree selected by others. Numerous, more or less centralized filters are in place to ensure us the best or most relevant information, and we have placed an implicit trust in them. In the book market they are agents, publishers, bookstores, librarians, and school teachers who will all claim that they are necessary experts in the selection process. They are part of a highly complex market mechanism in which some books become bestsellers, many more disappear rapidly into oblivion, and a few end up as what we call classics. Over the centuries only a minute portion of publications have survived, and we more or less blindly assume that the selection mechanism ensures the survival of the best books. Yet, we really know very little about these mechanisms, and our grounds for trusting their fairness are at best questionable. But there is a certain comfort in relying on professionals to choose for us. As long as we trust our institutions, publishers, newspaper editors and broadcast media we can live with this arrangement, and it has the great advantage that it promotes a shared understanding among the population. Centralized control of the media supports cultural and political unity, whether the news are trustworthy or pure manipulation, whereas in a world where everyone has access to publishing, issues like trust and reliability become much more apparent and complicated.

Insofar as trust and reliability can be defined unambiguously these issues can be solved through computation, and a number of solutions have sprung up during recent years. The so-called reputation technologies usually rely on users to provide the evaluation of contributions as well as contributors, but unlike for instance Wikipedia they introduce a computational element to the equation. In systems such as epinion.com, contributions and contributors are rated by other users, and users can actively choose who they trust based on the usefulness of their contributions. In this way individual users build individual trust circles and contributors gain or lose reputation. Both of these factors influence in what order reviews are given to users, and in epinion.com they even form the basis of a system of monetary rewards for reviews. You

can write a review, and others can read it, but you are only paid when your review helps others in coming to a decision.[66]

1.2.2 Distributed Storage and Computation

One of the great advantages of digital networks is the ability to distribute both storage and computation. P2P networks provide examples of distributed storage systems, where files can be kept and shared by all clients on the network ensuring that a given file is available even if the originating host or client is off line. This architecture is obviously much more resilient than a server-based system, but while the high redundancy provides a high level of assurance against data being lost or unavailable, the fact that files can be found on client machines renders the systems vulnerable to censorship. People advocating free speech on the internet have thus come up with a variety of solutions to not only secure redundancy, but also to protect single users from persecution.

One such system is Freenet[67], where files are continuously passed around the net without any of the nodes being aware of what is being passed through them. Nodes can keep a copy of files for redundancy purposes, but will normally just pass them on to keep them alive. In this way a file can be kept available without existing in any one place for longer periods of time, and file encryption can ensure that only the users and not the relayers of information are aware of its contents.

Nevertheless, since the files are kept in one piece, systems like Freenet are, at least in principle, vulnerable to attack at any given location. Information can be found and decrypted, and the holder of the file at any given time might be held accountable. Not so with systems like Pasta[68] and CFS[69] where the files themselves can be split up and distributed over the network and thus only exist when retrieved by users. In principle this means that you can have libraries of e.g. pirated copies of films where none of the films exist in any one location, and no users can be held accountable for the information they hold on their computer, since it is just a bunch of garbled data with no apparent reference or structure.

In fact, this type of storage closely resembles our best guess of how the human brain retains information, and the metaphor holds when we extend from storage to computation. It has long been known that the sequential, single-processor way of computing is far from the most efficient way of dealing with complex problems or large amounts of data, and over the years a number of models for splitting computation up into separate, simultaneous tasks have been developed. The simplest version is exemplified in the much publicized SETI@Home project[70], where data from space observatories around the world is distributed to thousands of computers where computing time has been volunteered. Each computer uses its idle time to perform calculations on small packages of data registered with the time, place, angle of view etc of the observation with the ultimate goal being to find signals from extraterrestrial life. The project is looking for patterns, correlations and regularities in and between very large data sets, so each local computer plays just a minute part, and, of course, no individual computer will suddenly jump up with a heureka. Yet, the project would never have been feasible without this massive parallelism, which marks a whole new form of global collaboration.

In the case of SETI@Home the final analysis and the collective data are centralized, so in terms of a completely distributed system of intelligence we are pretty far from the goal, but a picture of the internet as a brain with truly distributed data collection, computation and storage is slowly emerging, and chances are that we are in for some interesting surprises as the net comes to resemble our own brain more and more.

1.2.3 Existing Communication Technologies

New technologies hardly ever replace their predecessors, but they often influence them in profound ways. There is no reason to believe that digital technology will make photographs, books or films obsolete either, but it challenges these and all previous communication technologies at virtually every level and is already now causing profound changes in the way we deal with media.

Print Media

> *'For those who value the life of the mind, even word processing unvarnished and unconnected is surely as profound an invention as the alphabet and the printing press.'*
>
> Paul Levinson[71]

The changes brought about to the production, reproduction, distribution and presentation of text by digital technology are in themselves sufficient to justify the claim of a digital revolution. The printing press, which basically changed only the reproduction of text, revolutionized the World, but digital technology changes virtually every aspect of text processing. With standard computers text is normally entered through a normal keyboard, but both handwriting and speech recognition are rapidly gaining ground, and the computer can also be used as a tool for sketching and ordinary longhand writing. Once entered, typed text is fully editable and searchable and standard word processing software today contains fairly advanced layout and language checking facilities. When the text has been finalized it can be distributed around the world or shared via the web within seconds – still in an editable format, which means that it can be modified and redistributed by others. It can of course also be sent directly to a printer to be produced as a book, and today several companies offer print on demand with a fixed cost per copy[72].

This basically means that virtually every function hitherto performed by printers and publishers has become or is becoming obsolete. We still need machines for printing and binding books if we wish to read them in the traditional format (which definitely has its advantages), but in principle we are able to write, reproduce, distribute and sell or share our literary works on our own or in collaboration with others down the street or on the other side of the globe.

This has obvious and immediate implications for every industry making its living off written material and, indeed, every activity involving the production and distribution of text. We first saw this in the work place where word processors rapidly replaced typewriters and during the 80s and early 90s entire work flows were revolutionized and professions such as traditional typesetters suddenly found themselves obsolete[73]. Digital distribution was

already gaining ground before the Internet gained serious momentum, but once the web started growing the impact went deeper and entire industries became threatened.

Now, there should be nothing new to you in all of this. We have all taken part in this development over the last few decades, and the success of the web is a clear testimony to the power of digital text. In my view, however, the potential consequences of this fundamental change in the production and distribution of knowledge and information reach much further than most of us have expected. Since the advent of printing we have built up a number of assumptions about the appearance, function and use of text, most of which we are not even aware of, and we are currently only in the early stages of discovering the surface phenomena of the new technology. We are lured in by the concept of hypertext, because we can understand it as an advanced index function, by word processing as an advanced typewriter and by the web as a new publishing medium, but we fail to see the deeper, more profound differences. In our gradual adoption of new possibilities we are blinding ourselves to the secondary effects that are already changing our lives in fundamental ways.

Where the printing press brought text to everyone and publication opportunities to some, the Internet enables everyone to become his own global, instantaneous publisher. This in itself accounts for a revolution at least on scale with Gutenberg's, but in the longer perspective the malleability of digital text may become even more important. When every text can be copied, modified and republished, the written word becomes akin to dialog and its nature changes profoundly. What is a work of text and when is it published if it is continuously being changed? Who is the author when the text is the result of collaboration between tens, hundreds or even thousands of writers? How can we assign any kind of credibility to it? How can we assign rights to it? Should we? And will anyone be willing to pay for information when it is available in such abundance for free?

The Music Industry

With digital technology we are able to digitize, manipulate and transmit sounds, and, just like with text, we have seen a progression of changes happening first in the production process, then in distribution and finally in the entire value chain resulting in some major disruptions in the industry.

The music industry was among the earliest to adopt digital technology, first in musical instruments and later in both production and final product, but when it comes to selling music over the net it has been more than reluctant. Apparently the industry has not learned its lesson from its conflicts with radio transmissions, which will be discussed in Section 3, but has remained stuck in a mindset and a revenue model that requires music to be stored in some physical container to be sold. Clearly, the ability to copy and share music files with digital technology represents a significant threat to the industry, but digital distribution is inevitable, and there is an obvious need for the development of new business models. The recording industry, however, has chosen to take a defensive stand and currently looks like a wounded and trapped animal. There seems to be a stalemate between it and the file sharing community, which has a working system of distribution, but no viable business model. Whether the record industry will survive the extinction of records is still an open question, but there is no doubt that digital communication is changing the music industry completely and, hopefully, eventually to the benefit of the musicians who have for years been exploited by an increasingly monopolistic industry.

Digital music can of course be manipulated in much the same manner as digital text, and this is another thorn in the eye of musicians, labels, and copyright lawyers. Sampling other people's music has become a mainstay in a number of popular music forms, and whole new genres like 'bastard pop', where the music from one song is mixed with the vocals from another, have appeared. When DJ Danger Mouse mixed Jay-Z's The Black Album with The Beatles' "The White Album' to create the not particularly widely acclaimed "Grey Album', he was served with a cease-and-desist note from EMI, which owns the rights to "The Black Album". When he complied, others stepped in and made the album available on the Internet, only to be pursued by the

owners of “The White Album”, SONY Music. Even websites that linked to the Grey Album site were under attack, and some rather absurd discussions about free speech vs. incitement to commit a crime ensued. Notwithstanding, the album is still freely available on the net to serve as a small example of things to come.

Apple has appeared to find a solution in the interplay between the iPod and iTunes. By bringing back the physical element in the form of an MP3 player that keeps close tabs on its contents, the company has been able to attract an initially reluctant recording industry and create a very lucrative online market, but at the same time the service is facing an increasing animosity from users, who resent the fact that they cannot freely share and copy their content[74].

Telephony

Modern phone systems are already using digital encoding, but this use is basically transparent to us, and the fundamental functionality of telephones has not been dramatically changed by digital technology so far. With the marriage between telephony and the Internet called IP-telephony we are, however, in for some important changes. The routing of telephone conversations in packages over the Internet finally challenges the idea of a one-to-one connection between callers, and this already has both economic and conceptual impacts on telephony.

With traditional, circuit switched networking a line has to be held open between the two parties for the duration of the call. This means that telephone systems in principle must have a 64KB line for each simultaneous phone call, and that at least half the bandwidth is wasted by silence (between words and between sentences). Conference calls, in turn, require the simultaneous establishment of several lines with at least a linear cost increase.

During recent years telephony has started moving to the internet. In IP-telephony, audio is transmitted in packages like all other Internet data, and it is routed through the system using space wherever available. This method not only reduces waste of bandwidth, but also allows all packages to be distributed to many destinations with only a marginal cost increase.

The most well-known IP-telephony service was created by the founders of Kazaa. Skype[75] was established in 2003 and offered free telephony between Internet users and later low-cost calls to normal phones as well. Within two years their small program had been downloaded more than 150 million times, and the company had more than 45 million subscribers. In September of 2005 Skype was sold to EBay for 2.6 billion dollars and shortly after announced its entry into the mobile phone market.

Skype was hyped as, but is not really a particularly good example of peer-to-peer communication. It provides p2p communication, but basically only in the same fashion as telephone systems do. Yet, this may be one of the reasons for Skype's success. Where Kazaa challenged not only a number of very large corporations, but also the legal system and some of our basic notions about rights and ownership, Skype falls squarely within an established paradigm and thus competes within a known and non-contentious sphere. As it emulates the phone and phone system it is easy for consumers to understand and adapt, and though it poses a severe threat to traditional phone companies, it belongs within the sphere of fair competition. Had the phone companies been able to challenge Skype on legal ground, they certainly would have done so, but for the political environment the system posed no threat and therefore led to no controversy.

We may keep thinking of telephony as primarily a one-to-one communication technology, and it may very well be that speech is not suitable for many-to-many communication, but at least we now have the opportunity to experiment with new forms of audio communication. During recent years many experiments have been made with for instance online jam sessions, where musicians in different places can join over the net to play together in real time, and we will invariably see hybrids between the mass media capability of radio and the interactive nature of telephony[76]. Products like Guitar Hero are still predominantly played off-line, but enable online play as well.[77]

Photography

In the spring of 2004 one of the icons of the photographic industry, Kodak, announced its intention to stop manufacturing analog cameras[78]. After 116

years of supplying one of the most democratic communication tools in existence, Kodak has seen the writing on the wall: The World is going digital, and photography will never be the same again!

When George Eastman in 1888 introduced the phrase ‘You press the button, we will do the rest”, his words were aptly chosen. Photography had become simple, yet production and reproduction of the actual pictures was still a complicated affair. Only true enthusiasts would dedicate a room in their home as darkroom, and for the next century the vast majority would trust others to process their film. Polaroid changed this with their instant camera, but neither option allowed for any post-shot creativity.

Today digital cameras are taking over the market at a rate that rivals that of mobile phones, and photography itself changes accordingly. You can now take just about as many pictures as you like, because they are virtually free and you can erase them again in the camera or after upload to your computer. Once in the computer, images can be enhanced, edited, and published on the web, which means that finally the consumer is in charge of the whole process. It may well be that most people will continue to accept the picture as it comes out of the camera, but we are already seeing the emergence of new forms of art and personal expression, and photography is starting to take on a new role in society. With everyone carrying digital cameras in their mobile phones virtually no event can go un-photographed, and once the picture is out there in a digital form, there is no way to curtail it. The images of torture by the American military in Iraq in 2004 gave us a glimpse of what the future holds in store for those who think they can control the media.

Collaborative systems like flickr.com and 23hq.com allow people to upload their digital images, share them with others, produce collaborative albums and so forth. The sites are changing the way we think of photography and photo album, and as more and more people are getting camera phones with instant upload, photography is becoming more and more like blogging where several people take pictures and use them to tell stories in real time. And it is only a matter of time before all new pictures are tagged with its GPS position, which will enable them to be organized and accessed on a geographical basis, so

that you will for instance be able to see pictures taken by other people from the spot where you are standing.

Film and Television

Until recently the main digital influence of television and film has been behind the scenes. Digital technology has made it possible to create alternate realities and realize just about any fantasy dreamt up by directors and scriptwriters, and it has revolutionized the entire film production process. But in terms of communication film and television initially changed only marginally. Numerous experiments with interactive film and television have been made over the last 20 years, but none have reached a mainstream audience.

Like the music industry, the film industry is being challenged by digital distribution, and since a large number of people are involved in the by now almost entirely digital production process, it has become virtually impossible for film companies to keep their new films from appearing on the net even before the official release.

Digital video cameras are rapidly replacing analog ones, and most new personal computers come with at least rudimentary film editing applications. We should therefore expect to see a rapidly growing number and variety of independent films appearing, and there is no doubt that a 'bastard film' genre will eventually appear as well.

The most visible change in the video and film world so far Is YouTube with its odd mixture of recorded television programs, amateur videos, commercial music videos, academic lectures etc. The site has grown from nowhere to become a favorite outlet for anything from aspiring filmmakers to political activists and mass murderers, and certainly its short term societal impact seems to be bigger than any other recent web technology.

Meanwhile digital distribution is changing the entire market. On the one hand we see the expected rampage of illicit film sharing, but on the other hand digital distribution is opening up completely new business opportunities for film makers. As described by Chris Anderson in "The Long Tail: Why the Future of Business Is Selling Less of More"[79] digital distribution will liberate the film industry (and other industries) from its dependence upon short-lived

blockbusters, because it is now possible to reach much more narrow audiences over time and on a global scale.

Convergence between computers and television was one of the big topics of the 90s, but both television and film were created for passive audiences and seem to be unable to break out of that mold. There is no doubt that all our media will become completely digital in terms of production and distribution, but in the case of mass media companies the picture is more likely to be one of decay than innovation. We will see the role of the media companies change radically to adapt to digital technology and counter outside pressures, but to examine these media for signs of radical change would be like looking at fireworks to study the possible effects of nuclear war.

1.2.4 Summing Up

At this point it should be clear, that some major changes are happening to the way we represent, manipulate and share information. What is less clear is what impact these changes will have upon our thinking, our culture, the way we organize society, and the balance of power across the globe. As I have stated in the introduction I wish to investigate, whether digital technology represents the most important qualitative development in communication technology at least since the advent of writing. Judging only from the current state of digital culture that is a very bold claim, and before we can even attempt to conjecture about what might be in store for us, we need a much more thorough understanding of what digital communication represents in both a technological and a historical context. In the following section I therefore introduce a framework that can help us understand communication technology, and with this in hand I will venture back into history in search for information about how previous qualitative changes in our communication capabilities have affected society. The historical tour de force will bring us back to the present armed with knowledge that allows us to put digital communication in context and make some informed speculations about the potential impact of the digital revolution.

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[1] Licklider 1968, p.21

[2] The first to use a binary notation was the Indian, Pingala, who used it to denote long and short syllables in the Vedic scripti. (Rao 1998). For a fairly comprehensive account of Leibniz see

Wikipedia /wiki/Gottfried_Wilhelm_Leibniz, Oct 2008

[3] Leibniz 1666

[4] See his article "Explanion of Binary Arithmetic" in Strickland /binary.htm, Oct 2008

[5] For a fairly comprehensive historical account, see Wikipedia /wiki/History_of_logic, Oct 2008

[6] See Archive /details/AristotleOrganon, Oct 2008

[7] See Wikipedia /wiki/Boolean_logic, Oct 2008

[8] An English translation can be found at Joyce 2008 /java/elements/elements.html, Oct 2008

[9] Wikipedia /wiki/Muhammad_ibn_Mūsā_al-Khwārizmī, Oct 2008

[10] Turing 1936

[11] See Wikipedia /wiki/History_of_computing_hardware

[12] The influence on the history of inventions of hoaxes, coincidences, misinterpretations, misspellings and the like should not be underestimated.

[13] Standage 2002

[14] For a more detailed historical account see (Sciencemuseum)

[15] According to http://www.softwaretop100.org 15 of the 20 largest software companies in the world are headquartered in the States (based on 2006 revenue), and according to http://www.netvalley.com 19 of the 20 largest computer companies are located in the States (based on 2005 revenue). Oct 2008.

[16] The following pages are based mainly on Levy, 1994 that provides an illuminating account of the early days of personal computing.

[17] Levy 1994, p. 41-42

[18] Ibid, Chapter 9

[19] Ibid, p. 200

[20] BASIC is the simple and intuitive high-level language that eventually brought programming to large numbers of amateurs.

[21] Wikipedia /wiki/Image:Bill_Gates_Letter_to_Hobbyists.jpg, Oct 2008

[22] A large number of examples of the tension between Microsoft and the free software community can be found at https://www.fsf.org/search?SearchableText=microsoft, Oct 2008

[23] See for example http://en.wikipedia.org/wiki/Microsoft#Criticism, Dec 2008

[24] Recently Microsoft has attempted to embrace the open source paradigm through initiatives such as codeplx.com and Port25, and have, in fact, succeeded in changing the image of the company in open source circles.

[25] Heikkila 2001

[26] ibid

[27] ibid

[28] See http://www.nationmaster.com/encyclopedia/IBM-PC-compatible, Oct 2008

[29] Sage

[30] Sabre

[31] For a fascinating account see Steve Brand's interview with Paul Baran in Wired 9.03,. The following paragraphs are a summary of it.

[32] I find the idea that the origins of the Internet started in models of the human brain very evocative. It suggests that the net was modelled over the most advanced biological mechanism known, and the only one to have achieved a selfreflecting consciousness. As the Internet is today approaching the complexity of the human brain in terms of nodes and connections, one cannot help but speculate when its own FOXP2 gene will start to kick in.

[33] Baran, 1964

[34] As described in for instance Zittrain 2003, China has gone to considerable lengths attempting to enforce censorship on the internet by a variety of means, but since most of the material on the net is published beyond their control, and since access becomes increasingly harder to control, it seems likely thast they are fighting a loosing battle.

[35] Wired 9.03

[36] Ibid

[37] Ibid

[38] The following section is largely taken from Hauben 1996

[39] Licklider 1968, p. 21

[40] Ibid, p.

[41] Ibid

[42] Berners-Lee 2000

[43] Ibid, p. 14

[44] Ibid. p. 36

[45] Thoroughly described in (Eisenstein 1979) and (Johns 1998)

[46] http://www.google.com/intl/en/corporate/index.html , Feb 2006

[47] According to Sempo, the Search Engine Marketing Professional Organization (see www.sempo.org), the search engine optimization market was around USD 1.3 billion in 2007 in the US alone.

[48] Maurer

[49] http://www.census.gov/mrts/www/data/html/08Q3.html, Nov 2008

[50] For a comprehensive overview of Usenet and numerous other subjects related to the Internet, see livinginternet.com.

[51] See en.wikipedia.org/wiki/Weblog for an excellent article on the history and importance of blogging.

[52] See Gilmor, 2004

[53] http://en.wikipedia.org/wiki/Killian_Documents, July 2009

[54] http://www.wired.com/culture/lifestyle/news/2004/09/64987, July 2009

[55] See www.bikeforums.net and http://www.bikebiz.co.uk/daily-news/article.php?id=4668

[56] See (Wikipedia /wiki/Peer-to-peer), Oct 2008

[57] See http://web.media.mit.edu/~pattie/cv.html, Oct 2008

[58] Oakes

[59] See for example http://en.wikipedia.org/wiki/Rescue_of_the_Danish_Jews, July 2009

[60] http://www.opensource.org/docs/history.php, Sep 2004

[61] http://www.gnu.org/licenses/gpl.txt, Sep 2004

[62] For examples of open source strategies see http://www.opensourcestrategies.org/, July 2009

[63] In a letter to Madison concerning the issues of copyright and patents, Thomas Jefferson in 1813 wrote:

"If nature has made any one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of every one, and the receiver cannot dispossess himself of it. Its peculiar character, too, is that no one possesses the less, because every other possesses the whole of it. He, who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening me. That ideas should freely spread from one to another over the globe, for the moral and mutual instruction of man, and improvement of his condition, seems to have been peculiarly and benevolently designed by nature, when she made them, like fire, expansible over all space, without lessening their density in any point, and like the air in which we breathe, move, and have our physical being, incapable of confinement or exclusive appropriation. Inventions then cannot, in nature, be a subject of property"

[64] Wikipedia /wiki/Wikipedia:About

[65] Wikipedia /wiki/Image:WPsize.png, Oct 2008

[66] See http://www0.epinions.com/about/. Dec 2008

[67] http://freenetproject.org/, Oct 2008

[68] Moreton

[69] Dabek

[70] http://setiathome.berkeley.edu/, Oct 2008

[71] Levinson 1997, p. 120

[72] See http://en.wikipedia.org/wiki/Print_on_demand, Dec 2008

[73] For a brief description of how typesetting as a trade became obsolete, see

http://en.wikipedia.org/wiki/Typesetting

[74] See for instance Thomson

[75] www.skype.com. For a description and brief history see Wikipedia /wiki/Skype

[76] Wikiversity /wiki/Jamming_Online, Oct 2008

[77] See guitarhero.com, Dec 2008

[78] http://news.bbc.co.uk/2/hi/uk_news/magazine/3399529.stm, Oct 2008

[79] Anderson 2006

Section 2
A Framework for Understanding Communication Technologies

Introduces a theoretical framework for communication technology. The framework delineates central aspects that define the scope of a given technology in terms of the representation, production and distribution of information. The intention is not to provide a comprehensive model for communication or communication technology, but rather to define and clarify the elements that differentiate technologies in terms of their potential impact upon society and culture. The goal is to provide clear guidelines for identification of whether a given communication technology constitutes a qualitative shift in our communication capabilities.

2.1 A Definition of Communication

Communication is not an easy concept to define. When you start to think about the word and what it means, you quickly realize that it covers almost every aspect of human life. Rene Descartes claimed that being able to think was the fundamental quality of being[1], but what is thinking without communication? What are our thoughts, if we are not able to share them with others? Are they, indeed, thoughts at all?

Nevertheless, we cannot attempt an examination of communication tools and technologies and their impact on the human condition without some form of definition. And in order to identify the changes that make a real difference we need to break the concept down into a number of aspects with relevance to our pursuit.

In his book 'Understanding Media' Marshall McLuhan makes a strong case for the idea that communication technologies themselves, and not only the content communicated with them have a profound influence on the development of society and culture.

> *'Our conventional response to all media, namely that it is how they are used that counts, is the numb stance of the technological idiot. For the 'content' of the medium is like the juicy piece of meat carried by the burglar to distract the watchdog of the mind.'* [2]

McLuhan describes how every communication technology has a grammar, and that only the person who understands this grammar can discover the true effect of the medium.[3]

I agree wholeheartedly with McLuhan's view, but I do not find his own attempt at a syntax describing media as hot or cool particularly illuminating, In my view a more elaborate taxonomy of communication technology is needed. McLuhan focuses almost entirely on the effect of media on our senses and our degree of participation through 'filling in the blanks', and, like most other contemporary communications researchers, he lacks an emphasis on what is to me the essential aspect of communication - namely that it is about communication between people – not merely to people.

Communication is formed from the two Latin words ‘com’, meaning 'together with', and ‘unio’, meaning ‘union’, and the word has exactly the same root as the word community. The etymological root of the word thus indicates the close relationship between communication technology and culture, but for the purpose of creating a framework for describing and understanding communication technology per se we need to focus on the communication process itself rather than the broader scope. I shall therefore use the definition from Merriam-Webster: ‘*a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior*’[4].

This simple definition leads us to examine communication technologies in terms, not only of the communication act as such, but also of how information is represented and how we interact with communication technology as producers and consumers of information.[5] On the following pages I will introduce a simple framework that lets us do exactly that.

2.2 Infrastructure

The core of communication is of course the actual transmission of messages from sender to receiver – or what we might call the communication infrastructure. The scope of a given infrastructure is determined by the number of senders and receivers involved as well as by the speed of transmission and its range in space and time.

Scale: You cannot govern a society without being able to communicate to its citizens with some efficiency, and the number of receivers you can reach within a given time span is a determining factor in the impact of your message and the scope of your control. What is perhaps less obvious is that the number of senders involved in a communication process, or perhaps rather the balance in the number of senders and receivers, is a crucial factor in determining the kind of society that evolves. Scale is thus not simply a matter of how many people can be reached, but must cover both senders and receivers as illustrated below:

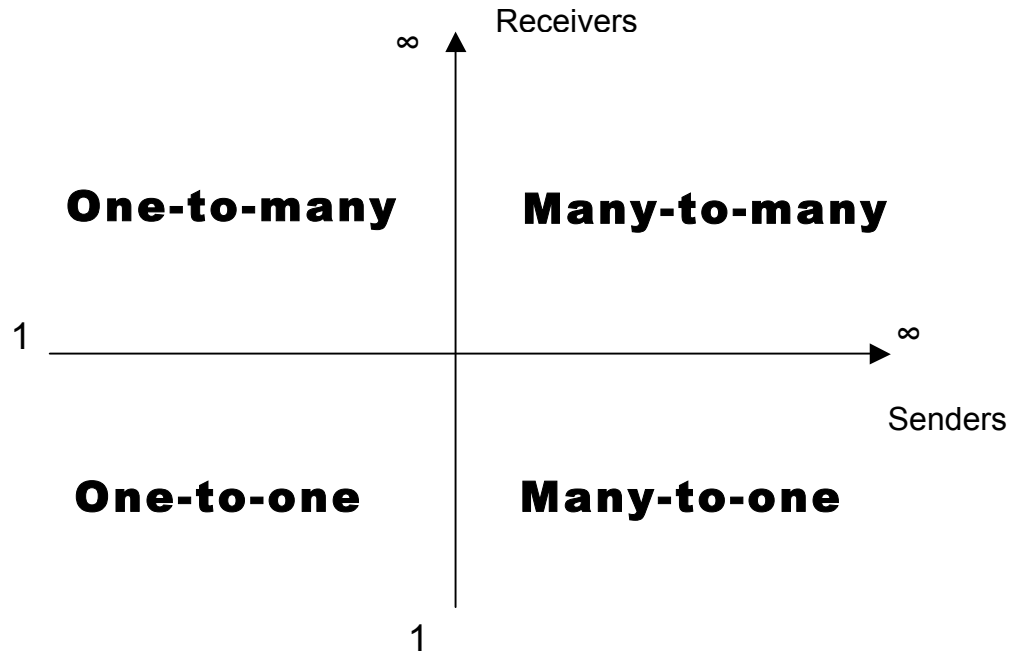

Figure 5. Communication scale

To simplify things I distinguish only between the four quadrants: one-to-one, one-to-many, many-to-one, and many-to-many. The borders between the four are blurry, and the term 'one' can signify as many as hundreds of people. The distinction between one and many is, however, central to the task of identifying the character and impact of different communication technologies, and the simplification aids tremendously in clarifying these.

One way of understanding the impact of scale is to look at the number of possible connections in the different communication systems. A one-to-many or many-to-one communication system of N participants, will have N-1 connections, whereas a many-to-many system according to Metcalfe's Law has a potential of N(N-1)/2 connections[6]. But the value of communication is not simply a matter of the number of connections. If we look at communication as a tool for community building, we discover an even more astounding difference between balanced and unbalanced communication. Where one-to-many communication can enable the sender to influence the whole population, properly designed many-to-many communication networks enable the formation of subgroups, and the number of potential subgroups in a population of N individuals is 2^N-N-1 (Reed's Law[7]). If we accept that the

value of networks can be characterized by their ability to form subgroups, the potential value of a group forming many-to-many communication system thus grows exponentially with the number of participants, whereas the value of a one-to-many system only grows in a linear fashion. This, in fact, means that a balanced network of only 20 participants has a higher potential communication value than a broadcast system reaching a million!

Scale is of course defined by the basic characteristics of a given communication technology, but secondary factors such as price, portability and the skills required to use the technology are important as well. A communication technology may in principle be able to provide balanced communication, but if the price, availability or manipulation of the technology favors a select class the potential will only be converted to actuality among that group.

Speed: Harold Innis[8] in 1951 remarked that media tend to extend communication either across space or time, but rarely both in equal balance. This seems to have been true at least until 1951, but we should bear in mind that virtually all technologies that enable the preservation of information over time also allow for the spreading of it in space. Preservation is therefore a prerequisite for communication over both time and space, but in terms of the communication act itself the important factor is speed, i.e. the coverage of distance per unit of time. Building and maintaining culture and knowledge requires preservation of information, but governing society depends on the ability to communicate quickly and efficiently over distance, and for both sender and receiver the time it takes a message to reach its destination of course determines the kind of communication that can take place.

This leaves us with three factors spanning communication space: The number of senders, the number of receivers, and the speed of communication. The model in Figure 6 enables us to visualize the different technologies in terms of their communication space in a clear, if somewhat simplified form. The speed factor has been reduced to a binary representation distinguishing only between real-time communication and communication over time, and you should note that it fails to take distance into account as an individual factor. This means that the model does not distinguish between for instance local

and global real-time communication, but, as it turns out, this limitation is not crucial.

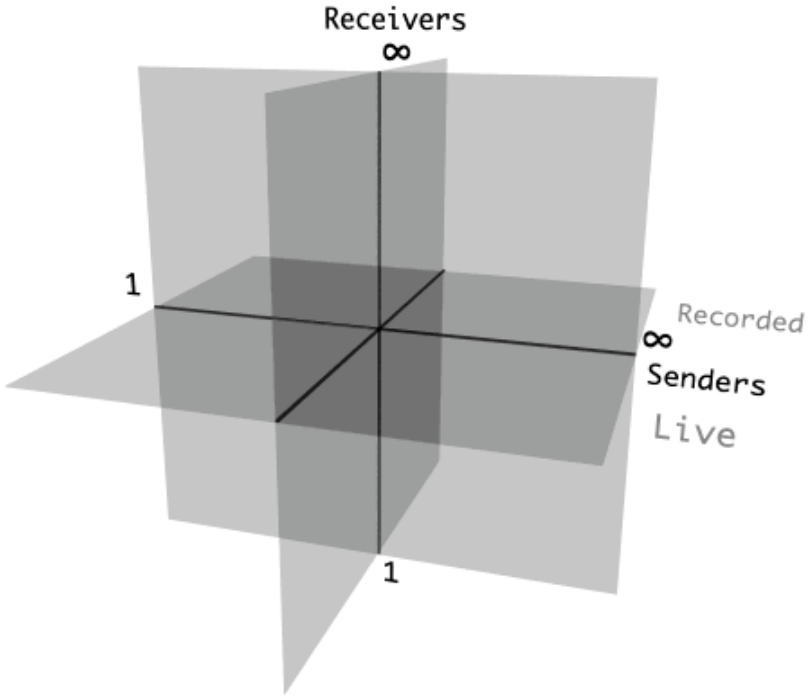

Figure 6. Communication space framework

2.3 Representation

> *'In the beginning was the word. But by the time the second word was added there was trouble. For with it came syntax…'*
>
> John Simon[9]

In order to communicate we must represent our thoughts and ideas in a format, which on the one hand fits the given infrastructure and on the other can be perceived and understood by people on the receiving end. And the representations we use in turn affect our thoughts and ideas.[10]

A cat figure made of clay, a picture of a cat and the word cat all represent the same concept, but they do so in very different ways. Each representation requires translation when created and when perceived and in the translation some aspects are emphasized while others are lost. Technology constrains

representation to certain forms and in this way it not only shapes our world, but also the way we perceive it. No aspect of human life is unaffected by the way we represent information, and in many cases we can trace some of our most fundamental ideas and conceptions directly back to the communication technologies used by the cultures that engendered them.

Information can take many forms - some of which appeal directly and intuitively to our senses and mind, whereas other ones require considerable training and active interpretation. Representation fundamentally affects the scope and character of communication, and as we progress through the history of communication, we will see that each new representation of information is accompanied by a set of specific developments in various aspects of culture. It will also become clear that each new technology development is highly dependent upon the previous technologies and their impact on society and thought. Abstract science could not have evolved without the alphabet, and without abstract science we would never have created industrialized society and its many communication technologies.

The other aspect of representation is its relation to our senses. Human beings have a very rich and multi-facetted sensory system through which we perceive information, but unfortunately we have been unable to make very good use of it with our various representations. Face to face encounters involve all our sensory-motor capabilities, whereas all the communication technologies developed so far utilize only one or two of our senses. As our technology-mediated representations have become increasingly important to us, they have shifted our bias toward sight and sound at the expense of the other senses. We have come to think of touch, smell and taste as primal senses related more to feelings and hunches than to information and knowledge – simply because our communication technologies have not catered to them.

Yet, making sense of received information is of course not only a matter of perception, but also of cognitive treatment of the perceived data, and in that context the symbolic nature of a given representation in my view plays a much more important role than the sense(s) through which the information is received.

2.4 Production

Creating, manipulating and distributing a representation requires production tools and a production medium, both of which influence the production process as well as the result. Tools and media can be cheap or costly, easy or hard to obtain, easy or difficult to transport and require little or great skill to use, and each of these factors influences who gets to wield the power of communication. Information has always been almost synonymous with power, but never more so than when only a few control the production, manipulation and distribution of information to a great many.

The two most important aspects of the production medium are durability and portability. Words chiseled in stone will last for a long time, but do not transport too well, penciled on paper they may be somewhat shorter-lived but can be carried to the furthest parts of the World, and when written in sand they may disappear with the next tide or wisp of wind. In this way our communication media affect our notions of time and space. Why worry about posterity if we leave no trail? And why go and conquer foreign lands if we have no way of controlling them through communication afterwards?[11]

There are of course huge advantages to being able to store information for the future, but there is an often-overlooked flip side to the coin. Information represented in a durable form is typically fixed and not modifiable, and fixed information promotes fixed thoughts. When something is cast in stone it is somehow no longer open to discussion and while the words may inspire us, they are not open to creative manipulation – only to consumption. As consumers we become informed, but as creators we participate actively in reshaping society and thought. The malleability of information in a given medium is thus an important factor in the impact of communication technology.

The history of production, manipulation and reproduction of information is one of skills, tools and materials – all of which determine who has access to producing and spreading information. It is thus a story of power and of the balance between creation and consumption, but it is also the story of history – of how communication technologies allow information to be preserved over

time and reproduced accurately. And this, by the way, is an important fact to bear in mind when we attempt to examine history – and specifically the history of communication. We invariably have a skewed picture of the past - on the one hand due to our own bias towards real time media and on the other hand to the fact that most of our historical knowledge stems from societies employing the written word and durable media.[12]

In summary the framework consists of three central concepts: Infrastructure, representation and production – all of which are conditioned by technology and have profound effects on the way we perceive, shape and structure our world.

In the following section I will use the concepts of infrastructure, representation and production to investigate how and why specific communication technologies have changed our world while others have not. I will show that the framework is an important tool in our attempt to grasp and deal with the changes we are facing today – of course bearing in mind that it does not provide the full explanation. Technology does not determine our future – people do, and we will see how the rise and fall of cultures have been determined by the ability and willingness of societies to embrace radically new communication technologies – rather than by the technologies themselves. But, as Heidegger argues in "The Question Concerning Technology"[13], we are 'enframed' by technology. Technologies have essential properties that are revealed through its actual manifestation and use. We challenged by technology to understand and bring forth its essence, but at the same time we are 'enframed' or limited by this very essence.

2.5 Summary

In summary, the framework describes three aspects of communication technologies:

- Infrastructure, which denotes the scale in terms of speed, distance and number of people on the sending and receing end of communication.
- Representation, which covers the way information is encoded for the purpose of communication.

- Production, which describes how the communication technology facilitates the creation, manipulation and reproduction of information

These three aspects constitute only a partial description of communication, but as will be demonstrated in this thesis they provide us with a clear and fairly comprehensive model for exploring the relationship between communication technology and cultural development. With the framework in hand we are now ready to embark on our journey through the history of communication.

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[1] Descartes 1637, Part 4

[2] McLuhan 1964, p. 19

[3] McLuhan 1964, p. 14

[4] http://www.merriam-webster.com/dictionary/communication, Dec 2008. For a more detailed definition, which also focuses on the interactional and transactional functions of language, see (Yule 1996), p. 9ff

[5] Consider a hand-written letter for instance: In order to produce it you need pen and paper, i.e. tool and medium. You need to be able to translate your thoughts into legible and comprehensible written form. Your letter needs to be addressed and transported to the recipient, who in turn has to be able to decipher your message. Each step in the process is part of the communication act and affects the scope and character of communication. Pen and paper cost money. Using the pen requires training, paper takes up space and can burn or get wet. Reading and writing requires abstract thought and a system of symbols that represent language. Transportation of the letter requires infrastructure and labor, and a handwritten letter typically only exists in one copy, which can only be read by a few people and changed by no-one.

[6] http://en.wikipedia.org/wiki/Metcalfe%27s_law, Dec 2008

[7] http://en.wikipedia.org/wiki/Reed%27s_law, Dec 2008

[8] Innis 1951, page?

[9] Simon

[10] It should be noted that I will only be dealing with representation created with communication intent, and I will not be considering the data embedded in artifacts that were not created for the purpose of communication. While it is true that pottery, ruins and graves give us a lot of information about life, society and technology of the past, such artifacts are not our concern unless they or parts of them were explicitly created with communication in mind. The difference is in some cases subtle, and it can be argued that we communicate through our appearance, our home, our car, etc, but we would never classify these as communication technologies, and their primary purpose remains outside the realm of communication

[11] We should therefore also be aware that we may have a skewed picture of the past due to on the one hand our own bias towards real time media and on the other hand the fact that most of our historical knowledge stems from societies employing the written word and durable media.[11] We for instance tend to see the time between the 1200 and 800 BC in Greece as a period of decline due to the fact that all writing seems to have disappeared and that people seem to have left the cities. Yet, there is no evidence that the people of that time lacked cultural or economic wealth, and the subsequent developments in Greece clearly built upon and benefited from the oral culture of the previous 400 years.

[12] See for instance Innis 1951, p. 325 ff

[13] Heidegger 1977

Section 3
A Brief History of Communication Technology

Gives a sweeping overview of the development of communication technology since the advent of speech. Only the most important developments are discussed, and each technology is examined through the theoretical framework. The purpose of the section is to use the framework to examine and demonstrate what technological developments constitute true, qualitative changes in our communication capabilities, and the section concludes with a comparison of communication technologies throughout history.

3.1 Speech and Basic Signs

> *'The spoken word was the first technology by which man was able to let go of his environment in order to grasp it in a new way'*
>
> Marshall McLuhan[1]

Being together is to communicate, and we do so with all parts of our body and all our senses. We communicate, not only through our vocal chords, but also with gestures, facial expressions, smell, and touch, and much of our communication is beyond our conscious control. This thesis, however, deals with conscious and intentional exchange of information, which can basically only exist through use of symbolic means of some kind, and our story of communication thus starts with speech and the use of visible signs.

Face-to-face communication is the oldest, most pervasive, most important, and, in many ways, most advanced form of human communication. In terms of intimacy, subtlety and immediacy all technological extensions to our communication pale in comparison to face-to-face communication, and even today most people in all cultures still prefer it to any other form for their most important issues.

Since speech seems to be a result of evolution rather than innovation, it may seem a little far-fetched to call it a technology. Yet, speech is a prerequisite for all subsequent forms of abstract communication, and in many ways it is the yardstick by which we measure all our communication tools, so it seems worthwhile to at least fleetingly dwell on its origins and characteristics.

It is possible that the leaving of signs for others to read preceded speech. A pile of stones could for instance signify a hunting ground or mark a territory, and virtually all cultures have created some form of monument for the dead and signifiers of other important events or discoveries.

The first sign of intentional, recorded human communication is found in rock carvings and cave paintings dating back around 77,000 years[2]. In these works we see the first recordings of human culture, life, and religion. What motivated people to create these works of art is a matter of conjecture, but there is no doubt that they indicate conscious reflection and communication.

Paintings and carvings in their rudimentary form are, however, a very limited and slow form for communicating in and organizing everyday life, and we must turn to the development of human speech to see the roots of fundamental social change. As the Australian mathematician Desmond Fearnley-Sander says:

> *"In the beginning was the Word'. So the Bible seems to acknowledge the specialness of language, the distinctive characteristic that separates the human from all other species, even from the other great apes. It is not the ability to communicate that distinguishes us. Other species communicate and depend for their continued survival upon successful communication. It is communication of a particular kind: no other species makes promises or poems.*[3]

We know next to nothing about the origin of speech and can only speculate as to the time, place, cause, and process of speech development. Opinions vary as to whether physical, cognitive or social development is to blame for language evolution, but there is general agreement that the development of language requires cognitive abilities of abstraction and complex thought as well as a lowered larynx not found in any other species. Recent research indicates that mutations in a gene called FOXP2 are likely to have been prerequisites for our ability to speak and perhaps for the human cognition necessary for speech[4]. These mutations happened between 10,000 and 100,000 years ago, which conforms to earlier assessments that have placed the development of human language later than 100,000 years ago.

There are, however, indications that human beings as early as 260,000 years ago conducted complex burial rituals, which indicates a transmitted religious belief that very likely required language[5], and the question of the date of origin of language remains controversial in scientific circles.[6] The Neanderthals, who occupied Europe and Western Asia in the period between 200,000 and 30,000 years ago, were the first humans to manufacture stone tools and conduct burying rituals, and there is evidence that they had at least the physical capability of speech. They did not, however, exhibit the kind of progress we would expect from a species capable of abstract thought and communication, and before the arrival of Homo Sapiens to Europe around 40.000 years ago the Neanderthal culture shows virtually no signs of symbolic behavior. This of course does not allow us to conclude that they did not have

the capability of speech, but it indicates that this capability was very rudimentary at best.

Homo Sapiens entered Europe from Africa, and within 10.000 years they had completely replaced the Neanderthals, who thus appear to be a dead end in evolution. There are many possible explanations of why the Neanderthals did not survive the arrival of modern humans, but what is clear, is that Homo Sapiens were far more sophisticated in their use of clothes, dwellings and weapons than the Neanderthals, and that they were thus better equipped for both war and adverse conditions. Homo Sapiens were also the first to employ abstract symbols and long distance communication through signs, and the combined evidence indicates that the Neanderthals were outcompeted, if not outright wiped out, by a species with better brains rather than stronger bodies. It seems reasonable to surmise that speech and the capability of symbolic thought was part of the competitive advantage of Homo Sapiens, which dates the appearance of speech to somewhere between 100,000 and 50,000 years ago.[7]

3.1.1 The Characteristics of Speech

Infrastructure

Face-to-face communication space is characterized by proximity, immediacy, and balance. Only a very limited number of people can be involved in a face-to-face communication act, but they can all be active participants - at least while they remain within earshot. Face-to-face communication does not carry over much more than tens of feet, and it disappears into thin air without a trace. Memory of face-to-face communication remains only in the heads of the participants and no messages of substantial length can be transmitted reliably. Unaided speech can therefore be characterized as real-time one-to-one communication over short distances.

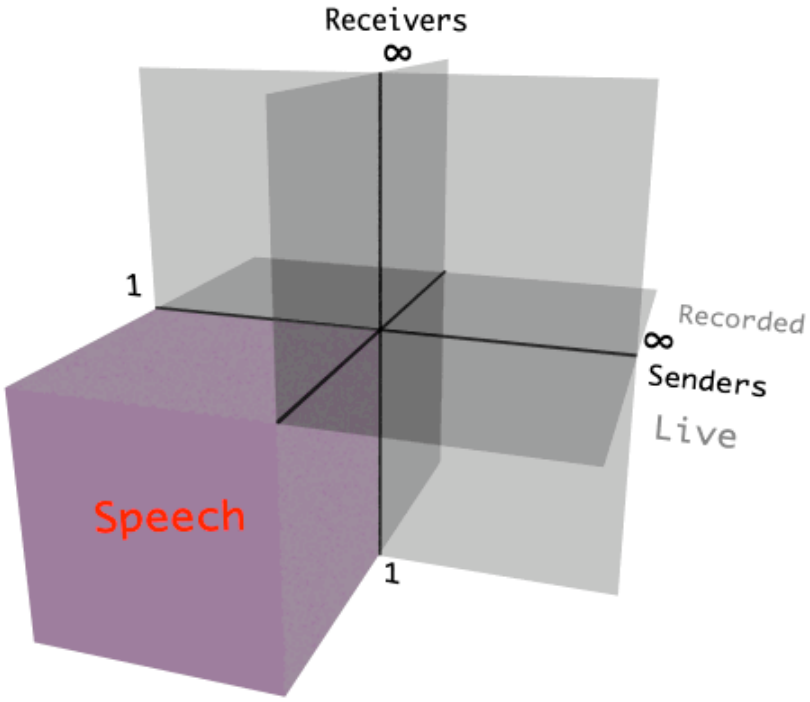


Figure 7. Speech unaided by technology enables real-time one-to-one communication

Representation

Speech is the verbal representation of thought with the intention of communication, and although we tend to think of speech as intuitive communication, spoken language is a very advanced and complex representation. In order to be useful for communicating our thoughts, speech must have the dual property of being powerful enough to express our thoughts and sufficiently structured for the expression to be understood by others. Had we been incapable of abstract thinking and imagination, speech would probably have been (and perhaps at one point was) a fairly simple matter of single words referring to objects in the world. But human beings have the ability to form abstract concepts, conjure up imagined scenarios, plan ahead, and self-reflect, and we thus need much more elaborate structures to express our thoughts. We need to be able to talk of not only things, but of concepts, and we need to connect things and concepts with action and attributes. We must be able to distinguish between past, present

and future, between subject and object, between class and instance, between questions, propositions and statements, and between singular and plural. And we need to be able to express these distinctions and connections in a way that can be deciphered by the receiver.

Every language in the world contains an elaborate syntactic structure from the level of phonemes to that of full sentences, and it is this structure that forms the basis of all our structured communication, whether it is through speech, writing or Morse code. In a sense our representation of information in ever more advanzced symbolic forms can be seen as continued attempts to catch up with the complexity and richness of speech, and viewed from this perspective they can actually be seen as continued investigations into how thoughts and concepts are represented in our heads.

We are for instance accustomed to seeing writing as a representation of speech[8], and it would seem logical for the syntactic and semantic structure of speech to lead to a rapid development of a similar structure in writing. But when we look to history, we discover that it took thousands of years for writing to exhibit anything like the sophistication of spoken language. This indicates on the one hand that writing was not initially seen as representing speech, but rather as purely visual and ostentative representations, and on the other hand that people did not reflect upon the structure of speech prior to or in connection with the development of structure in writing. As can be seen from childhood development it is perfectly possible to master a complex, linguistic syntax without any formal reflection, and the development of writing may have been what led us to reflect upon language in the first place.

Ludwig Wittgenstein describes life as an ongoing co-construction and negotiation of meaning through language games[9]. These games are of course best played when all players are present and able to contribute in real time, and when the speaker is able to make subtle adjustments to tone and emphasis based on the reaction of the audience. From this perspective of language as a game with ever-changing rules and continuous negotiation of meaning face-to-face communication is superior to all technological substitutes.

Meaning is an abstraction. Without abstract thought there can be no meaning, and without a symbolic representation allowing expression of abstract thoughts and concepts there can be no negotiation of meaning.

When a hunter sees a hoof mark or smells the scent of an antelope no abstract interpretation is necessary, but when symbolic words with no onomatopoeic connection to the real world are introduced, their meaning or reference can only be elicited through abstract interpretation, which in turn promotes the ability to form and express purely abstract concepts and thus express for instance inner states. In addition to this the ability to connect words in a meaningful sequence requires and promotes the development of logic and leads to the ability to argue and form propositions rather than merely point with words.

Human life without language is inconceivable to us. When we try to examine our inner life of thought and imagination we find it almost impossible to separate it from language, and our very ability to conduct this form of self-examination as well as other forms of abstract thought may very well be dependent upon our language abstraction ability. Language thus becomes the prerequisite for all development requiring abstract thought - including of course all later communication technologies.

The co-development of language and thought thus has several aspects:

- The development of words that are not merely onomatopoeic, but symbolic references, requires and drives the ability to interpret verbal symbols.
- The structuring of words in sequence requires and promotes a sequential structuring of thought.
- The development of syntactic structure in language, allowing it to develop in a coherent fashion, requires and extends an explicit or implicit logic
- Conscious development of language requires ability to reason about language itself.

Whether language or abstract thought came first therefore seems to be a chicken-and-egg problem, but once the seeds of both had been sown they grew in reinforcement of each other and endowed mankind with some of the basic capabilities and characteristics associated with humanity and civilization.

Face-to-face communication has the great advantage of being multimodal and real time. Communicating face to face we are able to use all our senses in both expression and understanding, and we can clearly communicate simultaneously at several levels when facing each other. In this respect face-to-face communication is obviously our most intuitive, dynamic and multi-facetted form of information sharing, but it is also the most difficult to control and the most ambiguous. It is rife with subtleties and subconscious expressions and inferences, and the very fact that it is the oldest and most used form of communication and is thus firmly attached to cultural and behavioral assumptions makes it a very rich and complex, but also dangerous and volatile communication form in many situations.

Production

Face-to-face communication does not require any technology. The infrastructure is created by people sharing the same space, and no tools are required to engage in conversation. Speech requires years of training, but the ability seems to be innate in Man, and only the very young and the speech- or hearing-impaired are precluded. As such, speech is thus a very democratic, dynamic and balanced form of communication.

Many animals use sound for communication, but only human beings combine the physical makeup, motor skills and cognition required for the production of intelligible and structured language. Speech is produced by a combination of our respiratory system, the sound-generating larynx, the sound-resonating pharynx and our sound-forming mouth, tongue and lips, and the result is an amazing complexity and diversity of expression enabling us to endlessly reshape and extend speech as a communication tool.

The use of structured language requires the ability to store and process abstract information, and although speech in itself is evanescent, the human

brain is a storage medium for speech. Human beings thus constitute a full production, storage and reproduction medium for speech. As a storage and reproduction medium we are, however, not very reliable. Our memory is a highly complex and dynamic web of interrelated data, and information received immediately becomes entangled in other information and depends on continuous exercise in order not to fade away. Even immediate reproduction of simple pieces of information can be a significant challenge to us, and judged by our normal standards for storage and reproduction technologies we rate very poorly. As noted by J.C.R. Licklider:

> *'By far the most numerous, most sophisticated, and most important models are those that reside in men's minds, In richness, plasticity, facility, and economy, the mental model has no peer, but, in other respects, it has shortcomings. It will not stand still for careful study. It cannot be made to repeat a run. No one knows just how it works. It serves its owner's hopes more faithfully than it serves reason. It has access only to the information stored in one man's head. It can be observed and manipulated only by one person.'*[10]

The main reason for this apparent shortcoming of the human being as a storage and reproduction device is probably our lacking separation of storage and processing. Not only are we unable to receive and produce information without interpretation, our storage itself seems to depend on continuous processing through which the information is interpreted, linked and transformed. We are simply unable to speak, remember or listen without processing consciously or subconsciously!

This transparent integration of storage and processing in man combined with the fleeting nature of speech means that there can be no such thing as an accurately repeated statement or a proper validation of an unrecorded oral statement. Every utterance will be shaped by its circumstance and exists only at a single instance. This is an important key to understanding oral society and the need for more reliable storage media when forming larger societal structures.

3.2 Writing

> *'Since I have seen those who have been beaten,*
> *it is to writings that you must set your mind.*

Observe the man who has been carried off to a work force.
Behold, there is nothing that surpasses writings!'

Satire of the Trades, Dua-Khety (around 2000 BC)[11]

Some of the earliest visual representations show the use of symbols. Alexander Marshack[12] has for instance theorized that the Cro-Magnon carvings in bone from around 28,000 BC are representations of the phases of the moon. But the organization of symbols into actual writing systems does not ahappen until well into the agrarian age.

As long as people live a nomadic life, roaming the land for food and water, there is not much need for advanced tools or record keeping, and life on the road does not provide much leisure time for pursuing anything but the most necessary craft work. Each family must be self-sufficient, so there is not much in the way of trade, separation of labor, or specialized crafts. But around 10,000 years ago the modern humans had developed sufficient agricultural skills to start settling in the fertile valleys around the Nile, Eufrat and Tigris, the Indus River and the Yellow River in China, and a new type of society with new needs started to emerge.

It would take another 5,000 years before full-fledged writing systems would appear, and some controversy still exists concerning both how and where this happened first and whether writing developed independently in different places or spread from one original source. What is generally agreed upon, however, is that systematic writing appeared almost simultaneously in the late 4th millennium BC in Mesopotamia and Egypt[13].

3.2.1 Mesopotamia

The appearance of cuneiform writing in Mesopotamia is a fascinating story as described by the French anthropologist Denise Schmandt-Besserat. As she sees it, the development of writing happened gradually over thousands of years of experimentation with symbols reaching its nexus in Mesopotamia around 3,000 BC.

Excavations in Mesopotamia have unearthed large numbers of clay tablets with writing on them, but in addition thousands of small, clay tokens were found both in the open and inside clay envelopes. No one had a good

explanation for the use of these tokens until Schmandt-Besserat[14] came up with the following interpretation: The tokens were originally used for counting and record keeping. Tokens had different shapes or markings, which would signify specific objects like sheep or grain, in some cases as purely abstract symbols. As a record of possession, trade or the payment of tax, tokens would sometimes be kept within clay envelopes imprinted with a personal seal (of course also a symbol).

This arrangement worked for recording a transaction, but it was rather impractical, because one would have to break the envelope to see what was inside. As a result people started creating impressed signs or incised pictographic descriptions of the tokens on the outside of the envelope. and eventually the whole idea of tokens was dropped, since all the information was on the envelope anyway.

The system of tokens used for counting appeared already around 8,000 BC, and around 3,500 BC the token symbols started appearing on tablets. Both on envelopes and on tablets the tokens seem to have been arranged in a specific order (mostly right to left and top-down), and there were distinct symbols for larger and smaller quantities such as a large and a small bushel of corn. This arrangement indicates the beginning of sequential writing as well as the first indications of the systematic counting system, but as long as the system required a one-to-one correspondence between symbol and real world object, it could not be characterized as a proper system for writing language. On the other hand, one might very well see it as the World's first spreadsheet, and the arrangement of symbols in sequence and hierarchical structures is clearly indicates a new level of sophistication in symbolic representation.

Around 3,100 BC a major breakthrough happened in Sumerian writing and counting: The use of abstract numbers on envelopes and tablets. We now see depictions of a token followed by a combination of symbols signifying the number of objects recorded. In this way the object was separated from number and later from quantity, and the first truly abstract symbols were created. As Schmandt-Besserat remarks, numerals do not exist in the real world abstracted from what they refer to, and the invention of abstract

numerals thus represents the conceptual leap that would open the door, not only to mathematics, but also to the development of a full system of writing.

Separating symbol and object liberated writing from a one-to-one correspondence. Once you understand that the picture of the pipe is not the pipe, a whole new, symbolic world opens up. Symbols can now be associated with attributes, actions and ideas rather than just objects, and in the Sumerian case the reference to the phonetic representation of the object depicted rather than the object itself made it possible to create rebus writing - the precursor of virtually every modern writing system.

And once signs start to have symbolic rather than direct reference the transition to purely symbolic signs is not a great leap. As the Sumer were using clay as a writing material they will have found it much more convenient to use simple, abstract symbols that could be inscribed or incised with a simple stylus. And over time the symbols became more and more stylized ending up with an almost purely syllabic writing systems based on cuneiform, i.e. wedge-shaped characters. This is the system of writing that would prevail in various forms in the region for more than 2000 years.

The earliest forms of writing in Mesopotamia thus developed in conjunction with property, trade and power, and the close link between counting and writing is a very significant clue to understanding the co-evolution of thought, technology and communication in the Western World.[15]

3.2.2 Egypt

The first, small agricultural settlements in Egypt appear to have formed around 5,000 BC, but unlike in Mesopotamia the settlements remained small and tribal until 3,400 BC[16]. Around this time urban centers started to grow in size and wealth and exert their influence on the regions, but it was not until around 3,250 BC when Narmer unified the country and created the first dynasty that the development of culture and writing gained momentum. This development was probably caused by an increasingly arid climate in the areas further from the Nile forcing people to settle closer to the river and develop more advanced farming methods. It was also concurrent with increased trade with the Middle East and a large number of improvements in the use of tools

and materials. In central Egypt, around present-day Luxor, large communities, like Abydos and Hierankonpolis, formed with specialized crafts, monumental buildings and other signs of the organized religious and urban life.

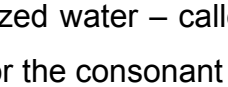
At this point in time hieroglyphs rapidly appeared as a fully developed writing system with upwards of 700 different characters[17], which was to remain in use more or less unchanged for the next three millennia. Archeological evidence does not show a progression from simple symbols to a full script like in Mesopotamia, and the origins of the Egyptian hieroglyphs remain unknown. But it seems likely that the extensive contacts between the Near East and Egypt have caused some mutual inspiration. In 1998 Dr. Günter Dreyer[18] discovered ivory markers with phonetic hieroglyphs in Abydos dating back to between 3,400 and 3,200 BC, and today one might as well claim that the Sumerians learned phonetic writing from Egypt as vice versa. However, when we consider the fact that Sumeria has a long and coherent history leading up to the development of a proper system of writing, whereas Egypt does not, it does seem likely that Egyptian writing was originally developed from Sumerian inspiration. Certainly the Sumerians seem to have been the first to develop both agriculture and urban centers and thus the need and preconditions for counting and writing.

The Egyptians may not have invented writing or mathematics, but they were faster to adopt and elaborate both into full-fledged systems. They also used them to build the longest lasting empire known to Man, and it was clearly Egyptian hieroglyphs rather than Sumerian cuneiform that inspired the next development in writing – the alphabet.

3.2.3 The Evolution and Spread of the Alphabet

The Egyptian hieroglyphs actually contained a set of so-called unilateral symbols, describing all consonant sounds in their language, so it is fair to say that the Egyptians actually developed the first alphabet. The unilateral symbols, however, were used only sparingly (for instance for writing foreign names and very common words)[19], and no attempt at reduction of the number of hieroglyphic symbols was made. In fact under Greek rule in the period between 300 and 20 BC the Egyptian priests elaborated hieroglyphic script

with new and sometimes obscure glyphs in order to make their writing more complex and mysterious. This development appears to have been a last attempt at sustaining power through hieroglyphic writing, but it failed in the face of competition from the much simpler and more accessible Greek alphabet and ended in the final decline of hieroglyphic script and of the ancient Egyptian culture.[20] The pharaonic state with its elaborate system of writing was simply unable to adapt to the radical changes in part caused by the export of a subset of their own writing system to a new, pristine territory – Greece.

Around 1900 BC[21] Semitic people adopted 22 hieroglyphs and thereby created Proto-Sinaitic, the first alphabet and the precursor of the letters you are reading right now. Interestingly, they did not adopt the Egyptian unilateral symbol, but picked iconographic hieroglyphs seemingly at random and used them to denote the first phoneme of the sound of the referenced idea or object in their own language. They for instance adopted the hieroglyph  , which symbolized water – called mem in the Sinaitic language.  thus came to stand for the consonant ‘m’ and over time it evolved into our current letter ‘m’.

One reason for this method of adoption may have been that the Semitic people needed a writing system for their own language, which had consonant sounds not found in Egyptian. By restricting themselves to unilateral symbols the Semites ended up with a small set of characters capable of expressing all consonant sounds in their language, one of many examples demonstrating that qualitative leaps are often made by adopters rather than the original inventors. Due to their long history and the tight relationship between power and writing the Egyptians were unable to shed the excess baggage of hieroglyphs, but the Semitic people were not hampered by such difficulties and thus ended up with a much simpler symbolic script. As would become apparent in the coming centuries, a limited, phonetic set of characters was vastly more powerful and flexible than hieroglyphs consisting of hundreds of symbols of mixed types.[22]

At approximately the same time almost the same happened in the Near East, where the Phoenicians in Ugarit developed a character system based on Sumerian cuneiform writing, but it was Proto-Sinaitic that would be the script

to spread to numerous Semitic peoples including the Phoenicians, from whom it would eventually be adopted by the Greeks.[23]

The Greek islands have a long history of prosperous and fairly advanced civilizations prior to the adoption of alphabetic writing, but there is no apparent continuity from early civilizations to the formation of city-states after 800 BC. It seems that the whole area suffered a rapid and radical decline around 1,100 BC, starting what is called the Greek Dark Ages[24]. The city-states were vacated, and writing was completely abandoned and forgotten for the next 2-300 years. The Greeks of the 8th Century BC were apparently unaware that their language had four centuries previously been written in a syllabic script, which originated in Egyptian hieroglyphic script, and when they started to use writing again it was with a completely different, alphabetic system adapted from the Phoenicians.

Our story of the culture that became the father of Western civilization starts with the reawakening of Greece in the 8th Century BC.[25] What spurred the Greeks to expansion is unknown, but shortly after 800 BC they set about colonizing their surrounding area, and fairly quickly city-states arose all around the Greek peninsula and as far away as Italy and the Eastern Mediterranean. This expansion was followed by a period of wealth and prosperity for the Greek city-states and remarkable rise in Greek culture that would last and spread to vast areas around the Mediterranean and the Middle East until the rise of the Roman Empire.

The increased contact with their surroundings led the Greeks to encounter and adopt the Phoenician script, and fairly rapidly they took to writing like no peoples before them. They wrote poems, plays, stories, philosophy, political treaties, etc, and they were the first to reflect upon writing itself in writing. In Athens the cultures of speech and writing truly met each other, and the result was a society in which the written word became a dominant force alongside the strong oral tradition in politics, culture and science.

The Greeks are often accredited with the invention of the first full alphabet, and it is true that theirs is the first alphabet containing both consonants and vowels. But calling it an invention may be a bit of a stretch. All but three of the

initial vowels stem from Phoenician characters with consonant sounds that the Greeks had no use for or were unable to perceive or pronounce and thus left out, ending up with only the vowel part. Nevertheless this transformation removed the ambiguity of consonant scripts, where any consonant symbol could end in any vowel,[26] and in this way the Greeks created the first true phonetic representation of speech.

Illich and Sanders[27] argue that the introduction of vowels was the single step that brought writing to life since the previous consonant alphabets required an understanding of the context to be read. Whereas it is true that consonant scripts do not give an accurate depiction of the spoken word, it seems no less true that the Greek alphabet requires little less of the reader. You may be able to reproduce Greek speech from the written words, but without an understanding of the Greek language you will just be producing meaningless sounds. As speakers of Hebrew or Arabic will argue, there is little difference between understanding a language and understanding a context.

In any case, the introduction of vowels completed the long journey towards a writing system that is a complete representation of the spoken word and completely abstracted from any contextual reference, and the alphabet became the basis of all Western writing and has remained a dominant force in global communication until today.

3.2.4 Other Writing Systems

In the West we tend to view the Chinese writing systems as inferior, because it never went 'beyond' the logographic stage.[28] This is of course due to our own cultural bias and belief that the alphabet is somehow superior to other writing systems, but we should not ignore the fact that the Chinese have upheld a vast empire for thousands of years and give us little reason to believe that they and the rest of the East Asian nations are less prepared for the future than the rest of the World.

There are several reasons why the Chinese script has never evolved into a syllabic script like the Japanese Kanji or an alphabetic one. The first, and the one most often given, is that the Chinese society is extremely conservative and bound to tradition. This would seem like a word of warning to the

Chinese, since conservatism has been the doom of several cultures before theirs, and it may well account for the lacking ability of China to keep up with Western technological development from 1500 until recently. But, while it is true that the Ming Dynasty became introvert, bureaucratic and lacking in support for technological development, its 300 year reign from 1368 to 1644 was marked by a flourishing artistic and literary culture and shows little signs of linguistic conservatism. Throughout its history China has shown surprising resilience and an amazing ability to step up to challenges, whether they be military, commercial or cultural.[29]

Two other explanations seem to be better candidates: First of all the pictographic nature of the script allows it to be used across the numerous mutually unintelligible dialects in China, and secondly the Chinese languages contain an inordinate amount of phonetic redundancy, which would render an alphabetic script much more ambiguous than in Indo-European languages.

Unfortunately the adherence to a script consisting of upwards of 50,000 characters has caused a number of problems in the development and adoption of later communication technologies – with dire consequences for the global competitiveness of China and other Far Eastern countries, and it is really only with the introduction of computers that modern communication technology is beginning to accommodate their complex scripts.

Other cultures, particularly the Harappans in the Indus Valley and the Maya Indians in Mexico, have developed their own writing systems, seemingly independently, but none of them have survived to this day or give us significant additional clues to the significance of writing and of the various types of writing systems.

3.2.5 Communication Infrastructures

An important rationale for the development of writing systems was the ability to communicate accurately over distance, but of course the written word does not travel very far by itself. It requires a system of transmission, and throughout time the access to and control of these systems have been a major factor in the control of power.

Postal systems have a history almost as long as that of writing itself. The first reference to postal services is from Egypt around 2000 BC, and relay systems using horsemen or runners were in use in China from around 1200 BC and in the Persian Empire from 600 BC. Not surprisingly the Romans were the first to develop a full-fledged postal service in the west. Using a similar system to the Chinese they were able to cover their entire empire with a very efficient system of riders who could cover as much as 270 km per day with dispatches. The Roman system lasted until some time past the demise of the Roman Empire, but from around the 9th Century AD and until the 19th Century Europe would be without public postal services, whereas the Chinese have maintained their system continuously at least since 270 BC.

The Romans and the Chinese also developed something resembling newspapers very early on, but, like the postal systems, they were mostly used in the service of the rulers. Newspapers as we know them today did not appear until well after the invention of the printing press.

3.2.6 Writing Tools and Materials

Ancient civilizations used a number of different writing materials ranging from stones, clay and pottery to leather, wood and plant fiber materials. As mentioned the Sumerians mainly wrote on clay, which is a fairly durable and lightweight material and a flexible writing surface. It was thus very useful for bureaucratic purposes – an important factor in the creation and maintenance of the efficient and large-scale Sumerian city-states.

The Egyptians wrote on both stone and papyrus from the beginning. Hieroglyphs were chiseled in or painted on stonewalls and pillars, and reeds were used to write on papyrus. Egypt thus had the dual advantage of the extremely durable stone with which to manifest and maintain their culture and power structure over time and the both lightweight and strong papyrus, which facilitated both trade and administrative matters like taxation and wage payment. The ancient Egyptians were, in fact, quick to recognize the value of papyrus and turn it into a state monopoly. The manufacturing process was kept secret, and papyrus was Egypt's greatest export item with the only real competition coming from parchment.

Parchment was probably developed in the Middle East in the second millennium BC. It is made from animal hides and possesses a number of advantages over papyrus. It is stronger and stiffer, easier to write on, and you can write on both sides. Parchment is also better suited for colder climates and was the preferred writing material in northern regions, but it was expensive and cumbersome to produce.

The Greeks and Romans used both papyrus and parchment, but for more daily writing chores like education they used wax tablets, which were pieces of wood (and later sheets of leather) covered with wax. Wax tablets were easily reusable, and they were thus very useful for note taking. They were also much cheaper than parchment and papyrus and would remain a popular writing surface all through the Middle Ages, but they did not retain information well and were thus not trustworthy for keeping records or other text over longer periods of time.

The origin of the word ‘paper’ is papyrus, but paper as we know it today was invented in the first Century AD by the Chinese and spread to Europe in the course of the next millennium. Paper is far cheaper and easier to produce than papyrus, and it would eventually replace virtually all other writing surfaces.

This brief history of writing tools and materials shows that although both have improved considerably over time, qualitative leaps are few and far between. In terms of preservation over time, nothing has surpassed Egyptian writing in stone, and in terms of portability combined with durability papyrus is still considered an excellent though cumbersome to produce material. And the ancient method of impressing tokens into clay envelopes or tablets, i.e. the very origin of writing, can be seen as the first example of movable type, which would turn out to be the basis for the next true revolution in communication – the printing press.

3.2.7 The Characteristics of Writing

Infrastructure

Undoubtedly the main general advantage of writing is its ability to preserve thoughts and records and thus enable communication over time and space. The distribution in time and space combined with the fact that written text can be copied accurately enables the spread of a text to a much larger number of people than an oral message. History, however, shows that only a very few written documents before the invention of the printing press have had wide-spread distribution, and it would certainly be wrong to call writing a one-to-many communication technology or a mass medium. Like oral communication it is a one-to-one communication medium, but the difference is that writing is one-way, persistent and static communication, which also enables it to support many-to-one communication as for instance in a census or referendum.

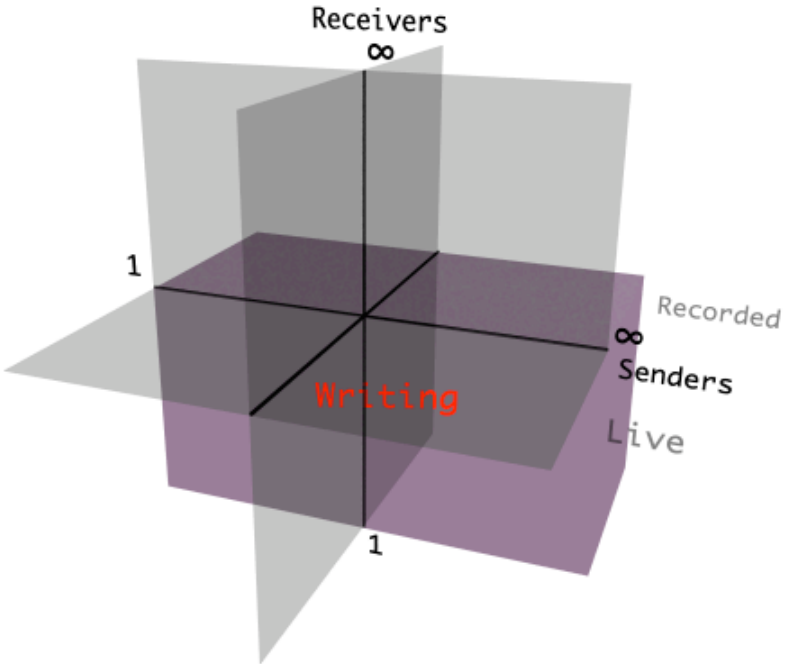


Figure 8. Writing enables delayed one-to-one and many-to-one communication.

The material upon which writing is recorded is of course a crucial factor in its distribution and preservation and therefore also in its use and its impact of society. Clearly the Egyptians for instance used the permanence of stone to record the exploitations of their Pharaohs for future generations, whereas papyrus was mostly used for more mundane purposes like accounting and messaging. The invention of papyrus must therefore have had a significant impact on the impact of hieroglyphs on society, just like the transitions from clay to parchment and from parchment to paper did in Europe and the Middle East.

Representation

Charles Sanders Peirce classifies representation (or signs) in terms of three concepts[30]:

- **Icons** (or Likenesses) are representations that refer to their objects directly by bearing some form of resemblance to the object**.** An example of an icon is a smiley.
- **Indices** are representations that have an existential connection to their objects. An example of an index is a footprint in wet sand.
- **Symbols** are representations that refer to their obsjects only through interpretation, i.e. through some form of convention.

In view of this classification we can distinguis representations on the basis of the character of the reference to the objects of representation, and all we need to complete the picture is to distinguish between pictographic signs that are based on visual representation and phonetic signs, which represent sounds.

Pictographic Scripts

The first writing systems were all visually based, i.e. the characters in the systems were based on the seen rather than the heard. They appear to have evolved from early pictorial or physical representation rather than from spoken language, and in that sense they did not even depend on spoken language.

The simplest pictograms are icons, i.e. direct pictorial references to the object denoted, and are in fact of a more intuitive nature than the oral representations, which in most cases have no direct referential quality. Pictograms differ from pictures in that they denote classes of objects, like “man”, “cat” or “star” rather than specific entities, but they can only describe concrete objects and a pictographic script based solely on pictograms has no means of describing abstract concepts, which of course makes it severely limited. The only present-day example of an almost purely pictogram-based script is Naxi from the Yunnan province in China, where all abstract concepts are merely left out and must be supplied from memory by the reader. Naxi is therefore more a mnemonic device than a proper script.[31]

Pictograms are universal and intuitive and requires less interpretation than words, but they require a notion of classes of objects, as they differentiate from pictures by denoting the general rather than the specific. Pictograms are thus the first non-verbal step in creating a representation of abstract concepts, and the classification of objects eventually leads to the development of ideograms.

Ideograms constitute a conceptual leap quite similar to that of oral language. When symbols can represent ideas associated with an object or a class of objects, the language of symbols suddenly becomes a vehicle for expressing abstract ideas, and new categories of symbols, like verbs and adjectives, are introduced making the language much more dynamic and versatile – in fact making it a language at all. Ideographic systems enable the development of complex symbols that combine other symbols to form aggregate concepts and indicate conceptual relationships between ideas.

Ideographic writing systems do not depend on the spoken language, but they are less universal than pictographic, since the interpretation of ideas from symbols is highly culturally dependent.

Pictographic writing systems have severe disadvantages due to their large number of symbols, but there is universality and richness to the ideographic, which is completely lost in phonetic representations. Western languages adopt many new words, and often just as sounds without any relation to

existing words. We adopted the Coca-Cola brand, for instance, as a sound rather than a meaningful word, but in Mandarin all symbols have a meaning in addition to representing a sound, and finding a good name that would sound like Coca-Cola without using symbols with confusing or derogatory secondary meanings was a bit of a challenge. Before the Coca-Cola Company came up with an official name, some local traders created signs that produced the right sound without paying heed to their meaning. A couple of these attempts turned out to be somewhat unfortunate, as the signs could be read as for instance 'bite the wax tadpole' or 'female horses stuffed with wax'. Contrary to popular belief, however, the Coca-Cola Company had done its homework and launched the soft drink under a name, which does not quite sound like Coca-Cola, but translates to something like 'Happiness in mouth'.[32]

As the Danish author Carsten Jensen[33] points out, this story indicates how the Chinese languages are enriched by the adoption of new words, whereas languages with alphabetic scripts are impoverished by the adoption of words with no inherent meaning or relation to tradition.

Graphic symbols can easily be misunderstood, but they can be used to bridge oral language barriers and are very useful in cultures like the Chinese, where the languages contain many phonetic ambiguities. Like in the Babel Myth the people of Mesopotamia was struck with different tongues, once the tokens and visual representations were replaced by syllabic writing.

Phonetic Symbols

The first step in the transition from pictographic to phonetic writing is logograms and rebus writing where pictographic symbols alone or in combination are used to represent a sound rather than what they depict. This transition of course opens written representation up to the syntaxctic and semantic richness of the spoken language.

A natural development of rebus writing is syllabograms, where pictures represent syllables rather than words. This construction of course allows for a larger set of expressions with a more limited set of symbols[34], but at the expense of intuition in representation, since symbols now start to loose their reference to real world objects completely, a development that continues with

the phoneme-based alphabet until even the pictorial reference to known objects disappears.

Since phonetic alphabets represent spoken language by its smallest constituent elements, the phonemes, the phonetic alphabet can be said to be the ultimate, atomized representation of speech. Phonemic writing can describe any sound that can be uttered, and as a representation of sound it can help newcomers learn a spoken language and the locals to write the newcomers name even when it has no meaning in their language. According to John Darnell, the ancient Egyptians may have invented alphabetic writing, because they needed a way to write the names of their Asiatic servants – names that were mere sounds without meaning to the Egyptians,[35] and Schmandt-Besserat shows a similar development in Sumerian writing, where phonetic rebus-writing first appears in the description of names of individuals associated with records.

Transitioning from a picture-based script to a syllabic and on to an alphabetic requires three different conceptual leaps: First of all the creation of meaning by the means of pictorial representations, secondly the interpretation of meaning from image, and thirdly the construction of a syntactically sound structure based on phonemes. At the same time each transition increases the semantic scope and complexity of the representation and thus of expression and thought.

Alphabetic writing is not intuitive, responsive, interactive, living or even aesthetic. It speaks only through our ideas, but strangely enough it seems to speak to our imagination better than virtually any other type of communication - or is that just a rationalization we have made to justify our dependence on such a poor communication technology? Certainly the simplistic, sequential and ambiguous nature of alphabetic writing forces the active use of imagination, and it is possible that the constraints imposed by writing have in themselves been a factor in our cognitive development. Irrespective of this, we should not forget that writing speaks no more than a musical score plays.

The fact that writing represents a transition of communication from ear to eye is perhaps the most researched and discussed - certainly by those who are

discussing the effects of television and digital media. Marshall McLuhan and Walter J Ong for instance place great emphasis on the visual nature of writing, and especially McLuhan sees the transition from auditory to visual media as a loss. And it is true that sound is omni-directional and seems to have a more primal quality than the mono-directional sight, but in my view the development of symbolic representation has had more far-reaching consequences than the transition to a visual representation.

Production

> *'One of the most startling paradoxes inherent in writing is its close association with death. (...) The paradox lies in the fact that the deadness of the text, its removal from the living human lifeworld, its rigid fixual fixity, assures its endurance and its potential for being resurrected into limitless living contexts by a potentially infinite number of living readers'*
>
> *Walter Ong*[36]

It is clear from history that the art of writing developed primarily from a need for more permanent and accurate records[37], and it has kept this role all through history, but the methods, tools and materials of production have changed considerably over time, and with them of course also the skills and resources needed to master and have access to writing.

One of the major problems with early writing systems was the considerable time and effort it took to learn the large number of symbols in the different pre-alphabetic scripts. Learning the Sumerian syllabary or Egyptian hieroglyphs took years and mastery a lifetime. The alphabet helped considerably in democratizing writing, but still required years of schooling, and it was only when the printing press made wider dissemination of knowledge possible and made the ability to read and write more and more important for all walks of life, that efforts were made to educate the general public.

The availability and price of writing tools and materials have also presented, albeit somewhat lesser, obstacles to writing. The clay used in Mesopotamia was of course an abundant and fairly durable material requiring only a stylus and an oven for baking, but the Egyptians in many cases had to travel far to obtain suitable stones for their inscriptions on obelisks and temples, and the process of carving hieroglyphs in stone must have been very time consuming

indeed. Papyrus, on the other hand, was lightweight as well as durable and produced from the abundant papyrus plant. Unfortunately the manufacture of papyrus was a lengthy affair and the methods kept as a closely guarded secret. This gave the Egyptians a long competitive advantage in the market for writing materials, and it also provided the ruling class with an ability to keep production and dissemination of information under control.

Parchment also required a rather elaborate manufacturing process and was quite expensive, and it was paper that finally made writing and written material available to the broader public.

The actual production of text depends on the writing surface, and until the invention of movable type, writing was basically an irreversible process. Once chiseled in stone, impressed in clay or written with ink on parchment, papyrus or paper the text is fixed in place and form and does not lend itself to any form of editing.

The permanence and unchangeable nature of text is an important part of its credibility, and even to this day we view changeable text, e.g. writing in pencil, as mere notes. Until a couple of decades ago students were required to hand in their papers in ink and thus had to live with the age-old problem of having to rewrite a whole sheet if they made a mistake. Imagine making a mistake on a 60-foot obelisk!

And writing is not only irreversible. It is linear in nature, and, unlike the dynamic, interactive speech, longhand writing requires us to structure our thoughts and phrase our sentences before expressing them. With the writing of each word we are faced with its immortality and the possibility that our words will come back to haunt us or become part of our legacy. Writing is indeed a serious affair.

The wax tablet used by the Romans, and the graphite pencil and rubber eraser invented in the 18th Century both enable a different and much freer writing process, and we should not underestimate the importance of scribbling in wax and penciled notes. Their very erasability renders them less consequential to us and allows us to at least partially escape from the restrictions of linearity in thought and expression.

Reproduction of text was a significant problem until the invention of the printing press. It could only be done by hand, and as the importance of books as a source of knowledge rose; scholars spent more time copying than reading books. As copies were often made from copies the risk of accumulated (intentional or unintentional) errors was considerable, and the tedious work of copying and checking copies distracted especially the European monks from accumulating knowledge and contributing to the generation of new knowledge.

In summary, writing constitutes two major qualitative shifts. First of all it introduces preservation of information enabling accurate communication over time and space. Secondly its various symbolic forms change the scope and complexity of expression and, in turn, thought. As will be discussed later, writing changed the World in many ways, yet its scope was limited by the cumbersome reproduction process, which was not considerably improved until the invention of the printing press several thousand years after the first characters were imprinted in clay.

3.3 The Printing Press

> *'We should note the force, effect, and consequences of inventions which are nowhere more conspicuous than in those three which were unknown to the ancients, namely printing, gunpowder, and the compass. For these three have changed the appearance and state of the whole world; first in literature, then in warfare, and lastly in navigation: and innumerable changes have been thence derived, so that no empire, sect, or star, appears to have exercised a greater power and influence on human affairs than these mechanical discoveries.'*
>
> Francis Bacon[38]

The invention of the printing press is usually ascribed to Johann Gutenberg, who printed the first book in Mainz in 1450, yet his invention really consisted of bringing together a number of different technologies that had been around for centuries:

- Mass-produced paper, which was developed in China as early as the second century AD and was brought to Europe in the 12th Century AD[39]

- The special press, where a wooden screw is used to press two plates together to press ink into paper. This type of press had long been in use in olive oil production and the Chinese developed the first printing press as early as 593 AD[40]
- Block printing, which was developed in China around 200 AD and was common in Europe in 1300 AD[41]
- Movable type, which was known in China around 1040 AD, and metal-alloy type, which was first employed by the Koreans around 1230 AD[42]
- The special, oil-based ink needed for metal printing, which had also been around for centuries, although it had not been found useful for books and was considerably improved in the period around 1450[43]

So, rather than creating a truly new and revolutionary invention, Gutenberg seems to have created the right assembly of technologies at the right time and in the right place.[44]

The print revolution would not have been possible without each of the developments mentioned above, but the single, most important aspect of the invention itself was without doubt the employment of movable type, which allowed each letter to be reused many times. As mentioned, movable type had been known at least since 1000 AD, but for two major reasons it was never widely deployed in the Far East:

First of all the Koreans and Chinese did not have an alphabet! Printing the Buddhist scriptures required either a very large number of meticulously carved full pages[45] or a collection of all the individual character casts representing the very large number of Chinese symbols. So, it may be claimed that the development of alphabetic script was the crucial factor in the development of printing and all it brought with it in Europe.

The second reason is similar to the failure of the Egyptians to utilize their alphabetic script: Whereas China was possibly the most technically and scientifically advanced civilization around the time of the development of printing, it seems that social and political factors were at play that would lead to complete technological stagnation by the 14th Century and thus prevent the spread and utilization of printing and other technological advancements[46]. The country and with it its science and technology, was controlled by strong

central dynasties, and when the Ming dynasty came into power in the 14th century, technology began to be viewed as potentially dangerous to the social stability, and the central authority began a period of five centuries of isolationist and protectionist policies.

In Korea the situation was similar. The first half of the 15th Century AD saw tremendous technological improvements in Korea under the reign of King Sejong[47]. He even developed a 28 letter alphabet, Hangul, which is still lauded as possibly the best alphabet in the World due to its correspondence between the letters and the shape formed with the mouth to produce the sound represented. In principle Korea was thus well poised to take the leap into the future, but later rulers failed to maintain the momentum, and struggles between Confucian and Neo-Confucian rule toward the end of the 15th century led to a series of literary purges and a return to conservatism.

In Europe the situation was virtually the opposite. After more than a millennium of scientific and technological stagnation the Italian renaissance in late 14th century led via the re-discovery of the ancient Greek culture and literature to a surge of artistic and scientific activity that would eventually form the basis of Modern Europe. In fact, the situation in Europe was perfectly ripe for the introduction of the first mass medium – the printed book. With the increase in wealth and trade during the 14th Century the merchants had gained enormous power, and society had become increasingly secularized. Humanism celebrated the individual genius, and increasingly people were valued for their acts rather than their social heredity. In addition to this there was a newfound interest in the Greek philosophy and in the beauty of grammar and rhetoric. Literature, both ancient and new, gained a revival, and slowly vernacular languages began to invade the territory of writing previously all but monopolized by Latin.

It is hard to imagine a more opportune time for the introduction of a technology that would allow the individual writer to reach thousands of readers in their own language and independently of monasteries and their scribes. Just like Ancient Greece in the 8th Century BC, Europe in the 5th Century was coming out of centuries of predominantly oral culture and little social or political cohesion. The humanism of the renaissance was a similar

awakening to that of Athens, and the roots were once again to be found in wealth and commerce. What is today Germany and the Netherlands were experiencing newfound prosperity and a rapidly growing population after the devastation of the plague in the mid-14th Century. A rising merchant class and the influence of humanism from Italy created a spirit of optimism and a growing opposition to the domination of the Catholic Church[48]. At the same time a weak or non-existing central power structure allowed for the rise of independent thinking and the spread of new ideas. A revolutionary communication technology had found virgin territory upon which to grow and prosper, and it did so with unprecedented speed.

The first printed books were published in Mainz in the 1450s, but within less than 50 years German printers had established print shops across most of Europe, and around 8 million books had been printed[49]. A whole new industry was in the making changing the production and sale of books from a small, exclusive retail business to a burgeoning wholesale affair resembling the later mass production economies of the industrial age. Europe was embracing its newfound literacy, and the stage was set for the Reformation and the dawn of the so-called Age of Enlightenment[50], where reason, rationality and empiricism would take center stage and spawn a period of scientific discovery leading directly to an unprecedented wealth of innovations in communication technologies in the 19th Century.

3.3.1 The Characteristics of Print

All the printing press did was enable mass production of identical documents, but this seemingly simple change made the print the first mass medium and would prove of fundamental importance to western society. In terms of the communication space it enabled a much larger number of people to publish and multiplied the number of readers. And of course the ability to create thousands of copies of each book or newspaper vastly increased the distribution of text and pictures in space and time. Print thus marked the birth of mass media as indicated in Figure 9.

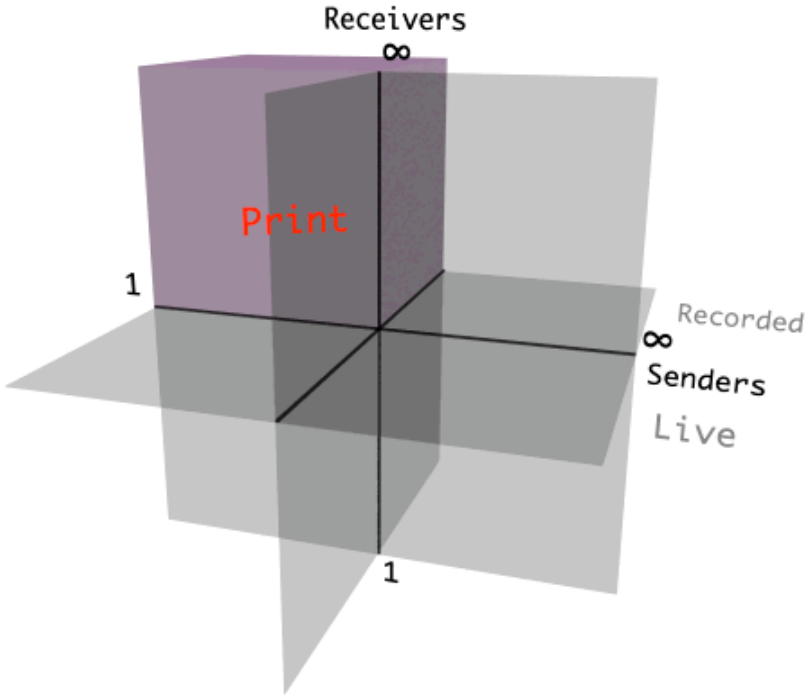


Figure 9. The printing press enabled delayed one-to-many communication

Representation

On first glance it would appear that the printing press changed nothing in terms of representation, but a closer examination reveals that this is not quite true. Before the printing press no two books were alike. Each copyist had his own style and handwriting, and each copy introduced new errors, omissions, additions or deliberate changes. Movable type brought fixity, i.e. the ability to produce identical copies of a text. Once a text has been typeset it can be printed as many times as the form and type hold up, and in principle this property enables perfect reproduction and the distribution of an identical body of knowledge indispensable to e.g. the development of science[51]. The uniformity of style and copies introduced by the printing press and the physical nature of movable type underscored the atomistic building-block character of the alphabet and actually changed the nature of the book as well as our perception of knowledge. Books for instance structured knowledge

around indices and categories that finally replaced the old mnemonic techniques inherited from oral society.[52].

Production

Printing required considerable skill and a fairly expensive setup. It was of course a far cry from the man-millennia used by monks to copy books, but the printing and distribution of books introduced a new point of control that kept the access to dissemination on few and privileged hands, where it has remained almost to this day[53].

The printing press introduced the concepts of copy-editing and proof reading, since the author no longer had to create the final work directly. This of course freed up authors somewhat, but it did not per se change the writing process, which was still done by hand onto paper or parchment.

Movable type brought malleability to text and changed the production process considerably. The uniformity of printed characters reinforces the modularity of the alphabet, and the process of assembling text for a printed document brings back a tactility of symbols resembling that of the Sumerian tokens. Printing thus directs the human mind once again to the atomic nature of its linguistic symbols. In this sense the atomic nature of the alphabet is only completed with the advent of movable type, and it seems likely that the physical manipulation of alphabetic symbols has had a residual effect on the human thought processes propelling Europe into the scientific revolution. Certainly many scientists during the 16th and 17th Centuries were directly involved in printing and saw it as indispensable to their pursuits. But we have to bear in mind that the malleability of movable type was available only to printers. Establishing and running a print shop was an expensive and fairly complicated affair, so for the average person the writing process was unchanged. And movable type was quite expensive, which meant that printers could not afford to store finished print plates. Therefore no malleable record was kept, and each new edition of a book would require a completely new typesetting process.

In summary, the printing press gave us accurate, industrial reproduction of text, introduced the notion of mass media and malleable text in the form of

movable type. The printing press made the written word an indispensable part of societal development in large parts of the World. Reading and writing takes years to learn and master, but became a requirement for participation in modern society – a requirement that is no less important today than three hundred years ago. But the centuries have not passed without the appearance of rivals to challenge the blessing of symbolic representations – and the 19th Century stands out as perhaps the most prolific period of communication technology development in history.

3.4 The 19th Century

There is no doubt that the 19th Century gave rise to more innovations in communication technology than any other century before it. The period from 1825 to 1900 gave us photography, the telegraph, the fax, the telephone, radio, cinema and television – a veritable explosion in recording, transmission and encoding of information and a radical departure from the ever-increasing symbolic representation of the previous millennia.

Much of the literature about communication attaches a great deal of importance to this period in history, and it would certainly be a grave error of omission to ignore it. But did the 19th Century really produce any true communication revolutions on par with the writing, the alphabet and the printing press?

On the surface the answer seems to be yes. The 19th Century would be the period when communication technologies finally broke the barriers of time, distance and the written word, and for the first time in history the globe became spanned by a fully connected communication grid, enabling almost instant communication between virtually any cities on Earth. It was also the century when the United States began to take the lead in innovation, and communication technology certainly played a role in this transition of momentum and power to the new continent. There are important lessons to be learned from this period about the role of technology in society, but in order to see whether any real qualitative changes took place we have to delve a little deeper.

There are two main reasons for the multitude of new communication technologies of the 19th Century. First of all the scientific efforts of the previous centuries had laid the foundation for practical implementations in a number of areas, and, secondly, one of these areas was electricity, which finally became practically useful with the generator developed by the British scientist, Faraday, in 1831. Electricity became as it remains the primary prerequisite for modern communication technologies, and although there are a few exceptions like photography and the early phonograph, it seems fair to call the modern era of communication the Electric Age. This term, however, is also misleading, since electricity is only a fuel and does not constitute a communication technology in itself. Without electricity the world of communication would have looked very, very different, but when we wish to examine communication we must lift our perspective above the electrical currents to the machines that utilize them. So let us have a brief look at electrical communication technologies and how they changed the World.

3.4.1 The Telegraph

Inventions like Indian smoke signals, semaphore flags and even string telegraphs preceded the electric telegraph in extending real time communication in space, but no technology before the electric telegraph enabled global real time communication. The telegraph heralded the coming of the electronic age and Marshall McLuhan's global village, and in many ways it is the most important precursor of the Internet.

The two basic premises for telegraphy are a communication infrastructure and a coding scheme. Electricity provided the ability to send signals over wires and later through the air, but initially the only basis for coding and decoding of signals was binary - voltage or no voltage. So the inventors were forced to come up with a binary coding scheme to make the infrastructure useful. Fortunately they had one important thing going for them: The alphabet as a finite coding scheme for language.

Ancient Greece started to make language itself a subject of systematic thought around the 5th Century BC[54], and it is not surprising that the alphabet led the Greeks to a proper coding scheme for long distance communication.

Around 150 BC the Greek scholar Polybius created the first known system to communicate the full alphabet using a system of fires. The system was based on splitting the 24-letter alphabet into 5 groups. 5 torches could then be used to indicate first the group then the letter in the group, i.e. a simple 5-based numbering system, and Polybius himself notes the systematic tradition of thought enabling him to come up with the scheme:

> *'In offering these observations I am acting up to the promise I originally made at the outset of this work. For I stated that in our time all arts and sciences have so much advanced that knowledge of most of them may be said to have been reduced to a system. This is, then, one of the most useful parts of a history properly written.'*[55]

Nevertheless, Polymbius' system does not seem to have found practical application, and it would take another 1800 years before the coding scheme was reinvented and yet another 150 years before it was finally brought to practical use by Claude Chappe with his panel telegraph, which utilized flappable panels rather than fires, but employed a coding scheme more or less identical to Polybius'[56].

Chappe's optical telegraph system enjoyed some success in Europe and actually survived until past 1860 in some European countries, but it was the invention of the electrical telegraph by the British businessman William Cooke and the American artist Samuel Morse in the 1830s that would create the breakthrough for long distance transmission of coded signals.

The telegraph spread across the Globe with a speed possibly only rivaled by the Internet. Within 30 years of Morse's demonstration of his electric telegraph just about the entire world was connected by telegraphy.[57] There were more than 1 million kilometers landline, 48,000 kilometers under-water line and more than 20,000 cities online.[58]

Already around 1855 telegraphs were developed to send pictures and drawings, and during the 1870s Emile Baudot developed the first truly digital encoding, the first multiplexing system, and a special terminal for entering Baudot code through a keyboard. His legacy remains to this day in the measurement of data transmission speed in baud and the ASCII encoding systems, which grew out of the 5-bit Baudot code.

In most European and Asian countries telegraphy was kept under government control and became part of the postal system, but in the States it spawned what was to become one of the World's largest companies, Western Union, which would later play an important role in the development of telephony.[59] Due to its centralized structure and cumbersome interface, however, the telegraph never became a household technology. It would take almost 80 years before subscriber dialing and a normal keyboard for text entry were introduced, and by that time telephony had taken over the market for domestic communication. Nevertheless, telegraphy did have a tremendous impact on global communications and was incredibly enough still widely used by governments and bureaucracies around the world at least until the end of the millennium.[60]

3.4.2 The Fax Machine

The fax machine in its original form, called the pantelegraph, was a more or less straightforward extension of the telegraph. It would work on the same lines and with the same binary, electric principle, but where the telegraph employs a specific coding for alphabetic symbols, the fax reads, transmits and prints an actual image. It is thus in principle far superior to the telegraph in that it is able to communicate a much larger category of information including handwriting, signatures, and (eventually) photographs. One would thus expect that the fax machine would rapidly replace the telegraph, but for various reasons more than a century would pass before that happened. First of all it was not marketed very aggressively by its inventor, the Italian Giovanni Caselli, and secondly because the various telegraph authorities feared the competition to normal telegraphy and thus did nothing to promote the fax. There does, however, seem to have been extensive negotiations with the Chinese, who saw the pantelegraph as a solution to the transmission of ideograms, and the system was eventually adopted by the Japanese, from whom it more than a hundred years later would spread to the rest of the World to enjoy its short-lived popularity in offices and homes.[61].

3.4.3 The Telephone

The telephone was not invented until 1877, but its invention followed 200 years of scientific experimentation and tinkering, and as with all other inventions of the era it is actually very hard to determine who should be credited with its invention. But, irrespective of who was the real inventor of the telephone, while most of the groundwork had been done in Europe, it was in New York that Alexander Graham Bell created the first commercial phone system and started the company that would evolve into AT&T.

The first telephone installations came in pairs[62]. There was of course no infrastructure for telephony, so purchasers would need to install their own system including a wire connection between the two locations. The lack of an infrastructure and switching technology was an important impediment to the spread of telephony, and Bell had a vision of a network much like the gas or water system with lines into every company and household as well as central offices and long-haul lines between cities[63].

This vision was radically different from the reality of telegraphy, where all communication was handled from telegraph offices. In fact it was in some ways closer to that of the Internet with its many-to-many connections, but Bell saw the network as only a point-to-point connection where '*a man in one part of the country may communicate by word of mouth with another in a distant place.'*[64]. And the world of telephony was built in accordance with his vision. Although it was technically feasible, no attempt was ever made to turn the telephone network into a many-to-many communication system, and the telephone thus failed to become a truly radical innovation.

Central switching stations began to appear already in 1878, but acceptance and deployment were not as swift as with the telegraph. There are several reasons for this: Firstly, it seems that society in both Europe and United States was by now so text-based that communication over distance by voice was generally considered amusing but of no real significance. Secondly, like the fax machine the telephone was considered a competitor to the telegraph and was thus suppressed by various means. Thirdly, tradition, especially in Europe, prevented people from conducting business over the phone.[65].

The fourth reason has to do with how the telephone business and infrastructure were handled. An investigation of this is more complicated, since matters were handled very differently in the different countries, but it deserves some attention, as the consequences of the decisions are felt even today.

The United States chose to leave the telephone market to open competition. So when Bell Telephone Company's patents ran out in 1893 and 1894 the market was swamped with new entrants ranging from the tiny exchanges serving small farming communities to the larger and more threatening competitors. Bell eventually adopted a mixed strategy of collaboration with those who served areas where Bell was not active and fierce competition with the rest. The result was incompatible systems, delay of national services, lack of quality service, dissatisfied consumers, almost a century of battles with the AT&T monopoly, and probably a delayed spread of telephony.

At the opposite extreme was United Kingdom, where the state in 1899 decided to take over all long-distance services and allow no local licenses beyond 1911. This of course meant that no companies made proactive initiatives in the intervening years. The public takeover was immediately followed by World War I, and the British telephone system deployment ended up being delayed by at least 20 years.

Most European countries nationalized at least part of the telephone service, and whereas the result may have been slower diffusion, it also meant telephone rates at around 10-20% of those experienced in Bell-controlled areas in the states, and, surely most importantly in the long run, it resulted in national standards for telecommunication.

The most successful approach in Europe was clearly the one taken by countries like Sweden, where the government took over all long distance lines, but encouraged local operators and cooperatives to establish their own exchanges. Sweden was also helped by the emergence of the LM Ericsson Company that produced both telephones and switchboards at a very early date. For the next century the state run telephone company, Televerket (today TeliaSonera), and LM Ericsson lived in a strong, symbiotic relationship, which

seems to have benefited both and certainly contributed to making Ericsson one of the largest hardware suppliers in the world of telephony.

The state-run infrastructures and the symbiotic relationship with equipment manufacturers in Scandinavia were not without problems, but during last quarter of the 20th Century the Nordic countries arguably reaped the benefits of their approach when they developed the first joint mobile telephony standard, NMT, which became the basis for the highly successful GSM standard.

3.4.4 The Radio[66]

The development of radio communication was preceded by a number of scientific experiments in the late 19th Century, especially following the discovery by the German physicist, Heinrich Hertz that electricity could be transmitted through air over electromagnetic waves. Most of the experiments, however, were only studying the properties of electromagnetic waves and had no inkling that these waves could be used for communication purposes. But in 1894 a 20-year old Italian named Guglielmo Marconi started experimenting with the transmission of information without wires. He was not thinking about radio, as we know it today, but rather of an improvement to the telegraph, and his experiments thus concentrated on sending signals rather than sound.

What would initially make the wireless telegraph famous was the saving of lives. Already in 1899 a lightship equipped with a Marconi transmitter signaled land for help when it was rammed by another ship, and instant, global fame was guaranteed, when the SOS signal from the Titanic guided ships in the area to the sinking ship and secured the lives of over 700 people.

The wireless telegraph has lived on until today, but it was of course the broadcasting of sound that would make the radio a household item. The leap from transmission of Morse codes to transmission of sound was not large given the already existing wire transmission of sound, and the first experiments with music broadcasting were done by the Canadian Reginald Fessenden in 1906 – but no one seems to have been paying much attention. All the companies involved in radio developments were concerned with

creating wireless telegraphy, and for them the free spreading of radio waves to anyone with a receiver was a liability rather than an asset.

There was an inherent problem in turning broadcast radio into a profitable business. Radio waves spread freely through the air and can be picked up by anyone with an appropriate receiver. They are thus neither attached to a physical material that can be sold, like for instance a newspaper, or traveling through controlled networks like telephone calls, where both caller and receiver can be clearly identified. On the other hand broadcast radio reaches a large audience within a well-defined area (the range of the transmitter), and it is thus an ideal vehicle for advertising. This would become the dominant model in the United States, whereas in Europe, where the state would become much more involved, the major radio stations were funded through taxes or annual fees on ownership of radio receivers.

Radio possesses several advantages over television. Programming is cheaper to produce, radios can be small and portable, and listening to the radio does not require the same amount of attention as watching television. Radio has thus maintained its position as a preferred broadcast medium for the car, the work place, the beach etc, and for many it is an important source of local news and information.

For the normal consumer, radio has always been a one-way medium, but from a communication perspective the two-way capability of radio is just as important. As a precursor to mobile telephony, two-way radio has been tremendously important in a wide variety of settings, and it is worth dwelling a bit on the fact that radio is at least in principle the first many-to-many communication medium. Radio waves spread freely through the air and can be picked up by anyone, which may make it problematic for personal conversations, but there are many other situations in which this feature comes in very handy. When a ship is in distress it wishes to notify everyone in the vicinity, and when a truck driver wants to find the best truck stop in an area far from home a local broadcast to other truckers and ham radio enthusiast is an extremely efficient method. Citizen band radio in particular under normal circumstances does not carry over more than a few kilometers, but there are many situations where local contact is exactly what you want, and for this

purpose two-way radio has been a superior technology. In fact, citizen band radio should be seen more as a precursor to the Internet than to mobile telephony, and a study of radio-based communities can provide some important clues to the development of communities on the Internet.

3.4.5 Photography and Cinema

> *'If we examine a work of ordinary art, by means of a powerful microscope, all traces of resemblance to nature will disappear—but the closest scrutiny of the photogenic drawing discloses a more absolute truth, a more perfect identity of aspect with the thing represented.'*
>
> Edgar Allan Poe[67], *"The Daugerrotype," (1840)*

Photography was invented in the 1820s and 30s, and it became an overnight success. One reason for this may have been that the technique was given to the public by the French government rather than having to wait for a commercial model, but perhaps more importantly was the fact, that photography was the first direct depiction of reality – seemingly without any intervention by the subjective human mind. Photography was hailed as the mirror of truth, and a daguerreotype of one's house or loved ones rapidly became a prized possession.

Creating photographs also had a fairly low threshold in terms of cost and skill, but it remained a fairly cumbersome affair until 1888, when George Eastman introduced the Kodak camera[68]. Eastman's idea was to make the camera as convenient as a pencil, and he arguably turned photography into one of the most democratic media ever.

Once photography was invented the conceptual leap to put together sequences of photographic images to depict motion cannot have been too large, and in fact the idea of using series of drawn images to create the illusion of motion was invented a few years before photography[69]. Unfortunately there were a number of technical issues to address, and it was not until the Lumiére brothers made their famous cinématographe in 1895 that cinema was born.[70]

Over the next few years the technology was rapidly improved, and an industry was established both in the United States and in Europe. Once the format

was established the industry grew at an astounding rate. In the United States for instance the number of permanent cinemas went from a handful in 1904 to between 8,000 and 10,000 in 1908, and producers and distributors were consistently unable to satisfy the demand.[71] In 1910 the weekly attendance at cinemas in the United States was up to a whooping 26 million[72], and over the next five years cinema changed from the so-called Nickelodeons showing short, cheap productions to purpose-built cinemas showing multi-reel features. Cinema was beginning to establish itself as an independent art form and a true mass medium.

In France, Pathé recognized the power of cinema as a means to reach a mass audience, and in 1910 his company started producing newsreels to be shown in conjunction with feature films. Until the advent of television newsreels were the only access to motion picture news, and they became an extremely important tool for informing the public and shaping public opinion. Lenin declared cinema the most important of the arts and used it to unite the Soviet Union, Hitler used it to rally the masses for war, and Churchill and Roosevelt depended on it for building patriotic fervor during the war years. Even today, newsreels still precede films in countries where television penetration is low.

The movie industry became the first example of American dominance in the global media market. Although both photography and cinema were invented in Europe, the American film industry grew much quicker and produced films for a broader audience. By the 1920s the Hollywood film industry had professionalized film production and distribution and was well on the way to the dominant position it has kept to this day.

Movie production and cinema attendance reached its peak in United States during the 1940s with more than 90 million tickets sold per week in 1946[73]. Television and a changing lifestyle within the next ten years caused attendance to fall to half that number, where it stabilized until the introduction of the VCR. Initially the film industry was highly worried about VCRs and actually tried to have them banned with reference to copyright violations, but as it has turned out, VCRs became one of their most important sources of revenue

3.4.6 Television

Society is now one polish'd horde
Form'd of two mighty tribes.
The Bores and the Bored

Lord Byron[74]

The first idea of television as we know it was conceived in 1884 by the German science student, Paul Nipkow[75]. He called it an 'electric telescope', and like other early experimenters he envisioned it as an adjunct to telegraphy rather than as a mass medium. The practical development and the first introduction to the market happened in the late 1920s in parallel in the United States and England – albeit in very different environments. On the American side it was of course once again Edison's company, now called General Electric, which was first with practical experimentation. By 1928 they were transmitting pictures from their Schenectady radio station, but the quality was so low that the experiments mainly consisted of having people guess, which one of their friends was on the screen.

In England the Scottish entrepreneur, John L. Baird formed his own company in 1928 and actually sold receivers to the public. The BBC initially considered Baird's company, BTDC, an unwelcome intrusion, and the BBC Director-General, John Reith, saw no future in television, but in 1929 the British Post Office forced the two companies into collaboration, and in 1930 the BBC in collaboration with BTDC transmitted its first play, 'The Man With the Flower in his Mouth'.

In Germany television was seen as an important part of the Nazi propaganda apparatus. With their superior mechanical precision skills the Germans had managed to improve considerably on the scanning techniques, they transmitted sound in parallel with the image, and they had even by 1935 developed a mobile unit with a camera on top and full development and transmission facilities inside.

In the 1930s the competition within communication technology had become global (in no small measure due to the progress in global communication of course), and all the developed countries were doing television experiments.

In spite of being first with a commercially viable technology the US came to lag behind both Germany and the UK in developing public broadcasting. The reason for this was that the FCC, probably under pressure from the radio and film industries, until 1941 insisted that television was still an experimental technology and was not ready for public transmissions.

In the UK television was stopped by the war, but would resume immediately after, and in Germany television transmission continued to grow during most of the war. In Japan NHK were gearing up to transmit from the 1940 Tokyo Olympics, when the games were cancelled due to the war[76].

Yet, in spite of all the experiments and of the public transmission in Britain and Germany television did not experience a commercial breakthrough. By 1939 only 20,000 sets had been sold in the UK and less than 1,000 in Germany. Explanations vary, but one likely reason is that broadcasting was put in the hands of institutions committed to and fully occupied with the fairly new medium of radio[77].

World War II put a halt to most television activities, but in an indirect way it became the cause of the final breakthrough of television as a mass medium. In United States in particular most radio companies had increased their manufacturing capabilities to provide the military with a variety of radio equipment, and when the war ended they had a large surplus capacity. In order to use these resources a major push for television was created, and within two years the market started to take off. The number of television sets grew from 5,000 in 1946 to almost 10 million in 1950 and 15 million in 1952, by which time television had bypassed radio in terms of advertising revenue. The picture was the same in Europe, although with slightly slower growth, and the next 50 years would more or less belong to the new medium of choice.

It would, however, take considerable time before TV found its own identity and form, and some might even question whether it has done so to this day. Being a child of radio, theatre and cinema, television inherited a number of traits that stayed with it for decades, and for the first many years it was little more than radio with pictures, theatre in a box or cinema in the home.

Just like with the film industry, the United States came to dominate the world of television. The early commercialization of television and the rapid rise of a large, domestic market allowed the Americans to reach an economy of scale and forced American television to create programming that fitted and followed public demand rather than was the extended arm of the government to inform or influence the public. This allowed the Americans to largely set the standard for television entertainment and to spread their programming and thus their cultural influence to the furthest corners of the World.

3.4.7 Personal Recording Technologies

A survey of industrial age communication technologies would not be complete without a discussion of personal recording media and their impact. All these technologies are extensions of and add-ons to technologies already discussed, and they all have a history of professional use before becoming available for private users. As technologies they thus represented nothing new, but in the hands of consumers they took on new forms of life, which changed our perception and use of media and were often perceived as a threat by industry and governments alike.

Sound Recording

Although the phonograph was originally created for dictation, it was not until the 1960s that personal sound recording technologies became generally available. Reel-to-reel tapes came first, but were rather cumbersome, but when Philips introduced the compact audiocassette in 1963 the market started to take off. Soon the recording industry was getting worried about piracy, but it appears that cassette tapes had no negative effect on record sales. According to Stan Liebowitz[78], data from 1978 onwards show that, although the sale of blank cassette tapes outnumbered that of prerecorded tapes, the total sale of prerecorded music continued to rise. His explanation is, that people primarily used blank tapes to record their albums to have them available on both media.

What was more important was the political effect of personal sound recording. Cassette tapes are small, cheap and easy to copy. During the 1970s and 80s

they became a major tool for underground movements in totalitarian countries around the World. Emerging leaders such as Lech Walensa in Poland and Ayatollah Khomeini in Iran used cassette tapes to spread their message beyond the control of centralized government, and even the more innocent spread of Western music into for instance the Eastern Bloc contributed to the eventual fall of the wall. The cassette tape was a precursor to many-to-many communication, and along with the fax machine, satellite TV, mobile phones and video recording it served as an example of what was in store for leaders who believed they could control information,

Video Recording

Smaller film cameras for personal use have been available since 1923[79], but they were very expensive, and it was the introduction of 8 mm film in 1932 that allowed more widespread making of home movies. Until the introduction of Super 8 in 1965, home movies were silent, but that did not prevent their widespread use during the 50s. Many families still today have treasured memories on old film reels stashed in the attic.

The introduction of video cameras for the consumer market in the 1980s quickly made Super 8 obsolete. They had the dual advantage of being able to record on re-recordable tape and producing film that could be shown on a normal television, and video recording has remained the preferred home movie technology until recently.

In the mid-70s the VCR did for cinema and television what tape recorders had done for the phonograph and radio. Suddenly it became possible to control what you saw on your TV at your own time, and people became able to store and replay copies of there favorite films or shows. A considerable power of control had been put back in the hands of consumers, and initially that caused a lot of worries, especially within the film industry. As VCR sales exploded all over the World during the 80s and the first part of the 90s it became clear that the film industry had nothing to worry about. By 1995, when more than 60% of European and American households with television also had a VCR, video sales and rentals produced 3 times more revenue than cinema distribution[80], and the only ones to have any real worries were the television stations, which

were now forced to compete with video stores offering almost new movies, and totalitarian regimes that saw the power of horizontal information exchange extend to video.

3.4.8 A Communication Revolution?

Judging from the number of inventions and their impact on the communication landscape the 19th Century and the beginning of the 20th was perhaps the most dynamic period in the history of communication. The telegraph enabled a global communication network in less than 20 years, and it became possible to record and broadcast pictures, audio and video. Telephony enabled ordinary people to talk over any distance, and news of an event could spread around the globe within minutes.

The inventions of the period were virtually all based in science and experimentation carried out in Europe, but it was the newly independent United States that became the dominating player in the innovation, commercialization and globalization of these new technologies. The strong nation states in Europe developed and utilized the different technologies, but kept most of them under state control, while the United States became the virgin territory for experimentation with infrastructures, economic models and competing technologies. Once again new technologies had to migrate to new territory, and the consequences were far reaching. But we have yet to answer the question posed at the beginning of this chapter: Did the development of new communication technologies in the 19th Century constitute a truly qualitative shift, or were they merely a continuation of earlier communication paradigms?

The technologies developed during this period represent an amazing spread in terms of infrastructure, representation and production, and it is almost impossible to create a coherent picture. But if we examine each aspect in turn a couple of patterns can be recognized.

Infrastructure

As late as 1830 the only infrastructure for communication was physical transportation of information by man, horse or carriage. There were no means

for recording or transmitting sound or pictures, and no real time communication over distance existed. The next century changed all that and in addition gave us the most powerful mass media since the invention of the printing press.

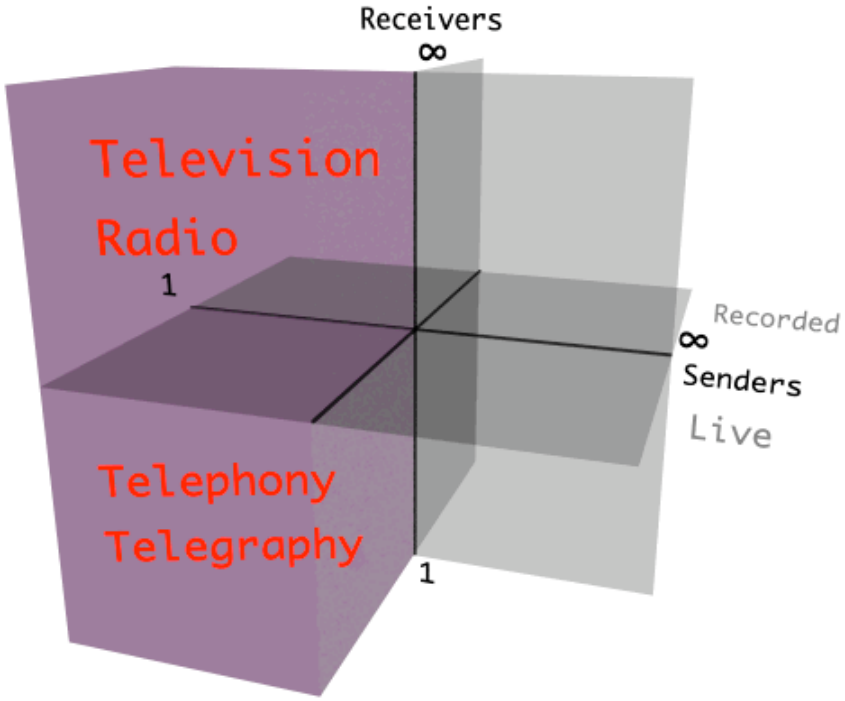


Figure 10 19th Century communication technologies primarily brought real-time one-to-one and one-to-many communication

One-to-one Communication

In terms of infrastructure the telegraph probably represented a greater leap than all the other 19th Century technologies combined. It is global, works in real time and provides something resembling peer-to-peer communication, making tempting to compare it to the Internet as Tom Standage did in "The Victorian Internet"[81]. The peers, however, were telegraph operators working on centrally controlled systems, and it would be a mistake to call the telegraph many-to-many communication. It made the furthest corners of the globe accessible and was arguably the beginning of McLuhan's global village, but,

unlike in a real village, conversation was only for the few and privileged, and the telegraph provided little in terms of interaction.

The telegraph and the telex systems were, however, important predecessors of today's digital communication networks. In their various incarnations these systems introduced binary encoding, digital communication, error-correction, and the interfacing of keyboards and printers to communication systems, and they have certainly made their impression on the design of computers and computer communication up to this day.

Telephony was the first technology to extend oral communication in space and along with its contemporary, the phonograph, it represents our first extension of speech. It equals or even enhances the balance of face-to-face communication, and among all the communication technologies in existence at the time it was unique in requiring virtually no learning and no intermediary like a printer or telegraph operator.

Initially the telephone was a toy and tool for the rich, but it would eventually become a truly democratic communication technology. This is, however, only true when seen from the narrow perspective of the user. From an infrastructure perspective the telephone network, like the telegraph system, ended up as a strongly centralized system controlled by governments and large corporation. Telephones are routed through centers and require point-to-point connections giving full control to whoever controls the infrastructure. Telephony thus creates the illusion of a democratic and balanced medium without technically, economically or even conceptually threatening centralized power structures.

One-to-many Communication

Radio was the first real-time broadcast medium and did for one-to-many communication what telephony did for one-to-one communication. It is radically different from both telegraphy and telephony, because it provides a direct, one-way channel to multitudes of receivers instead of a point-to-point connection between subscribers. Where the telegraph and the telephone are basically extensions of dialog, the radio is a monolog medium, which allows those in control of transmitters to spread their message instantaneously

across the land and exercise full control over both transmission time and content. No skills beyond the comprehension of language are needed to receive and understand radio, and very little infrastructure is required. Producing and communicating radio programs requires little other than a microphone and a transmitter, and receivers can be created with little means and only rudimentary electronic skills. In principle this makes for a very democratic technology and a very powerful one at that, so it is no wonder that radio has been the subject of vigorous control and censure

Photographic imagery entered the realm of one-to-many communication when lithography enabled mass production of photographs, but it never generated an infrastructure of its own. Cinema, on the other hand spread much like the early phonograph with Nickelodeons that eventually developed into a worldwide network of cinemas, but it was television that brought real time sight and sound into our homes and became the first true visual mass medium.

The proliferation capability of the printing press made it the first mass medium, but books must be distributed and picked up by readers, whereas radio and television contain their own distribution mechanism and simply hang in the air for anyone to pick up. We choose what books to read and when we wish to read them, but with radio and television we had no such luxury until the development of VCRs. The electric mass media were therefore and to a large extent still are a much more powerful tool for control and manipulation of entire populations and, indeed, of the entire world.

Representation

We have seen how the history of communication technologies since the days of the first sounds uttered by man and the first scribbling on cave walls has been one of ever increasing symbolic representation, but in the 19th Century representation exploded in all directions.

The use of painting and drawing as a communication tool has perhaps existed as long as speech and certainly much longer than writing, and, until the advent of photography, the visual arts were the only means of providing lasting and intuitive descriptions of the World. In their documentary capacity

drawings and paintings were very similar to text, since their credibility depended entirely upon the ability and faithfulness of the artist in conveying an accurate description. Pictures were an important supplement to text and particularly in the illiterate Middle Ages an alternative, but this would change over night when the photograph entered the stage.

Photography at least seemingly eliminated the middleman and gave a straight forward, true-to-life depiction of reality. Light reflected on the subject enters the lens of the camera and is imprinted upon a photographic plate with no interference from human interpretation. Not quite true of course: Photography does abstract certain features from reality and a photograph is thus both a representation and an interpretation of reality, but it does not constitute an abstract description, and it is intuitively graspable as a direct reference to a real-world situation. This lack of an intermediate layer of conscious interpretation is the true lure of the photograph and an obvious explanation of its great and enduring success. With photography, finally there was a way to create an accurate and direct depiction of a person, place or event without the interpretation of a writer, poet or painter. Where some forms of writing and imagery had certainly by the 19th Century gained great credibility in the minds of people, photography brought what seemed to be indisputable and true images of reality[82].

Visual representations like drawings and paintings and certainly photographs, film and television speak much more directly to us than text. Our brain is much better equipped to interpret the dynamic complexity of the real world than the static simplicity of written symbols, and no education is needed to make sense of two-dimensional images. A child can learn and form a world-view from television without any aid from teachers, and although older generations may see television as vastly inferior to books, the fact remains that the children of the television age take in much more information than their parents did through books.

What photography did to visual communication, telephony did to sound. In traditional telephone communication sounds are represented as modulations over a wire or carrier signal, and there is a direct correspondence between sound and representation – just like between sight and representation in

photography. The analog telephone does not provide an abstract representation of data, but merely transmits what it picks up - in real time.

As a conveyor of speech, telephony is very intuitive and provides all the immediacy and a lot of the intimacy of face-to-face communication. In fact, in spite of its monomodal character, telephony creates a new kind of intimacy and sensuality as you allow your conversation partner to whisper directly and secretly into your ear and virtually touch you through the receiver pressed firmly against the side of your head. At the same time the telephone provides a social distance and a certain sense of anonymity. We cannot see each other's body language or facial expression, and the bandwidth of telephony provides only limited clues to the prosody and finer details of speech. With today's cordless phone we can walk around doing other things while having conversations – including things we would never do if in the same room with the caller (although flushing can feel somewhat embarrassing ☺). The magic of telephony has never really left us, and it can be highly amusing to observe small children learning how to use this very alien device that seems to contain Grandma, yet how did she get there through the chord? A clear testimony to the power of sound and its role in giving us orientation in space and reality.

Similarly the radio entered our homes with a presence and immediacy that spoke directly and intuitively to our imagination. Pictures without sound are merely pictures, but sound without picture invariably makes us conjure up images – perhaps due to the fact that we are accustomed to hearing things we cannot see, but rarely see things we cannot hear. Our ears direct our eyes and not vice versa. In addition we can listen to radio while performing other chores, and radio is thus a fairly non-intrusive medium.

Photography and telephony were the avant-garde of a whole series of intuitive media like the phonograph, radio, cinema and television, and today our world is completely dominated by media that require little or no training and convey information in a radically different way than the written word. Intuitive media represent a complete reversal of millennia of increasingly symbolic representation, and they sparked an ongoing and widespread controversy over the value of writing. To the literate mind real value is found in the world of ideas as represented by symbolic representation, and intuitive media thus

tend to be viewed as destructive to civilization. But there is also the opposite view, expressed in its extreme by McLuhan, who sees the entire development of symbolic representation in spoken and written language as a gradual detachment from the essence of life and thus welcomes a return to the pre-literate and even the pre-verbal.[83]

The beginning of binary

With the influx of this new wealth of intuitive media it is easy to forget that the 19th Century also introduced a new representation that was an important precursor to digital communication. I am of course referring to the binary representation of the alphabet introduced in Ancient Greece and finally reaching widespread use as Morse code.[84]. This time the representation was driven by technological constraints rather than by a desire to create a more accurate or sophisticated representation of speech, and the binary representation encumbered rather than enhanced communication, since encoding, transmission and decoding had to be done manually by skilled operators. Nevertheless, the use of binary coding in the telegraph was clearly a factor in the development of the binary mindset that eventually led to the computer.

The fax machine also uses binary encoding, and in its most rudimentary form it simply samples points on the page and detects whether they are predominantly white or black. It does not, however, require any manual encoding and decoding and thus in principle is a less cumbersome and more direct communication form than telegraphy.

Production

In terms of production the 19th Century communication technologies also represent leaps in several directions. Photography allowed the general public an outlet for individual expression and telephony enabled a large part of the population to communicate instantly over distance, but much more importantly the new mass media left its consumers with an on-off button and a dial for choosing channel, but no choice as to what was received on these channels.

For most people the telegraph only represented a faster, more expensive postal service, which was basically only useful for short messages. Until the introduction of the first teleprinter and trunk dialing in the 1930s telegraphic message required trained operators, who were normally located at telegraph stations. To send a telegram one would thus have to call or go to a telegraph station, and the message would normally be hand-delivered to the receiver. Basically a telegram has thus always both started and ended with a written message, so in terms of production, storage and reproduction, telegrams are not very different from normal letters.

And just like written text, telegraphy was not created with malleability in mind. The main purpose was of course transmission of information, but the real-time character of the communication made it possible to conduct an actual online dialog over the telegraph. The encoding and relay of information of course also made manipulation of messages possible, and this intermediary stage in communication of a text or a verbal message introduces a risk of distortion not found in the hand delivered, hand-written message. It also meant that telegraphy in reality became a recording technology similar to text, since the coded messages on paper tape could be kept for posterity.

The telephone, on the other hand, fundamentally changed the nature of long-distance communication. Using a telephone requires little more than the ability to speak, and even though it conveys only one of our senses the telephone retains much of the dynamic nature of face-to-face communication – and its transience. In terms of production telephony should therefore be seen as a straightforward extension of speech in space.

Personal recording technologies made it possible for the individual to participate in the production and manipulation of media, and in some cases, like photography, the impact was quite spectacular. The technology and skill required to produce a photograph is amazingly simple, which of course is part of the explanation for the overnight success of photography. All that is required to produce a photograph is timed exposure of a photosensitive material through a pinhole, and all the photographer needs to do is basically choose the image through the viewfinder and press a button.

Until recently we tended to see the photograph as a fixed, non-pliable reproduction of reality. And of course this is generally true. We do not manipulate our paper- or dias-based family pictures, and we tend to consider them true images of reality. Yet pictures have been manipulated almost from day one, and photographic technology has always allowed for extensive manipulation after the fact[85]. This manipulation is of course little different from the manipulation of text, and we cannot escape the fact that a photograph is a dumb, static representation.

So, the 19th Century did provide important and far-reaching improvements to personal communication, but from a cultural and societal perspective the effect was negligible compared to that of mass media, where the nature of production is very, very different. Telephony and photography extended our capabilities for personal expression and communication, but the most significant effect of the new technologies was a vast increase in the amount and character of the information received and thus a significant shift in the balance of communication.

Radio, television and cinema all require considerable resources and skill, and thus created their own production industries. The ordinary citizen was left to enjoy the results of the labors of industry, and the threshold to participation was even higher than was the case with print. Eventually the various recording technologies would democratize the production process, but distribution of especially television and cinema has remained in the hands of large companies, and the separation between creator and consumer has become ever wider.

3.4.9 The 19th Century in Summary

So, what does it all add up to? Mainly three things:

1. The 19th Century spawned real-time communication on a global scale.
2. It also introduced recording, storage and transmission of sound and images and thus reintroduced intuitive communication on a grand scale.

3. However, all the communication technologies developed enabled only one-to-one or one-to-many communication, so in terms of the basic communication space no qualitatively new territory was claimed.

Real-time intuitive and global communication is no mean feat and its impact has of course been tremendous. Yet, all the new communication forms basically only extended existing communication paradigms and thus existing power structures and thought patterns. The major changes as a result of the 19th Century were intuitive mass media and a many-fold increase in the reach of and access to information, which did have a significant effect on media consumption, but also increased the imbalance between consumption and production. Fast, global communication only served to increase the power of those already controlling media space, and all the filters known from the world of publishing remained in place or were merely replicated in other media areas.

But, surely electrification and its massive compression of time and space must have caused a revolution on par with that following the printing press? The overall answer is no, and the reason fairly simple. No communication technology developed in the period between the printing press and the computer introduced a qualitatively new form of representation or changed the scale of communication, and in retrospect they basically just extended existing one-to-one and one-to-many communication paradigms. Intuitive mass media and increased centralization are not the best recipe for radical change, and I would claim that the 19th Century created a very rapid and rich extension of existing communication space rather than a qualitative shift in the nature of communication.

3.5 Comparing Technologies

We are now in a position to take stock of all the major communication technologies developed before digital technology. The table below shows the most important characteristics of each technology and highlights those that set It apart from previous technologies.

	Infrastructure	***Representation***	***Production***
Speech	*One-to-one* *Local*	*Symbolic and complex, but intuitive.*	*Innate* *Intuitive*

	Real-time	*Ephemeral*	
Writing	*One-to-one* *Distance* *Over time*	*Lasting and fixed*	*Accessible* *Requires education*
The alphabet	*One-to-one* *Distance* *Over time*	*Atomistic*	*Accessible* *Requires education*
The printing press	*One-to-many* *Distance* *Over time*	*Haptic*	*Industrial.* *Accurate reproduction*
The telegraph	*One-to-one* *Distance in real-time*	*Morse*	*Requires operator*
Telephone	*One-to-one* *Distance* *Real-time*	*Sound*	*Intuitive, accessible*
Radio	*One-to-many in real-time* *Distance*	*Sound*	*Predominately professional*
Television	*One-to-many* *Distance* *Real-time*	*Sound and image*	*Professional*

Table 1 Aspects of major communication technologies

It is a many-facetted picture that emerges, but over all we can identify trends within each of the three categories: **Infrastructure** moves from local to global and from one-to-one to mass communication, **representation** moves from ephemeral to fixed becomes increasingly symbolic until the 19th Century, and **production** increasingly separates the producer from the consumer. We can see every technology invented since speech as an attempt to conquer space and/or time using predominately our visual sense and until the 19th Century sacrificing the intuitive character of speech.

From a purely technological perspective it would seem that the 19 th Century with its introduction of intuitive media covering the globe in real time with both sound and picture marked the most revolutionary development in communication technology. But the aim here is not to look at technology alone, but at the relationship between technology and culture, and in order to understand what constitutes qualitative change from this perspective we must take a closer look at the elements that define culture and how they have been affected by the different technologies. This, then, is the subject of Section 4.

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[1] McLuhan 1964, p. 63

[2] Most sources date the first human art work to around 28,000 years ago, but carvings found recently in South Africa showing signs of abstract thinking are around 77,000 years old. (http://www.nature.com/nsu/020107/020107-11.html)

[3] Fearnley-Sander 2002

[4] MacAndrew

[5] O'Neil 2003

[6] For a very amusing discussion about the issue, listen to (Science Friday 1995)

[7] See for instance (Mayell 2003). In 2003 a 160,000 years old Homo sapiens skull was found in Ethiopia, indicating that modern man may been around for somewhat longer than previously thought (Berkeley 2003)

[8] We for instance use terms like the written word

[9] (Wittgestein 1976)

[10] (Licklider 1968), p. 22

[11] Dollinger

[12] Marshack 1993

[13] See for instance Schmandt-Besserat 2002 Logan 2004

[14] Schmandt-Besserat 2002

[15] Incidentally one might wonder, why the Sumerians with their development of writing from tokens and their numerous other inventions did not come up with the idea of movable type.

[16] Most historical evidence in the following has been obtained from (Schultz)

[17] A logophonetic system is one in which there are both logographic characters that stand for whole words and phonetic ones than stand for sounds.

[18] See for instance (Archeology 1999)

[19] Logan 2004, p. 23

[20] Hare 2004

[21] Lo 2004 (http://www.ancientscripts.com/protosinaitic.html) Lo's website is an excellent reference document for ancient scripts from around the World.

[22] In fact, in Egypt hieroglyphs and their successors, hieratic and dietic scripts, were finally replaced by an alphabetic script, Arabic, after more than 3,000 years.

[23] The Phoenicians also used cuneiform writing to some extent.

[24] See http://en.wikipedia.org/wiki/Greek_Dark_Ages, Jan 2009

[25] As pointed out in (Logan 2004) p. 31ff, Joseph Naveh has argued that the Greeks adopted the alphabet as early as 1050 BC, but while there is evidence of contact between Semitic people and Greeks at this early date, we have yet to find Greek alphabetic texts dating back before around 730 BC.

[26] An example of this ambiguity can be found in the Hebrew word for God yhwh, Yahweh, which in New Latin became Yehovah.

[27] Illich 1988, p. 11 ff.

[28] Contrary to common belief the Chinese writing system is logographic rather than ideographic, since symbols from the beginning have been used to create rebus-like writing with each symbol representing the sound rather than the idea of the object depicted.

[29]http://www.britannica.com/eb/article?query=history+of+china&ct=eb&eu=127720&tocid=71737#71737.toc

[30] Peirce 1868, §13

[31] Ancientscripts

[32] See for instance Urban 2004

[33] Jensen 1985, p. 81

[34] At least in theory – in practice logographic languages tend to inflate due to ambiguities stemming from the lack of a uniform and purely abstract system of signs.

[35] In fact, even the most purely ideographic languages, such as Mandarin, contain numerous purely sound-based symbols. See for instance (Chan 1996)

[36] Ong 1982, p. 81

[37] Bearing in mind that whatever may have been written in the sand is of course long gone, but could have served completely different purposes.

[38] Bacon

[39] Dahl 1957 p. 36

[40] http://en.wikipedia.org/wiki/Printing, March 2009

[41] Ibid, March 2009

[42] http://en.wikipedia.org/wiki/Movable_type, March 2009. The first known example of the use of character stamps is the Phaistos Disc from 17 Century BC Greece. While not representing movable type per se, it is the first example of character-based elements used for printing. http://en.wikipedia.org/wiki/Phaistos_Disc, March 2009

[43] http://en.wikipedia.org/wiki/Movable_type, March 2009

[44] There are indications that similar developments happened in both Prague and Holland at roughly the same time, but our infatuation with ascribing inventions to individuals - in fact to some degree as a result of the printing press - leads us to cling to the name Gutenberg. See for example Dahl p. 87-88.

[45] Eg. the Tripitaka Koreana from the early 13th Century, which consists more than 80000 wooden blocks. See http://en.wikipedia.org/wiki/Tripitaka_Koreana

[46] Castells 2000, p 7ff

[47] http://www.koreanhero.net/kingsejong/index.html, Jan 2009

[48] http://en.wikipedia.org/wiki/History_of_Protestantism, March 2009

[49] Eisenstein 1979, p. 45 quoting Michael Clapham

[50] http://en.wikipedia.org/wiki/Age_of_enlightenment, Jan 2009

[51] Adrian Johns (Johns 1998) shows that this was by no means a given, since printers took great liberties in modifying texts and even did so during the printing process, and it was only with the development of the notion of the edition (when?) that uniformity could be expected.

[52] Eisenstein 1979, p. 66ff

[53] Numerous print-related technologies have been developed since the printing press, and some of them have had a significant impact. The typewriter, which was invented (repeatedly) during the 1800s, made it possible for normal people to produce legible and uniform texts, but without access to reproduction and distribution the impact was limited. But the typewriter had a major impact on the writing process and in a sense did to the writing process what the alphabet did to writing itself. Where the pen is a simple extension of the body and thus provides a very intimate link between thought and expression, the typewriter introduces a mechanical intermediary and a uniformity of visual expression that makes both process and result seem more objective and impersonal. Typing is fairly easy, quite fast and produces legible results, and it did not take long for the typewriter to become the preferred tool for office

work. Longhand has, however, kept a large following, even into the age of computers and word processing.

When cheap reproduction became available through first stencils and later various form of photocopying it finally became possible for individuals to produce their own pamphlets and books, but while these technologies have certainly had their impact, the well established and somewhat closed publication and distribution systems in the world of books have limited the importance of independent publications.

[54] http://en.wikipedia.org/wiki/Philosophy_of_language (Jan 2009)

[55] Polybius, *The Histories*, Book X, 47a. Quoted from Holzmann 1994

[56] Jones 2005

[57] Telemuseum 2004

[58] PTT 2004

[5959] On January 27, 2006, Western Union announced laconically on its web site: *Effective January 27, 2006, Western Union will discontinue all Telegram and Commercial Messaging services. We regret any inconvenience this may cause you, and we thank you for your loyal patronage.*

http://www.westernunion.com/info/osTelegram.asp

[60] During the mid-80s I developed software for a microcomputer-based telex-controller for the shipping industry. A somewhat anachronistic experience after having done computer communication for years, but then again, in the 80s sending a telegram was still considered the most formal and festive way to send a note of congratulations – at least in Denmark.

[61] Feydy

[62] http://en.wikipedia.org/wiki/Telephone, July 2009

[63] Brown 1991

[64] From a business prospect wriitten by Bell in 1877 or 1878. Quoted in (Wiinston 1998), p. 248f

[65] Winston 1998, p. 254 f.

[66] The historical account is mainly taken from (Winston 1998) and (Marconi).

[67] Poe 1840

[68] See www.kodak.com for the history of Eastman Kodak

[69] The so-called phenakistoscope (1832) and the zoetrope (1834)

[70] http://en.wikipedia.org/wiki/Auguste_and_Louis_Lumiére, July 2009

[71] "History of the Motion Picture." Encyclopædia Britannica. 2004. Encyclopædia Britannica Premium Service.

22 July 2004 <**http://www.britannica.com/eb/article?eu=119924**>.

[72] Approximately the same as today (www.nationmaster.com)

[73] Rifkin 2005, p. 362

[74] Byron, Canto the Thirteenth, XCV

[75] http://en.wikipedia.org/wiki/Paul_Gottlieb_Nipkow, Jul 2009

[76] NHK 2002

[77] Winston 1998, p. 112ff

[78] Liebowitz 2003

[79] For a history of sub-35 mm film making see

http://www.saunalahti.fi/animato/filmhist/filmhist.html, March 2009

[80] Winston 1998, p. 126

[81] Standage 1998

[82] See for instance http://www.photographymuseum.com/phofictionsreading.html, July 2009

[83] McLuhan 1964

[84] Morse code as used in telegraphs was actually trinary, as it contained dots, dashes AND breaks, but in principle it is a binary coding scheme.

[85] See for instance Douglas

Section 4
Communication Technology and Culture

Having examined the basic characteristics of the most important communication technologies we are now ready to investigate the relationship between technology and culture using the theoretical framework as a tool. In order to do this I first discuss and select some central elements of culture as subject for examination, and then go on to examine, how each cultural element has been influenced by the various technologies.

The aim of the section is twofold: First of all it provides empirical evidence of the validity of the framework, and secondly it provides us with a solid, historical foundation for the subsequent examination of digital technology and culture in Section 5.

4.1 Elements of Culture

Culture is a very broad concept with many meanings and connotations, and any definition I could come up with would be subject to any number of criticisms. Culture covers all social aspects of what separates human beings from animals and is thus an important part the yardstick by which we measure ourselves. Since culture is essential social, it depends entirely upon communication

One definition in Merriam-Webster states culture to be:

> *The integrated pattern of human knowledge, belief, and behavior that depends upon the capacity for learning and transmitting knowledge to succeeding generations.*[1]

This definition clearly points out, that culture is entirely dependent on our ability to communicate, and it identifies three central aspects – knowledge, belief and behavior - all of which are clearly affected by communication technologies, as will be shown on the following pages that are structured as follows:

First I examine the relationship between communication technology and knowledge with an initial discussion of truth and credibility followed by accounts of the development of thought and of education and learning. Secondly I discuss belief systems and finally behavior is unfolded into an examination of our concept of the individual and the way we have handled power and organization. Each subject is treated historically in view of each of the major technological developments, and the section is concluded with some deliberations about, how the theoretical framework reflects the relationship between communication technology and cuilture.

4.1.1 Knowledge

A closer examination of the definition above reveals it to be somewhat tautological since the word knowledge is part of the pattern that needs to be transmitted as knowledge to succeeding generations. The problem is, that the concept of knowledge is a cultural construct, and it turns out that our changing understanding of the concept itself is what is most relevant to this thesis. And the concept of knowledge is inseparably tied to our ideas of truth and credibility, which have also changed radically over time.

In order to examine knowledge and its changing role in culture we thus have to start with our notions of truth and credibility. Only then can we go on to to discuss the changing concept of knowledge itself as well as our ideas of and methods for acquiring and transmitting knowledge.

Truth and credibility

In an oral society meaning and tradition is maintained through presentation and re-presentation and is thus continuously created in a dynamic interaction between presenter and audience. The stories that shape culture have no representation external to the storyteller or the audience in interaction, and the storyteller thus becomes a vessel for the transmission of culture rather than an individual genius of narrative. No documents can exist to describe the political or social structures, and the upholding of society is thus inextricably linked with stories and with the generations of storytellers. The storyteller thus

in one way yields an enormous power and status as described by Larry Wendt:

> *It is said that in many early and oral tradition-based cultures, the poet was the most important member of the community, since he or she knew all of the words, and all of the stories which the words made, and therefore they knew the order in which the society existed. In pre-Christian Ireland for example, the poet was in a social status right next to the king. In battle, kings could be killed, but the killing of a poet, was considered to be the worse sacrilege. Poets of opposing armies would often begin a battle by flinging satires at each other. A gifted poet could blight crops, raise blisters, and even kill with a single word.*[2]

Yet, as noted by Adam Parry[3], the storyteller only possesses the story in the instant of his song, and he is held accountable by his audience to staying loyal to the story as told by generations before him. The song or story thus supersedes the individual, and the real power lies in the memory of the collective.[4] Oral man exists only as part of the collective, and the collective is the true 'in-dividuum'. Without the collective, oral man looses his history and his identity, and he becomes nothing.

This also means that concepts like truth and objectivity mean little in oral society. 'Truth' in oral society is the ever-changing collective agreement based on dialogue between subjective minds, and the individual contribution is inextricably linked to personal integrity and relations. In a sense, there can be no lie as there is no factual truth, there can only be trust or lack thereof,[5] and there can be no separation between fact and fiction. Only the trustworthiness of the storyteller and the reaction of the audience count, as there is no other way to account for the validity of the story. This lack of distinction may explain much of the apparent mixture of fact and fiction found in religious texts stemming from oral traditions – an apparent inconsistency that only becomes problematic with literacy.

So, what happens to the notions of knowledge and truth when society is suddenly given a memory and a way of passing a message on to other people, places and times independently of the origins?

Clearly, the character and apparent value of information as such changes radically. Where the previous world was dependent on oral commitments and

the notorious unreliability of oral transmission, a society with access to writing is able to separate the information from the author and in this way give the message its own validity and life. The written word becomes the mantra of the day, and the concepts of truth and knowledge are separated from the individual and placed in the abstract realm of writing. As Larry Wendt states:

> *'Getting one's commitment 'in writing' firmly placed the 'truth' upon a distinguishable physical object, the validity of which would be apparent by its mere existence. The authentication of truth was transferred to a device exterior to the narrative. Thoughts could be transferred remotely without the originating human present. The material became more powerful than the spoken."*[6]

This means that validity and truth are transferred from the dynamic and flexible oral dialog to static, inflexible, written monolog. A new kind of permanence is introduced, and with one stroke rulers become able to lay down the law in writing and enforce law, power and taxation over a much greater distance. Tradespeople become able to make use of sophisticated loan and accounting procedures, and religious leaders can spread their message with unprecedented effect.

Writing externalizes knowledge as well as opinion and thus separates it from the subjective mind. This very separation and fixation onto a physical medium changes the character of the utterance. As it is separated from the writer, it cannot be discussed or modified to fit a context, and, as Ong[7] says, no matter how thoroughly it is refuted it still says the same.

It is therefore no wonder that writing was initially brought to use by those in most need of claiming ownership of the truth – state and church. Christians read the Bible as the word of God, even though it is a hodgepodge of oral history and later writings from a large variety of authors, and in spite of the fact that it has been repeatedly changed, abridged or extended in accordance with prevailing dogma.

It is even possible that the concept of truth as such appeared with writing. Where religious beliefs in oral society were and are a matter of dynamic social convention (of course with its own dynamics of power), the externalization of language transforms the belief system to a set of laws and the religious power to those with control over writing and literacy. On the other hand this very

objectification eventually provokes the discussion of validity and truth and thus the birth of philosophy, and the history of social, political and religious development in all literate societies becomes closely tied to the spread and control of literacy.

The credibility that we attach to the written word is closely connected with the fact that only written words can be the subject to criticism over time. As a written work is separated from its author it must take on its own life and offer itself to scrutiny by others. It critics are of course unable to change the words, but they can write commentaries and refute it orally. This, of course, is the basis of the way academia builds a body of knowledge through publications, reviews, seminars etc, and, in fact, the basis of what we hold to be true.

Today we place great faith in print – and perhaps more than we care to admit. A book written by a reputable author and published by a well-known printer is more likely to be considered credible and reliable than most other media representations, and the mere fact that a book is reproduced in thousands of identical copies increases the likelihood of its contents to assume an air of truth.

Whereas it is true that print led to a greatly increased written dialog and a more active reading public, the pervading long-term effect of the wide distribution of printed matter is the increasing imbalance in both number and influence of writers and readers. For the general, increasingly literate public, knowledge and learning gradually became synonymous with internalization of information from books rather than with personal activity and creativity. The uniform appearance of print and the large number of identical copies gave books an air of authority and thus an enormous power over minds.

The assumption of accuracy and credibility of print is, however, fairly modern and according to Adrian Johns[8] it took at least 300 years to develop. In our current discussions about the credibility of information on the Internet it is worth noting that the world of print during its first many decades was rife with inaccuracy, piracy and outright fraud. When Martin Luther translated the Scriptures, the first version on the street was a pirated one. Catholics would write books and ascribe them to Luther, his own books would be ascribed to

other authors, and during the first half of the 16th Century pirated texts outnumbered originals by as much as ninety to one[9]. Even a hundred years later, printing was so fluid that Shakespeare's first folio did not exist in two identical copies! From the beginning it was obvious that some forms of quality assurance had to be developed, but, unlike today, there was no precedence for how to do it, and many of the aspects of books and other printed materials that we take for granted today took several centuries to develop.

The matter of credibility was dealt with in numerous different ways. In several European countries printing would remain under control of the state until the 19th Century, and in England the use of royal charters and the so-called patentees gave sole rights to specific titles or subject areas to individual publisher[10]. Sir Francis Bacon even suggested that only a very small elite appointed by the state should have the right to interpret nature, and that their most vital knowledge should not be made public.[11] Some scientist, like the Danish astronomer Tycho Brahe, set up their own print shops in order to control the process and result themselves, and on a national level copyright laws were enacted in most of Europe during the 17th and 18th Century in order to ensure the legal rights of both authors and publishers[12]. The written word was thus both legally and economically tied to its author and his representatives – a development which fueled the individualism and contributed to separating creator from consumer.

The different measures gradually increased the accountability of authors and printers and allowed print to give the written word a status as more credible and reliable than any other form of communication. As noted by Illich and Sanders[13], '*the printed word impresses its own version of reality'.*

Photography changed our notion of truth in communication. With the photograph the artist was seemingly taken out of the equation, and the image became a straight and unadulterated depiction of reality – suddenly making the writer and painter as interpreter visible again. A photograph invokes an implicit trust, because we 'can see it with our own eyes', and from the outset photography was heralded as more credible than even the best hand-written account by an eyewitness.

Although we like to claim to be skeptical about the validity of mass media, the media themselves do not leave much room for doubt. A medium that distributes information to a large part of the population and gives no means to answer back or even choose alternative viewpoints is an incredibly strong meme machine, and even the most blatant lies can be turned into popular truths by effective use of media.[14]

To varying degrees this has been the case since the development of writing, which due to its persistence and unalterability tends to gain weight with time, but with radio and television like with photography the author is apparently taken out of the equation, and it becomes much more difficult for us to distinguish between fact and fiction or between reporting and manipulation. We hear it with our own ears and see it with our own eyes, so where is the room for doubt? At the same time we have limited control over what we see and hear and virtually no opportunity to respond through the same medium. Radio and television stations control what we see and, perhaps more importantly, what we do not see, and neither the medium nor the way it is generally used encourage reflection or reaction. Where text requires abstract thinking and interpretation, the sounds and pictures of intuitive media just blend in with everyday life and thus influence us in subtler and potentially more dangerous ways.

Recorded media have an edge over speech, since the creator can be held accountable for the message, and the questions of accountability and credibility have been essential in the development of social use of media. Unfortunately history has repeatedly shown, how centralization of media control in governments, church or large corporations tends to limit accountability and reduce credibility, and the very nature of mass media makes them susceptible to centralized control and manipulation. At the same time these media can to a large degree control the image we get of the world around us, and their message over time becomes the accepted ‘truth’.

There is little doubt that mass media from the printing press and onwards have allowed more people and views to be heard, but I would argue that, on the balance of things, they have tended to help the few monopolize truth and credibility – and thus also what is accepted as knowledge.

Knowledge and the Development of Thought

Like truth, knowledge is a very vague concept, when the only carrier is voice. Oral society has no way of storing or formalizing a body of knowledge, which means that a culture can only accumulate knowledge about its past and its discoveries through stories and actual manifestation in artifacts. This of course means that formal education is inconceivable and that science as systematized knowledge cannot exist. Whereas informal and apprenticeship learning of course take place, education in the sense that we understand it is not possible – and actually not necessary either.[15] Spoken language is learned automatically through interaction with adults, and a society with no formal body of knowledge and no formal writing system really has no need for formal education

A society lacking education and science will naturally be limited in its technological developments, and its innovations will necessarily be fairly simple. Yet, some inventions, like harnessing fire, making tools and irrigating fields were of the utmost importance for the development of civilization and were prerequisites for the formation of the societies that would eventually develop writing.

Writing allows for the accumulation of knowledge outside individual minds, and it thus not only creates an opportunity for creating a body of knowledge across time and distance and developing a concept of time and history; it gives completely new opportunities for immortality, an immortality carried through name and text rather than through elaborate burial chambers. The emphasis moves from the physical, concrete world to the world of abstract thought and allows for new ways of theorizing about virtually every aspect of human life.

The ability to separate information from the individual and preserve it over time was to have a profound impact on the development of thought. Through this externalization knowledge could be transmitted, and an accumulation of a body of knowledge was enabled. The ability to accumulate knowledge over time is of course a prerequisite for developing science, and there are strong indications that the evolution from iconographic to alphabetic script was

instrumental in the development of the abstract science that we value so highly today. Writing requires syntactic structure, which again requires and promotes abstraction and structured thought processes, and the ever-increasing semantic richness and atomic structure of writing systems (described on p. 80 ff) indicates a co-evolution of writing and thought, which will invariably have had an impact on for example science, philosophy and innovation.

Images and Tokens

Images and tokens were of course highly limited compared to verbal communication and lacked the dynamics of dialog, but the character of tokens allowed for and promoted a whole new set of cognitive structures as described by Schmandt-Besserat.[16]

First of all pictures and tokens allowed data to be transmitted unchanged over time and space and independently of the individual. This separation of knowledge from the individual subject and the face-to-face meeting introduced the notions of data, history, individualism and immortality.

Secondly transmitting knowledge in this way encouraged structure and formalized meaning, which was not necessary or even desired in a world of dialog. In order to be understood in the absence of its creator a picture or token would need to either have a direct reference to the object described, or it would have to be part of a formalized system, which could be taught across generations and perhaps cultures and languages. We can of course not know whether cave people created their drawings for posterity or just for living room decoration, but later generations will have seen the drawings and attempted to interpret them as messages just like we do today. The need for interpretation and structuring would automatically encourage abstract thought, and the entire history from cave painting to alphabet can be seen as a continuous refinement of structure and symbolic representation.

Thirdly tokens represent data removed from the rhetoric and oratory of speech. Each token is a concrete representation of a real object, and tokens enable manipulation of data in a variety of ways including counting, ordering and grouping. We thus in tokens see the precursors of mathematics and

grammar, and an important aspect of this is the physical nature of tokens. Several theories of cognitive development such as Seymour Papert's constructionism[17] espouse the idea that cognitive structures are strongly related to the body, i.e. to physical manipulation and movement. The development of language from gesture is one example, and the development of spatial, numerical and linguistic reasoning from manipulation of physical tokens is a very good candidate as well. As we can see from later clay tablets, tokens led to the arrangement of symbols in lines and columns, indicating both temporal and spatial order and thus the beginnings of both written narratives and 'spreadsheets'. This transition of the temporal structure of speech to the temporal and spatial structure of tokens and writing was crucial for our ability to handle complexity.

Ordering also leads to classification and categorization and thus to the first steps in the kind of abstraction necessary for scientific thought. The most important example of this is the development of numbers as a natural result of the representation of collections of tokens. The separation of number from object is arguably one of the most important steps on the journey towards scientific and mathematical thought.

Gradually the physical tokens were replaced with sequences of symbols requiring more advanced abstraction processes. This transition moved the attention from the symbols to actual language constructs such as words and sentences. The direct and tactile connection between symbol and expression was lost and would not reappear until the introduction of movable type, but the more fluid representation allowed the art of writing to transition from the physical world to the world of ideas and thought. The symbols became abstract rather than concrete, and the stage was set for experimenting with symbols representing ideas rather than just real world phenomena. This transformation of representation facilitated the development of structured thought from the purely bureaucratic and mercantile of early Mesopotamia to the highly evolved abstract philosophy and science of the Greeks.

Pictographic Writing Systems

Since pictographic scripts are based on images rather than abstract symbols it is very difficult to build a formal syntax within the symbol structure itself and thus no incentive to build larger systems of categorization. So, whereas ideographic writing is rich, intuitive and freely extended, it does not in itself invite the development of logic and other formal systems required for the development of for instance science and mathematics. This of course does not mean that such systems have not evolved in visually based cultures, or that visual writing systems do not allow systematic descriptions. The hieroglyphic Eye of Horus below, for instance, is a beautiful example of how the relational structure of ideographical symbols can inspire and support mathematical concepts. Each part of the eye represents a fraction, and using selected parts of the eye it is possible to depict all fractions based in the number 64 with the complete eye representing the integer one.[18]

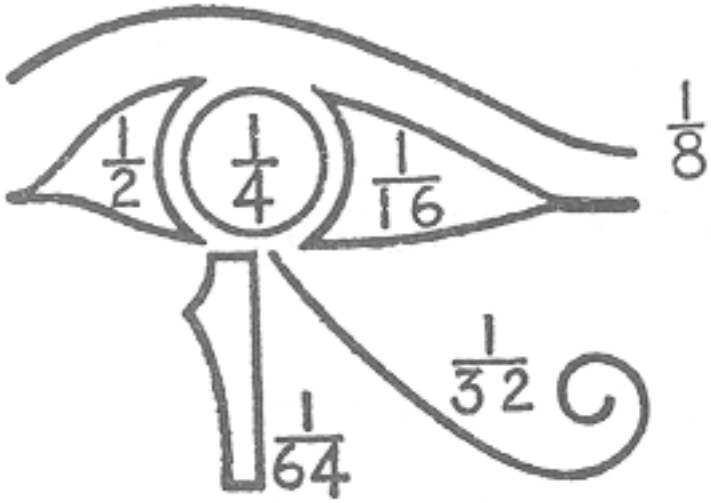

Figure 11. The Eye of Horus representing fractions[19]

Pictographic writing systems like the Chinese have their own kind of logic, which promotes a specific mindset. As previously mentioned new words can only be adopted in Mandarin through some relation to other words, and the same goes for the symbols representing words, where semantic clarifiers are used to indicate related concepts[20]. In this way the writing system itself promotes relational thinking and categorization.

Phonetic Writing Systems

Phonetic writing systems are fundamentally different from visual writing systems. They build upon the already existing syntactic structure of speech and thus in a sense have a more advanced genetic makeup. But the original phonetic systems grew out of visually based scripts and retained a number of the visual features and limitations of these. It was only when outsiders like the Semites in Egypt looked upon the script with new eyes and adopted it for their own language and purpose that phonetic writing systems achieved their full potential.

As we have seen, the development of a syllabary in Mesopotamia coincided with the development of classification and bureaucracy, and it can be argued that the writing system all the way back to its most rudimentary token form inspired the development of structure and classification in for instance administration, law and science. Nevertheless, for more direct evidence we have to turn to the Greeks.

The alphabet provided an example as a tool for breaking down language into its individual constituent elements and rebuilding it to produce words, sentences and worlds of literature, and it very likely inspired the Greeks to attempt the same when it came to description of nature, life and reason itself.[21] Animals, plants, objects, actions, emotions and thoughts that had previously only been understood in the context of narrative and action were categorized, systematized and ordered, and this new, rational view of the World rapidly came to dominate thought in all of the alphabetic cultures.

As writing developed into more and more abstract and syntactically elaborated forms, writing and language became the subject of reflection. There is little evidence of direct reflection upon language as a construct and a representation of reality before the Greek civilization, but once language and writing became a subject of discourse a tremendous boost to philosophy and science occurred.

These developments in essence stem from three aspects of phonetic writing systems: First of all the transition from a visually based language to a phonetic allowed for statements and discourse with no relation to context.

Secondly the very fact that a very limited set of symbols could be used to describe every possible human uttering inspired fragmentation, division and quests for similar, atomistic systems to explain nature, thought, beauty etc. And thirdly the ordering of the alphabetic symbols gave rise to classification and systematization of knowledge – a prerequisite for modern science[22].

Perhaps the most far-reaching consequence was the development of formal and symbolic logic. Up until the rise of the Greek civilization all science had been purely empirically based and no methods of proof had existed. Egyptian geometry, for instance, was quite advanced, but it was purely empirical and developed from the practical need of reallocating land after the yearly flooding of the Nile. It was not based on axioms, no theorems, proofs or propositions were used, and no formal basis was created for Egyptian geometry until the Greeks beginning with Thales set about to prove it.[23]

An examination of Greek thought from the time of the Ionian scholars until the decline of Athens indicates a clear alphabetic influence. The pervasive notion of unifying elements and universal law, the increasing focus on cause and effect in nature and the introduction of symbolic arithmetic and early algorithmic thought as well as Aristotle's categorization and formal logic can all be linked to the use of phonetic writing as an abstract representation, where a limited number of symbols combine in a linear fashion to form a complete description of spoken language[24].

Of course, no structure or categorization comes without a loss, and the rational thinking inspired by the alphabet imposed some quite important and far-reaching limitations on Greek thought. In a world fully composed of discrete, atomic elements there could be no concepts of the infinite or the infinitesimal, of irrational or negative numbers, or of zero or non-being. In fact, Parmenides went so far as to logically conclude that change was impossible since it would cause the appearance of non-being of the initial condition.[25]

One of the most famous examples of these limitations imposed by Greek discrete logic is Zeno's paradox of Achilles and the Tortoise. In defense of Parmenides' theories Zeno employed an argument implying that a moving object must exist at a specific, discrete point in space at a given point in time.

The conclusion is that Achilles will never reach the Tortoise and, in fact, that motion cannot exist. And, even though philosophers and mathematicians from the time of Archimedes have refuted the paradox, it still to some degree haunts us today. On the one hand it helped us develop calculus and all other branches of discrete mathematics including the binary arithmetic that lies at the foundation of computers, but on the other it still lurks in the background of all discussions about whether discrete representations like those in the computer can be true to reality.

Perhaps the most important consequence of the stubborn adherence to the principle of the indivisible was the failure of the Greeks to develop a notion of zero and negative numbers, which of course limited their mathematics severely and made it impossible to develop a position-based notation of numbers[26].

With the rise of the Roman Empire, Greek culture was forced eastward and slowly withered away along with its literature, but much of the writing was kept intact if not alive in Hellenic cities in the region until it was picked up centuries later by a newly enlightened and knowledge-seeking Islamic culture. The writings were translated into Arabic and, along with Hindu texts, they inspired a tremendous development in science, medicine and philosophy, which would spread through Muslim territory and eventually through Muslim Spain back into Europe where it would inspire thinkers like Thomas Acquinas and lay an important part of the foundation for the Renaissance[27].

All the mentioned mathematical concepts that eluded the Greeks and without which our mathematics and science would never have reached the current level were developed in India by the Hindu population and refined by the Arabs. The Hindu people were not inhibited by formal logic, and, contrary to the Greeks and the Hebrews, they saw non-being as an ideal state and space and time as infinite, and they thus had no difficulty dealing with the concepts of nothing and infinity. They wrote in a so-called syllabic-alphabetic script, but their philosophy allowed them to develop the decimal system with positional notation as well as a number of other mathematical concepts such as negative numbers, infinitesimals, infinity and computational mathematics, all

of which were later adopted by the Arabs, who combined them with empirical methods to lay the foundations for modern science.[28]

It is a popular misconception that modern science arose directly from Greek thinking due to the revival of learning in the Renaissance after a thousand years of inactivity. Not only does this analysis ignore the accomplishments of the Indians and the Arabs described above but it also fails to take into account some of the negative effects of the alphabet on classical learning. The abstractness of the phonetic alphabet promoted a divorce of brain and hand, a disdain of empiricism, and excessive adherence to logical rigor among Greek thinkers, thus inhibiting the development of modern science. Greek and Latin learning, rather than being two thousand years ahead of its time, had, in fact, run its course and had exhausted its possibilities for further development. The decline of book learning and the channeling of intellectual activity into the practical arts during the Middle Ages thus can be seen to have had a positive effect on Western learning, as it permitted an infusion of new ideas from the so-called barbarian cultures. Once again human thought was catalyzed by the confrontation between speech and writing, and classical learning was revitalized when it resurfaced during the Renaissance.[29]

Robert K. Logan[30] has made extensive studies of the differences between Eastern and Western thinking and his conclusions are strong indications of the profound influence of writing systems upon human thinking. The linear, phonetic and atomistic alphabet promotes causal, time-based, rational thinking and a classification of objects based on their properties, whereas logographic systems where each symbol represents a, sometimes complex, set of relations between its constituent parts promote holistic, spatial and intuitive thinking with a focus on relations rather than object properties. As shown by Richard Nisbett[31] psychological experiments with Koreans, Chinese, Europeans and Americans reveal exactly these differences in today's population – a strong indication of the power of writing and an important thing to bear in mind when we discuss the potential use and impact of digital media.

Whereas we may not be able to conclusively prove that writing led to an improvement in the cognitive ability of man, we can clearly identify a causal

relationship that suggests a co-evolution of writing and thought, and we can certainly show that we owe our ability to handle abstraction, logic and science to the development of writing and specifically alphabetic writing.

The Printing Press

Like the alphabet in Ancient Greece the printing press (described on page 98 ff) aided the ignition of a long period of extraordinary generation and spread of knowledge. One reason for this was, that the renaissance and the press reintroduced the alphabet to circles outside the monasteries, but at least as important was the introduction of mechanical reproduction.

The production of multiple copies of scientific results, medical treaties, philosophical and political works and so on enabled an unprecedented spread of knowledge and collaboration between thinkers across a rapidly more literate Europe. The gradual introduction of the perfect copy gave a completely new credibility to the written text and made it suitable for the sharing of factual and systematized knowledge. Charts, diagrams, pictures, astronomical observations and so forth could now be mass produced and shared among the academic community, thus making it possible for scientist to compare and pool their efforts. This proliferation of thoughts and ideas of all kinds and qualities forced science to develop a new kind of credibility through rigidity of method and dissemination and in this way paved the way for modern science.[32] One could no longer assume to be in complete control of a passive reading public, but had to expect to be rapidly countered by an active audience across the continent, and scientific work rapidly changed from an individual endeavor to a collective effort to contribute to a body of knowledge. The emphasis changed from the preservation and recovery of old knowledge to the discovery of new, and within a couple of centuries Europe became the global center for scientific knowledge and for innovation.[33]

The printing press enabled the spread of the revolutionary religious, philosophical and political ideas that brought reformation, democracy and the Age of Reason to Europe, and it was the same press that allowed scientific discoveries to be shared and co-developed across Europe to create the knowledge base for virtually every industrial age technology. It is therefore not

an exaggeration to say that we in large part owe the Enlightenment and the Industrial Revolution to the invention of the printing press.

There is no doubt that the communication technologies of the 19th Century contributed greatly to the dissemination of knowledge across the globe, but the book would remain the single most important repository and source of knowledge. The recording and transmission of sound and image provided direct and intuitive depictions of the world, but probably did little to qualitatively alter our thought patterns or concept of knowledge.

Education and Learning

Education in the sense of passing on knowledge or wisdom to others is indispensable to all forms of human culture, but its form and the importance ascribed has changed radically with the development of communication technologies.

In oral societies skills are passed on through example, and history is passed on as storytelling, and formalized education does not exist. The skills needed for communication are acquired through everyday life, and no formalized body of knowledge exists, so there is no need for educational institutions.

Writing, however, introduces not only the notion of formalized knowledge, but also the need for structured learning of the system of communication itself. Learning a writing system normally requires years of teaching and repetition, and every culture that has developed or adopted writing systems have eventually built systems for formal education.

Sumerian children who were to learn writing would spend large parts of their youth in temple schools copying cuneiform symbols on clay tablets[34], and since the script was so difficult to learn and primarily used by the temples it is highly likely that only a small proportion of the youth would ever be trained to read and write. The same would be true for Egypt although the development of the cursive hieroglyphic script and later the demotic enabled a much more widespread use of writing. The spread of reading and writing skills has of course always been closely related to its importance in the power structure, and in both societies like the Egyptian learning to read and write was a

privilege of the elite, whereas the Jews of Sinai as early as 1300 BC required everyone to learn to read the Torah.[35]

With writing, education became not only a question of acquiring reading and writing skills, but also of receiving the accumulated body of knowledge from previous generations, and clay tablets from Mesopotamia show that children were learning for instance arithmetic. By copying books they were also acquainted with the classics of their literature, although archeological finds indicate that they rarely made it beyond the first chapter, so we might imagine children owning several first chapters of books in much the same way that many families today own incomplete encyclopedias received as free offers from book clubs. In fact, much of the Sumerian literature known to us today only exists in partial copies made by school children[36].

The unambiguous nature of the Semitic and Greek alphabets made it possible to teach it to children without requiring any previous understanding of the subject matter, but the earliest indications of Greek children being taught writing do not appear until the early 4th Century BC[37]. At around the same time oral teaching changed from the style of the bard to more prosaic speech[38], and when Plato some years later created his academy it was only open to those who could read and write, indicating that the transition from a predominantly oral society to one of literacy was quite rapid and happened in the middle of the golden period of Greek culture.

Literacy became even more important in the Roman Empire, but with its decline Europe fell once again into illiteracy, and the only formal education up until the Italian renaissance would be for the very few who entered monasteries and spent their time copying books in much the same fashion as Sumerian children.

With the Renaissance libraries and books gained renewed interest and the rise of the merchant class and monetary trade in large parts of Europe led to a need for education of bookkeepers, correspondents and other business professionals. This newfound focus on education created a need for books, but it was the printing press that made education on a mass scale not only possible but also necessary. Eventually and inevitably reading and writing

became as important to society as roads and taxes, and although it took almost four centuries for public libraries and public schools to become widespread, we today consider them to be fundamental parts of any civilized society.

With formalized education came a completely new concept of childhood. Prior to the 16th Century childhood was spent in the home or in the home of other people, and children seamlessly entered into working life from a very early age. Boys would join their father in the smithy, while girls would do house work with their mother, and their was no concept of treating, dressing or addressing children any different from adults. Children were simply seen as small adults, but when formal education became the order of the day they started to acquire a special status reflected in their clothing, their role in the family, and the way they were treated by adults. The printing press thus marked the beginning of the childhood we take for granted today, but which has in fact changed considerably during the last 50 years due the pervasive influence of newer and more intuitive mass media.

Radio and television require no education to use. They provide impressions, imagination, entertainment and sometimes education to anyone capable of tuning in, and as all parents will attest to, keeping children from television or even censuring their use of it is virtually impossible. Through television children escape the confines and protection of childhood, which has led some commentators like Neil Postman[39] to announce the end of childhood.

So far television does not seem to have significantly influenced the need for formal education or the importance of the book, but it has undoubtedly changed the relationship between learning and education and the nature of childhood. Before the age of radio and television parents and teachers wielded almost absolute power over the upbringing of children. They controlled what children heard and read, and what the teacher said was tantamount to truth to the students.

Concluding Remarks About Knowledge

Clearly, our notion as well as our production and use of knowledge has been radically changed over time due to communication technologies. The concept

of knowledge itself would not have been possible without communication across time, and it is technology that has made the spread of knowledge and collaborative creation of knowledge possible.

The technology itself influences who has access to knowledge – and who has access to produce and share knowledge. It even affects the way we think and what we think about, and it is thus fair to say that knowledge and communication technologies are intimately related and have been throughout history.

4.1.2 Belief Systems

Where there is no knowledge there is only belief, and since the dawn of time mankind has been creating belief systems to explain the unexplainable and create frameworks for shared values. Whether religion existed before language is a matter of some controversy[40], and the fact that Neanderthals conducted burial rituals must invariably lead to the conclusion that either they had language, or religious behavior is possible without language. But rituals may seem religious without implying a religious belief system. Elephants, for instance, can go through elaborate rituals over their dead, but we do not imagine that they have a concept of gods. Religious belief systems are inherently abstract, and, as stated earlier, abstract concepts require language. It thus seems reasonable to assume that religion understood as belief systems appeared with or after language.

Throughout history writing has been a tool for spreading religion and maintaining power through it. Egyptian priests used hieroglyphs and the medieval Catholic Church Latin to maintain their control of the dissemination of knowledge and interpretation of religious texts. And Martin Luther used printing to bring about a revolt against the church and create the Reformation.

But the relationship between writing and religion goes deeper than the visible expression in power. In fact, writing seems to have been a crucial factor in the creation of monotheism.[41] No oral society that we know of has practiced exclusive monotheism,[42] and all surviving monotheistic religions have a background in alphabetic writing[43]. Is it possible then, to see a connection

between alphabetic writing and the notion of monotheism? I would claim that it is, and that the connection exists on several levels:

- Visual scripts are additive in the sense that new concepts tend to invoke new symbols, much in the way that polytheistic religions add new gods (and new symbols) for each higher concept.
- The alphabet is an exercise in reducing language to its basic, atomistic elements. The same principle applied to religion will eventually lead to one god or no gods, since this is the only way to solve the ambiguity inherent in the idea of several gods as creators of the universe.
- The alphabet is completely devoid of reference to the visual world and encourages abstract thinking. The concept of an abstract, omnipotent god is completely in line with the kind of thinking invoked by the alphabet.
- All polytheistic, but no monotheistic religions depict their gods, i.e. monotheistic religions have removed their gods and their writing scripts from the visible world to the world of ideas.

The first monotheistic religion in recorded history existed for a brief period in Egypt under the rule of Akhenaton 1353-36 BC[44]. At the time of Akhenaton Egypt had many gods, and each temple was devoted to its own deity. When Akhenaton, or Amenhotep IV as he was then called, assumed power, he was still worshipping the old gods, but gradually he became more and more infatuated with a little known sun-god, Aton, who was never depicted as anything more than rays from the sun. Eventually Amenhotep changed his named to Akhenaton (he who worships Aton), moved his capitol from Thebes, where Amon was worshipped, to a desert bay 300 kilometers to the north, made Aton the sole god, and devoted his life to ideas and ideals rather than warfare and affairs of state. This of course caused a major disruption in Egypt, which was at this time a great empire built upon a very strong priesthood, polytheism and a divine pharaoh. As could be expected, Akhenaton's reign caused great damage to the empire, and his monotheistic ideas survived him by only a few years – at least as part of the official power structure in Egypt.[45]

Akhenaton remains a controversial figure, and little is known about his motivation for adopting monotheism and giving up his own divine status, but he was undoubtedly an important figure in ancient Egyptian history, and his religious beliefs have quite likely been an inspiration for later monotheistic religions.[46]

The time of the exodus of the Jews from Egypt is highly uncertain, but some theories hold that it happened around 40 years after the reign of Akhenaton. At around the same time the Semitic scripts were standardized, and some sources speculate that Moses, who, according to the Bible, led the exodus and was raised as son of the Pharaoh, could have been responsible for the bringing of not only monotheism to the Semites, but also the standardized Semitic alphabet.[47] While the theory seems far-fetched, it certainly rings true that Moses would have been familiar with a number of scripts including hieroglyphic, and when he delivered the Ten Commandments, they were presumably written in the North Semitic alphabet, which became the standard for the region and the basis for all subsequent alphabets. Since the first written Bible is from a much later date, there is little we can say about a possible influence on the Bible and Judaism from the religion of Egypt, but it is tempting to speculate that the persecution of the Jews by Seth I and Ramses II were somehow related to the monotheistic beliefs of Akhenaton.

When Moses brought the Ten Commandments to the Israelites, they were basically polytheistic, but he forbade them to worship idols or create any kind of imagery of God. The god of Moses was invisible and omnipresent – a god of the abstract alphabet, and, in fact, God presented himself through Moses in writing. The Ten Commandments constitute the first example of writing in the Bible, and they introduce the first written law in Semitic society.

Ancient Greece of course had a very rich cosmology with numerous gods and demigods, but in the encounter with writing and with the alphabet their polytheism came under pressure. With the alphabet came science and philosophy, and the atomistic thinking invoked by the alphabet may have been what led several Greek philosophers to believing in one unifying force in the universe, yet never to the exclusion of other gods, and it was only with the influx of Christianity that exclusive monotheism gained foothold in Europe.

Interestingly it was Christianity that would turn out to be almost the sole European guardian of the written word from the fall of the Roman Empire until the Renaissance. During this thousand-year period literature and religion went hand in hand. Monotheism was responsible for the survival of literature, and books were instrumental in the survival of monotheism. The monasteries became the only libraries, which naturally affected the scope of the literature that was passed on to posterity, and had it not been for another monotheistic religion, Islam, much of the ancient knowledge could very well have been lost forever.

Today the Western world has become so entrenched in alphabetic thinking that polytheism is no longer even an option – only monotheism and atheism are acceptable.[48] I do not believe that the appearance of both individualism and monotheism with writing was a coincidence. The reflection of writing and reading back upon the individual in his solitude is like the reflection of the rays from the one, all-mighty God. How could the God reflected in the alphabet be anything but a single individual, made in the image of man? Am I not, after all, a divine creature?

The printing press probably did not influence religion as such, but its impact on the church in Europe was considerable. During the decades leading up to the invention of the printing press the Catholic Church had fallen into internal strife, greed and corruption, and dissent had been brooding for many years, when the printing press entered the picture. Its development was fuelled by a rapidly increasing need for books, but also by the church itself, which had become dependent upon the so-called indulgences – pieces of paper sold to sinners as proof that good work was being done to pay for their sins. Producing indulgences was time consuming, and Gutenberg saw a business opportunity in printing them in large numbers. The printing press did indeed vastly increase the church's income from indulgences, and it was this very practice that would lead to Martin Luther's famous 95 Thesis and the subsequent formation of the Protestant Church. In this way the printing press played the role of culprit as well as prosecutor and played the central role in the ending of the literary and religious monopoly enjoyed by the Catholic Church for a millennium.

The mass production of books and pamphlets helped both catholics and protestants spread their word of God, and subsequent mass media have contributed to the spread of religious doctrine and provided breeding ground for innumerable religious sects. The television screen is a perfect extension of the pulpit as demonstrated by the proliferation of religious television channels, but there are also those who hold, that television is either replacing religion as the myth upon which culture is based or increasing the secularization brought on by what Arend van Leewen calls the Technological Era[49].

4.1.3 Behavior

Cultural behavior covers everything from morals and ethics to the overall structure of society. Most aspects are relevant for this thesis, and many could merit an entire thesis in themselves, but two stand out as particularly important, because they have both been radically and repeatedly affected by communication technology: Our concept of the individual and our organization of society.

The Individual

Society is held together by memory, and in oral society memory only exists in the individual. The individual would thus seem to play an important role, yet the individual memory only makes sense when expressed in a social context, and the individual essentially only exists the social encounter. As Goody and Watts write:

> *'As we have remarked, the whole content of the social tradition, apart from the material inheritances, is held in memory. The social aspects of remembering have been emphasized by sociologists and psychologists, particularly by Maurice Halbwachs. [5] What the individual remembers tends to be what is of critical importance in his experience of the main social relationships. In each generation, therefore, the individual memory will mediate the cultural heritage in such a way that its new constituents will adjust to the old by the process of interpretation that Bartlett calls 'rationalizing' or the 'effort after meaning'; and whatever parts of it have ceased to be of*

contemporary relevance are likely to be eliminated by the process of forgetting.

The social function of memory - and of forgetting - can thus be seen as the final stage of what may be called the homeostatic organization of the cultural tradition in non-literate society. The language is developed in intimate association with the experience of the community, and it is learned by the individual in face-to-face contact with the other members. What continues to be of social relevance is stored in the memory while the rest is usually forgotten: and language - primarily vocabulary - is the effective medium of this crucial process of social digestion and elimination which may be regarded as analogous to the homeostatic organization of the human body by means of which it attempts to maintain its present condition of life.'[50]

Whereas the storyteller in oral society is at the same time immensely powerful and merely a vessel for the memory of the collective, writing has a very different paradoxical effect. Writing separates the words from the writer and thus makes them autonomous and available for interpretation and re-presentation by others far away in space and time from the writer. In this way the writer becomes even less important than before, yet at the same time the notion of 'authorship' emerges as the name of the writer rather than the memory of the people frames the story. In this way writing gives language its own place, separate from the individual, yet gradually gives rise to individualism and the ideal of the autonomous individual. As noted by Walter Ong:

'The development of writing and print ultimately fostered the break-up of feudal society and the rise of individualism, Writing and printing created the isolated thinker, the man with the book, and downgraded the network of personal loyalties which oral cultures favor as matrices of communication and as principles of social unity.'[51]

Writing allows the individual to stand out from communal memory and opinion to form his or her own thoughts and offer them to posterity. As the words are committed to paper they are no longer dependent on a current or local audience, and writing that has no resonance in its surroundings at the time of

the creation can turn out to be revolutionary at a later stage. Writing thus becomes Man's first true encounter with immortality, and the desire to be remembered seems to have been a strong driving force in the development of writing in many cultures.

Our concept of ‘self’ has developed slowly and in pace with our emphasis on writing over oral communication. The development of the alphabet added to this emphasis with its indivisible letters and increased focus on the products of thought rather than images of the World, and we can today observe that individualism is as closely linked with the alphabet, as is monotheism. The entire Western World is based upon predominantly individualistic ideals, whereas Asian societies are considered collectivist in nature and tradition.

In Sumer the habit of placing a personal seal on token envelopes and later clay tablets seems to have inspired the decoration of graves with the deceased persons personal seal and possessions and later with epitaphs describing his life and achievements. Through this the individual separated himself from the collective and a notion of authorship gradually evolved[52].

In Greek society the meeting between oral culture and literacy was marked by a fierce political and philosophical debate over the nature of the individual and the balance between individual and society. The oral legacy promoted an emphasis on debate between individuals as the means of addressing issues, but around the notion of debate several extremes developed. On one side were sophists who held the only basis of meaning and truth was the individual, and on the other side were the growing number of natural philosophers who sought the truth in nature and political thinkers trying to develop the ideal state. The political fruits of this conflict were the notion of democracy, which creates a balance between the individual and the state, whereas sophist individualism as a philosophical point of view became widely discredited. Greek and after it Roman society remained largely anti-individualistic with the individual seen mainly as a servant to the supreme good – the state, but Greek thought put the individual at the center in both political and philosophical discussion and laid the foundation for the notion of the individual so prevalent in Western society today.

The return to oral culture in the Middle Ages caused the individual to disappear almost entirely as anything other than an ethical concept of individual responsibility towards God. In both daily life and in philosophical discussion the individual disappeared from focus along with literature, and society was once again ruled by subservience to liege lords or religious authority. But writing had sown the seeds of the individualism, which would come to dominate the Western world with the renaissance and the appearance of the printing press.

The humanists of the Italian renaissance brought European thought out of the collectivist and oral Middle Ages and caused a return of individualism inspired from Greece and Rome. The arrival of the printing press strengthened this development in a variety of ways. First of all the appearance of small, fairly affordable books changed the experience of reading from a social one in which someone read aloud from a script to a private and personal one, where a person could read and contemplate the words in solitude and thus in a confrontation between the individual mind and the printed page. It is not hard to see how this new learning and thinking situation would promote individualistic thinking and it is even easier to recognize the impact of the accurate reproduction and wide distribution of printed books on the notion of individual authorship and ownership of words.

The culmination so far came when Rene Descartes gave us the notion of the individual as the center of everything and separated our mind, not only from our body, but also from the mind and body of others[53]. Out of this has grown the individualism that dominates Western society today and is so entrenched that virtually everything is related to our notion of 'self'. The focal point of knowledge, contemplation, politics and even society is the individual, and it is virtually impossible for us to conceive of a selfless society. The individualism of today is very much a product, not only of writing, but also of the printing press and subsequent mass media.

Power and Organization

Organization and power structures can only exist through communication, and throughout history our societal structures have reflected the specific

constraints and possibilities afforded by our communication technologies. Empires have been built and crucial battles won by those who had access to superior communication technology. And at the core of it all lies our ability to use language.

One of the most obvious advantages of language is that it enables us to plan and to separate tasks and responsibilities. Being able to talk about things that do not yet exist and create a plan to make them happen provided homo sapiens with a continuity and structure that let us create permanent dwellings and develop all the necessary ideas, tools and implements for organizing village life and farm the land. It took us a while to do so, but had we not acquired abstraction and language we might well still be roaming the land as hunter-gatherer clans.

Community is defined by social cohesion in terms of e.g. shared values, customs and rules, and social cohesion is created through communication and governance. In very small groups no formal structure of governance is necessary, but as soon as the community grows beyond the bounds of daily contact a system for developing and maintaining shared values must be put in place. Systems imply separation of roles, which in turn implies the creation of power structures. These structures are confined and shaped by their means of communication, and there is thus a very close link between community, power and communication technologies.

Before Writing

Due to the lack of dependable records from pre-literate times we know very little about the actual changes brought about by the advent of language. For inspiration concerning preliterate society we can look to current oral cultures, but as to the cultural changes brought about by the emergence of language we can only speculate. The nature of speech, however, can give us some important clues.

It is often argued that speech in itself does not suffice for the creation of what we today call civilization[54]. There is, however, little doubt that the development of speech was the single most important factor in the emergence of civilization. Pre-oral society had no way of maintaining larger

structures through separation of responsibilities etc, and it seems likely that the primary social unit in pre-oral life was the family or the flock. As speech evolved, larger groups were able to share values and knowledge through stories, and they were able to separate tasks, which in turn allowed village structures with an established separation of responsibilities to emerge. Speech thus heralds the beginning of consciousness, social cohesion, time and narrative – in short, the emergence of society and of the human being.

A proper language makes it possible to form propositional statements, create tactics and strategies, and organize complex activities involving larger numbers of people. The advantages in coping with an adverse climate or geography, in hunting, in transitioning to an agricultural economy, or in warfare against other species are obvious, and even seen in isolation language can provide a large part of the explanation of how Homo Sapiens succeeded the Neanderthals as the dominant species within a fairly short time span - and perhaps caused their extinction.

The development of language enabled human beings to organize society and its values along higher order constructs, but with severe limitations in terms of space and time. Oral communication is ephemeral and invariably oral messages are distorted and reinterpreted each time they are repeated. This quality allows for a very dynamic society where stories are continually adjusted to current and local conditions, but it also limits the ability of organization to be kept up over distance and time. The consequence is that small societies like villages can exist as very organic democratic structures, whereas larger societal structures can only be kept up through strong hierarchical power systems with concrete reward and punishment structures.

Some social structures, like for instance trade, can be maintained over distance through the use of physical intermediaries such as a monetary system and a transport infrastructure, and there are examples of large, fairly coherent oral societies, but the vast majority of known oral societies were or are based on the village as the structure of social cohesion.

Reliance upon face-to-face communication as the only means of communication is a ludicrous proposition from the vantage point of current

society in all its complexity and dependency upon accurate records and information exchanges. It would, however, be wrong to assume that the accuracy of later communication technologies is only a blessing. The dynamic nature of face-to-face communication and the ability of everyone to participate in conversation help to prevent lopsided communication and fixation of truth. True, one person can dominate others in face-to-face communication, but this is a question of social relations rather than a feature of the communication form itself.

Yet, in order to spread beyond the boundary of the village and develop advanced bureaucratic and organizational structures, human society needed a way to communicate over both time and distance. And this is where the art of writing came in very handy and provided its inventors with a competitive advantage almost comparable to that of the Cro Magnon over the Neanderthals as described on p. 74 ff.

Writing and Print

Examining the effect of early writing upon power structures must be done with a certain amount of caution due to the fact that virtually all of the historical information accessible to us comes in the form of writing. Writing thus in a sense becomes its own witness, and we might be led astray by it. Indeed, it is very probable that for instance the Sumerian and Egyptian cultures are accredited with more cultural and technological innovation than is merited due to the very fact that these are the first cultures from which we have written records. But then again, this only goes to show the importance of writing in the formation of the modern mind and modern society.

The fact that writing seems to appear concurrently with the formation of city-states and even empires is not a coincidence. Writing first and foremost appeared as a tool for bureaucracy, trade and the wielding of power, and without an ability to record and communicate accurate information it is doubtful that for instance the formation of city-states in Mesopotamia, the unification of Egypt, or the development of the Chinese and Roman empires could have taken place. From 3000 BC and for millennia to come writing

became the key to cultural and political dominance – not least when mass production of text entered the stage.

> *'Politics in modern states and mass societies is no longer possible without the mass media. In Ancient Greece, citizens would come together in the agora to discuss current political issues - this is no longer possible today.'*
>
> *Unesco*[55]

During the Middle Ages writing and at least to some degree reading as well had been a prerogative of the church and the aristocracy. Society was to a certain degree dependent upon the written word, and numerous professional scribes made their living preparing legal and administrative documents, but books were only available to the rich, and reading for pleasure or for the purpose of learning anything other than the scriptures was for the very few.

In all of its forms the written word was an instrument for those in power and did not serve as a vehicle of public discourse. Where broader literacy was encouraged it was only for the purpose of control by the government or church, and there is little evidence of public, written debate about religious or political issues. Most of Europe was engulfed in wars and power struggles amongst kings and aristocrats or between the Catholic Church and the various kings and noblemen. The church to a large degree wielded its power through its control of the written word and its interpretation to the illiterate, and the aristocracy similarly had no interest in encouraging the development or spread of a literacy and literature which might question its hereditary status and rights.

The late Middle Ages did see a spread of vernacular literature, but it was mostly in the form of poetry and epic stories of heroes and wars, and it seems that political, religious and philosophical debate was held within very confined circle with little room for disagreement.

When the wealthy and powerful monopolize the intellectual discourse it tends to become a reflection of their own situation. As Tocqueville remarks, people with a hereditary position will tend to adopt a fixed and introspective view of society. [56] Their thinking and discourse thus become self-serving and may in some cases loose all touch with reality. They will strive for preservation,

stability and expansion of their power, and they may very well succeed over long periods of time, but the longer they succeed and the more they believe in their own superiority, the more vulnerable they become to changes in their environment.

The increasing wealth and influence of the merchant class brought a breath of fresh air to the public discourse, but it was the printing press that brought the discourse to the public. With books being published in thousands of copies and in the local languages the power of the written word rapidly became available to the general public, and although only the few had access to publishing, those who did could address virtually whole populations. Dissenting views could be aired and spread without the distortions of oral transmission, and debate among the populace could be referenced in published works, thus creating a continuous feedback cycle of public opinion. Certainly it is unthinkable that an upset of the magnitude created by Martin Luther could have happened in such a short time without the power of the press.

Printers became a new powerful class because they came to form the link between the most powerful groups in society – the literates, the church and the state.[57] Both church and state had to deal with this new phenomenon, and they did so in a variety of ways ranging from monopolizing printing to banning books. Most authorities recognized the new power of publishing as a means to their own ends, but there was widespread concern about the effects upon the public of literacy and access to possibly damaging literature. Censorship became widespread, often under the guise of protecting the public or regulating the rights of authors and publishers, but more often than not as a means for the powers that be to maintain an iron hold on the indoctrination of the population.

In 1547 the Catholic Church published the first of a long series of lists of forbidden books, which would come to include such authors as Rene Descartes, Victor Hugo and John Locke. It also led to a ban in 1616 of all publications supporting the Copernican worldview, so in spite of the fact that the Catholic Church was an enthusiastic advocate of the printing press, it also clearly felt threatened by published views not in line with official doctrine.

The effect of political and religious suppression and censorship in Italy and France was undoubtedly an important factor in the rise of Northern Europe as the center for political, religious and scientific discourse. Particularly the Netherlands became a haven for publishing literature considered improper elsewhere. Consisting of small city-states they were part of the Spanish Empire but enjoyed considerable political freedom until 1520 when Charles V became king of Spain. The weak or non-existent central government prior to the 16th Century made it impossible to exercise censorship, and the heavy oppression by Charles made it a center of revolutionary and Protestant thought and publication.[58]

Yet, while printing first flourished in areas with weak central control, its long-term effect was basically the opposite. When writing can be multiplied and shipped across large territories it becomes a vastly more powerful political and bureaucratic tool, and there is no doubt that print was a crucial factor in the formation of nation states in Europe and in the spread of new political doctrines that would influence World events in the centuries to come. Until the advent of real-time mass media the printed text was by far the most efficient way to spread a meme throughout society, and the printing press has arguably been the single most influential factor in the spread of religious dogma and political isms over the last five centuries, starting with Martin Luther's revolt against the Catholic Church. Before the age of the printing press it was inconceivable that political philosophers like Adam Smith, John Locke, Karl Marx or Mao Tse Tsung could have had the widespread and rapid impact they did, and it is the ubiquity of their books in the hands of their followers that has ensured their sometimes almost religious following.

19th Century Technologies

It took society at least two centuries to adjust to the printing press, and it could be argued that we cannot yet assess the impact of the various 19th Century technologies. On the other hand their effect has been so rapid and pervasive, yet of a less revolutionary nature than that of the printing press, and as they are all in the process of being changed radically by digital technology, this may be a very opportune moment in time to take stock.

Telegraphy for the first time in history enabled human beings to communicate over virtually any distance in real time, and this compression of time had tremendous impact on the coherence of nations and on global trade and warfare. Without the telegraph it is for instance possible that the United States would have fallen apart during the Civil War, and Abraham Lincoln made extensive use of the technology to spread his message to the people and coordinate the war effort.

The telegraph radically sped up the spreading of news across the globe. Since the advent of the printing press, news and newspapers had gained ever increasing political and economic importance, and as the telegraph by 1870 could bring news of an election result or a financial disaster from one end of the World to another in a matter of minutes as opposed to the days or weeks required previously to hand-carry the information, it became a powerful instrument in the hands of politicians and businessmen alike.

The introduction of the telegraph was the first step in the establishment of some of the World's largest private corporations. The service provided by these companies was the transportation of information, and since their earnings were based on the amount rather than the content communicated, they cared little about what information they transported and to whom. In countries where telecommunication was controlled by public institutions, the information flow could be controlled, but where private corporations ruled, conflicts over the control of information would soon emerge.

When Edward Callahan invented the stock ticker in 1867, the telegraph was suddenly useful for bringing real-time stock price information from the stock exchanges in New York and Chicago to broker offices. The telegraph thus became of central importance to the major stock exchanges, but within a few years it led to the development of so-called 'bucket shops' – independent exchanges trading with lower commissions and smaller lot sizes. In effect they were no different from the major exchanges, and in fact they represented a democratization of the stock market, allowing the ordinary person to play the speculation game. Yet, they were cutting into the business and power of the major players and their appearance marked the beginning of a 30-year struggle involving both the federal authorities and the telegraph companies.

The stock exchanges argued that the bucket shops were mere gambling houses, and that the telegraph companies were profiting from illicit trade in information. They eventually prevailed through a decision in the US Supreme Court, but in the meantime the telegraph companies made a very large portion of their profits from supplying bucket shops with ticker information. Irrespective of whether the bucket shops were a vehicle of democracy or of illicit gambling, the telegraph companies were merely the messenger and would always claim their innocence – in spite of perhaps being the main beneficiary of the system. The basis of the business was no less the content than the delivery of it to the right place at the right time, yet the companies would claim that content was not their concern. [59]

This paradox of large companies controlling vital communication networks and making immense profits from transmitting information with no responsibility for the content is of course no less relevant today than it was in the early days of the telegraph.

The telegraph was an expensive and cumbersome technology, and it never became a household item. For private use the telegraph would remain a costly solution, and it was mainly used in the service of governments and businesses. The ability to communicate almost instantaneously over large distances constituted an important competitive advantage in politics, economics and warfare, and as telegraphy was a fairly straightforward and controllable extension of the postal system, it was easily understood and utilized by existing power structures. The main effect of the telegraph was thus a reinforcement of existing political and economic structures with governments around the world taking and maintaining control over the communication infrastructure.

But what about the more intuitive media that entered the picture around the same time? We have already seen how the intuitive and direct representation afforded by photography had an immediate and widespread popular appeal, and we would of course expect the same from telephony. As we know today, telephony would indeed develop into one of the most popular, widespread, influential and indispensable technologies in modern culture, but the breakthrough was neither to be as rapid or as painless as that of photography.

In its early days, telephony suffered from patent wars, opposition and difficulties financing the infrastructure. Some saw the telephone as a toy with no serious use. Others again saw it as a threat to telegraphy and thus had every interest in suppressing it or at least make it conform to the telegraphic worldview. In Sweden, for instance, the telephone was initially ignored by the telegraph administration with reference to the Latin expression, 'Verba volant, scripta manent' (words fly, writing remains), but after a few years the telephone was recognized as an important competitor, and a royal proclamation was made to prevent telephone circuits to be made without government permission.[60]

In principle telephony removes all hierarchical and educational barriers to communication, and had it developed into a many-to-many communication technology, it could have been seen as a serious threat to established structures. But, in spite of early ambitions, telephony became and remained a one-to-one medium.

In the very beginning this limitation was obvious, since telephones were always sold in pairs with a direct line between them and were not able to establish any other connections, but with the development of the first telephone exchanges in 1878 connecting multiple callers would have been possible in principle, yet this capability was never developed to more than the rudimentary form we know today. One reason for this was that the telephone initially was seen only as an improved telegraph, and that it was first only employed for business and bureaucratic purposes; another was purely economic. During the first decades after the invention of telephony numerous experiments with using the telephone as a broadcast medium were made, but the telephone companies quickly saw that there was more profit to be gained from one-to-one conversations, and that human conversation required much less bandwidth than for instance hi-fidelity transmission of music. Bandwidth was deliberately kept low to maximize the number of telephone calls per line.

The telephone thus never became a mass medium, let alone a many-to-many communication medium. As a one-to-one medium it did not pose a serious threat as a tool for rebellion or insurrection, and history has shown us that the

telephone has probably been a better tool for the surveillors than for the surveilled.

Nevertheless, our lives have been profoundly influenced by the phone. It represents an intrusion into increasingly private spheres; first the office, then the home followed by the car and finally our body, wherever we are, and in that sense it has become a fairly sophisticated tracking device used by spouse, thieves and police alike.

Broadcast radio turned out to be probably the most powerful political tool ever devised, perhaps not even surpassed by television. Where the extent of the ancient Greek democracy was defined by the range of the human voice (what Levinson calls acoustocracy[61]), the radio extended instant political influence to whole nations and eventually the globe; but of course as monolog rather than dialog.

The instant propagation of information to the whole population coupled with the intimacy of audio abstracted from image made broadcast radio the perfect vehicle for propaganda from government and dissidents alike, and the history of radio from 1920 until the spread of television in the 50s and even onwards till present times in many parts of the World gives an amazingly clear picture of power struggles, totalitarianism, democracies in crisis, war, resistance and changing social environments. The ancient power of rhetoric was resurrected on a hitherto unseen scale by charismatic characters like Roosevelt with his fireside chats, Hitler with his fiery speeches, and Churchill with his passionate and poetic calls for unity and patriotism.

Without the radio World War II may have never happened and most certainly would have taken a different course. To the nazis the radio constituted both an invaluable tool and a threat. As discussed by Susan Cavin[62], on the one hand it was the perfect medium for spreading propaganda and lies, and on the other hand it was harder to control than newspapers. During years of occupation the spirit in Western European countries was kept high by for instance BBC broadcasting news from the war and messages to local resistance groups. For a Dane like myself the sound of John Sørensen's

announcement of the surrender of the German troops on May 4, 1945 never fails to produce goose bumps – even though I was not even born at the time.

In totalitarian and democratic states alike the radio has been used as a tool of power, but also perceived as a threat, and measures have ranged from censure to propaganda run through purely state-controlled radio space. In Ghana, for instance, the Rawlings government during the 1980s manufactured a transistor radio, which was only able to receive the Ghanese government channels and sold them at a fraction of the price of other radios[63], and when the government gave up the monopoly, Rawlings lost the democratic elections overall and only won in those districts that did not yet have independent stations[64].

Two interesting aspects of broadcast radio are that it has always been free, and that it is simply not possible to allow people to listen to a radio program and at the same time prevent them from recording it. And, unlike any previous communication technology, broadcast radio knows no limits! Every radio program ever sent travels forever at the speed of light outward from Earth into space in search of unknown receivers, and radio waves do not acknowledge borders.

Throughout its history film has been seen and used as a powerful political tool. We have seen how newsreels have been used to inform and influence the audience, but the film industry itself has certainly both influenced public opinion and felt the heavy hand of political power. Russian expressionism flourished as a part of the revolution during the 20s, but was destroyed when Stalin forced cinema under politburo control, and Hollywood was severely stymied by the so-called Production Code, which set almost impossible limitations on artistic freedom, and again by the political persecution of McCarthyism during the 50s. On the other hand, numerous documentaries and several feature films have set or helped set the critical, political or social agenda. *Easy Rider* and *Woodstock* helped spread a cultural revolution throughout the Western World. Oliver Stone dangerously flirted with the borderline between documentary and fiction in his *JFK,* and recently the film Fahrenheit 911's scathing depiction of President Bush and his administration caused great uproar.

There is probably no other medium that has been the center of as much attention and criticism as television – and with reasonable cause. Television is the most pervasive and influential medium created since the printed book, and its influence on the social fabric of society is perhaps more important than that of the book.

The image of a 1960s family dressing up to watch television carefully arranged around the cubical alter is a picture of the national family all sharing the same friends and emotions – at the same time. We go to the movies, but we are visited by television, or rather, it moves in with us and becomes an intimate part of our lives.

As we progress to the 90s the picture is somewhat different. With multitudes of channels and the TV relegated to a corner of the room, television no longer is the great unifying force in society, but rather a diversion on par with radio. Yet, it still keeps up the pretense of being a socializing force. Turn on any local news channel in the States, and notice the pains it goes through to knit the social fabric of heroic firemen and national holidays. Turn to the next channel and you find exactly the same thing, unless you have by chance hit a religious channel pounding its own message of unity and devotion. Unlike cinema, television has never developed into an independent art form, which may in fact become the cause of its eventual downfall.

Brian Winston gives a lot of attention to how the established industries worked to suppress the radical potential of television, but he fails to show what this radical potential is. While it is true that the radio and film industries to a large degree managed to control developments, it is also clear that television is a straightforward evolution of radio and film. To cinema television added the dimension of live transmission, which of course held some risks of uncontrolled events, but these risks were already well known in the radio industry and were not significantly compounded be the addition of pictures.

In the context of this thesis, radical potential is not just a question of disruption to an existing industry structure, but one of challenging the communication paradigm itself, and in this respect television brought nothing new. On the contrary, television can be seen as the ultimate mass medium transmitting

sound and picture straight into people's living room with broadcaster controlling not only the content, but also the time at which it is seen.

One of the most important aspects of television and radio is that we as consumers are not able to freely choose what we wish to consume. This makes broadcast radio and television much more centralistic media than books and audio or video tapes, that can be easily transported, stored and read beyond the control of centralized powers. The Charta 77 movement of Czechoslovakia, for instance, was heavily influenced by underground music from the States brought in on records and distributed on cassette tapes, and in Poland the political messages of Solidarnosc were distributed on cassette tapes to elude the eyes of the authorities. So, in spite of their limited power of reproduction and distribution, tape recorders have had a major influence on world events in much the same ways as the printing press during the 15th and 16th centuries.

Paul Levinson concludes that *'new media since the printing press have in every case served to ultimately further the democratization it engendered'*[65]. The statement would seem to imply that all new media since the printing press have engendered democratization, which I believe is doubtful at best. There are certainly examples of media and especially personal media that have aided democratization, but based on the observations in the preceding pages I would argue that the dominant media type of the last century, mass media, on the whole has weakened democracy. It has made vastly more information available to the public, but it has also allowed an increasing control of the information flow to pass into the hands of centralized political or commercial structures. The flow of communication has become increasingly one-way, and there is a good chance that we in the future will come to see the 20th Century with its world wars and its Western media dominance as the century of deceit and manipulation.

4.2 Learning From History

The purpose of the entire historical account has been to determine how changes in infrastructure, representation and production influence the long-term development of society and culture, and we have now, finally, reached

the point, where we can reexamine the framework introduced in Section 2 from a historical perspective. Each technology has provided us with clues, and we should now be able to turn the framework into a tool for examining the technological changes we are facing today. On the following pages I thus interpret history in terms of the framework in order to finally set the stage for an examination of digital society.

4.2.1 Infrastructure

As seen in Figure 12 communication technologies have widened our communication space to include all aspects of one-to-one and one-to-many communication, but only marginally touched upon many-to-one communication and not at all addressed many-to-many communication. We have enlarged our communication space to cover the globe in real-time, but at the cost of the balance between sender and receiver.

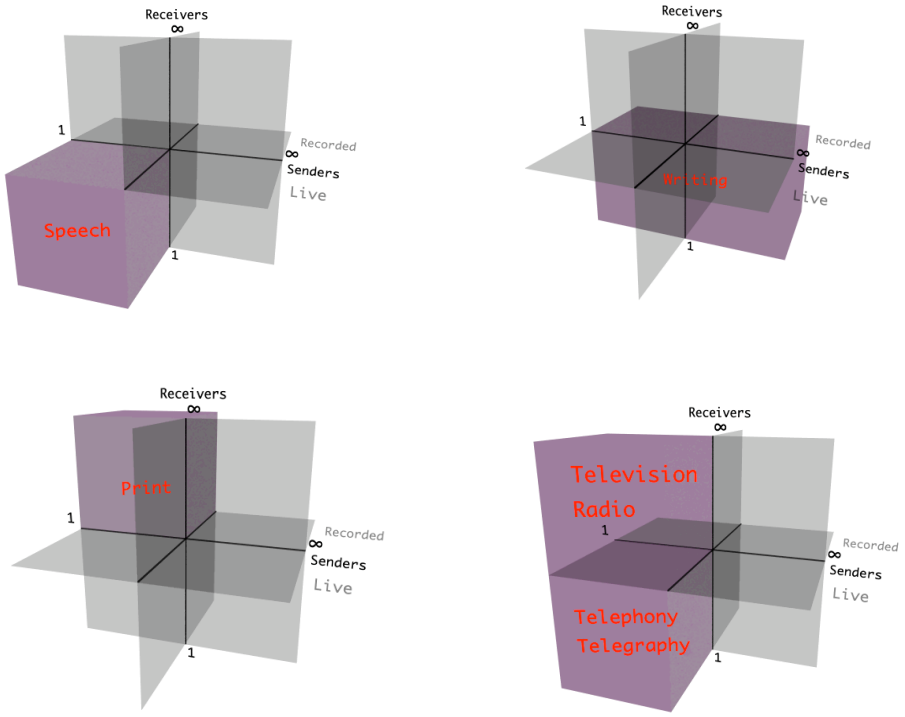

Figure 12. The progression in communication space over time showing that speech covers one-to-one communication in real time, writing extends one-to-on communication in time, print introduces one-to-many communication, and 19th Century technology creates real-time one-to-many communication in real time and extends the power of speech and writing over distance in real-time.

Working our way through history we have seen that the combination of one-to-one and one-to-many communication is sufficient for creating and maintaining societal structures that reach as far as the communication technology can carry, but the character of especially one-to-many communication invariably leads to centralized power resting with those who control the access to mass media.

Until now, balanced communication has only existed on local levels such as in villages or among the elite in the Greek city-states, and, in fact, the balance between sender and receiver was corrupted with the very first proper communication technology, writing. Communication has yet to recover from this blow. Up until the advent of the printing press the effect was basically, that only the ruling class had access to reading and writing, and within this group communication might have been balanced, but viewed from the perspective of society as a whole the written word only contributed to the centralization of economic, religious and political power.

The printing press spread the word to the people and caused an upheaval in the power structure with the Reformation, the rise of the merchant class and an increasingly literate and demanding populace leading to the formation of modern democracy. Yet its effect on the balance of communication was negative, and it ushered in a period in which the general population would be subject to an ever-increasing barrage of information from the few. The net effect has arguably been an increasingly centralized power structure with a no less pacified population than before.

Industrial age communication technologies only served to further the separation between those who create and those who consume – at least when it comes to one-to-many technologies. In terms of breaking down the barrier between creator and consumer both photography and telephony presented breakthroughs, but only as one-to-one media. The potential for a many-to-many communications revolution was there with the telephone, but throughout its history this possibility was not explored, and the infrastructure, which it to a large degree inherited from the telegraph, prevented this. The result was an even greater imbalance in communication and the development of a society dominated by mass media and consumption.

We can conclude that communication infrastructure is a crucial factor in the development of societal structures. On the one hand the extension of communication over time, distance and number of receivers has enabled the growth of organized society from village to global, but on the other hand the development of mass media has caused an increasing imbalance of communication and thus of power and control. Communication infrastructure is a central, determining factor in how we organize society, deal with power, conduct business and educate our children, and we can conclude that radical change in our communication infrastructure is bound to cause long term disruption in or social, political and economic structures.

4.2.2 Representation

The history of representation (at least in the Western World) is one of ever-increasing atomization and detachment until the 19th Century, when the media space exploded and brought us straight back to intuitive representation. Speech was probably the first symbolic representation of thought, but we quickly digressed into more visual representations starting with direct reflections of what we saw and gradually moving towards representing spoken language as we searched for the perfect balance between universality and ease of use. As we did so we increasingly emphasized the visual over the auditory, but, once again, the 19th Century brought some balance back to the equation.

Abstract thinking and symbolic representation of information have developed hand in hand and have been prerequisites for the science and innovation that have been central factors in cultural development and competitive advantage since the dawn of mankind. Symbolic representation comes at a price, however, and we should not ignore the effect of photography, radio, the phonograph, film and television as the first communication technologies able to record and/or transmit visual and audio information in an intuitive format. Many have argued that the end effect is a dumbing down of the population, but so far there is little doubt in my mind that the net effect has been a much more well-informed and certainly more intensely entertained public.

Being informed, however, is not the same as being creative or innovative. Passively received information may in my view serve to dull the senses and the urge to create, and the less exposed we are to abstract information the less our thinking is conditioned to abstract reflection and the inventiveness it engenders. Whereas information may be a prerequisite for creativity, tools for thought and for construction are indispensable, and throughout history we see that the eras of great innovation have been closely aligned with leaps of development in our linguistic tools.

I have demonstrated, how static, atomistic representation of language has promoted an atomistic and individualistic worldview, which has had a profound effect on Western culture, science and philosophy. We have achieved incredible scientific and technological breakthroughs, but perhaps to the detriment of attention to relations, processes and more holistic views of the world.

4.2.3 Production

In terms of production, speech is beyond doubt the most democratic form of communication. Virtually everyone is born with the ability to acquire speech, and speaking requires no tools, materials or other resources. The freedom of speech can be suppressed, but as speech is local and leaves no trace it is nigh on impossible to control in practice.

Not so with writing. All writing systems require considerable effort to learn as well as both tools to write with and material to write upon. Writing normally persists over time and is thus easier to keep tabs on, and control of the written word as well as its production has been a key factor in the distribution of power ever since the advent of tokens. And since writing is a much more powerful tool for transmitting information over time and space than speech, it changed the power structure in society fundamentally.

One cannot overestimate the importance of the permanence and unchangeability of writing. Since the days of the Sumerians writing has been used to confirm deals, record crops and property for taxation purposes, record history, create identity and immortality etc - all usages that rely on the integrity of the writer and the trust of the reader. Written text is fundamentally different

from the spoken word in that it is one-way communication and thus separates the reader from the author. The written word must stand for itself, and it thus inadvertently takes on the character of 'truth'.

Writing turned the production process into a solitary pursuit and separated the producer from the consumer. The notions of authorship, authority and individualism arose with writing, but as long as the writing tools and materials remained simple and easily accessible just about anyone who could read would also have access to writing and thus to participate on fairly equal terms in the production process. This all changed with the printing press, which both amplified and concentrated the power of writing. Every literate person could still jut down words with a pen, but only those with access to the fairly expensive, labor-intensive and often politically controlled printing presses could spread their message to large numbers of people. The printing press thus heralded the beginning of what we have since come to call the consumer society, where the few produce for the many.

Every reproduction technology developed since the printing press has only increased this separation. Books, newspapers, film, radio and television all require substantial production facilities and have from the beginning been subjugated to both economic and political control. In fact, the last few decades have brought the economic control over our media on fewer and fewer hands resulting in a decreasing diversity in the media messages we receive.

Photography and tape recorders are an exception to this trend, yet when it comes to reproduction and distribution they have had limited success in the democratization of media.

If the tools of language are crucial to the intellectual development and creative powers of the individual, their availability is equally crucial to the development of society. And availability is characterized by access to production and consumption respectively, but certainly also by our ability to manipulate existing content.

In oral communication production, manipulation and consumption are inseparable. We are virtually all able to speak and listen, and dialog is a continuous negotiation of meaning in which words are uttered, interpreted and

restated – never frozen into a given 'truth', but always used and interpreted in a dynamic context. Writing, on the other hand, separates the literate from the illiterate and the producer from the consumer and thus creates a three-way split in society: Those who are able to produce become the manipulators of information, those who can decipher it become consumers, and those who cannot are left out in the cold.

In terms of manipulation improvements have been few and far between since the advent of speech. Every single technology that has been able to preserve information over time has also frozen the information into a basically unalterable form – at least for the average person. This is not surprising, since one of the foremost qualities of writing and even more of printing was the accurate preservation of information over time, which enabled the development of concepts like truth and accountability and of a society that would depend on these constructs. In the individualistic and information-centered culture of writing altering a message is akin to forgery. A film, a document, a radio show or a painting are all considered finished works, and up until the 1970s only the likes of surrealists and collage artists would dare to mess with the works of other people[66].

We should not underestimate the importance of malleability. Our concept of truth, our belief systems, and our understanding of intellectual property, the individual and art have all been profoundly influenced by the non-malleability of writing and most subsequent communication technologies- As we enter a new age of malleable media, we will do well to bear this in mind.

4.3 Concluding Remarks

Section 3 and 4 have supported the first claim stated in the introduction, namely that we can find important clues to the development of past and future cultures in the fundamental properties of their communication technologies. By examining history in view of the framework I have shown, that only speech, writing, the alphabet and the printing press qualify as revolutions within communication technology, and, in fact, I believe that communication technology provides as much of a basis for defining major periods of human history as does economic yardsticks.

Traditionally we identify four major periods in World history based upon the type of human activity responsible for the main economic production: The hunter-gatherer society, agricultural society, industrial society and the information society. An alternative, but almost coinciding perspective of history emerges if we look to communication and communication technology instead. It does not replace or invalidate the traditional view, but I believe it can provide us with some new insights into the factors that have driven some of the major shifts in global economic and political dominance and in the way we think about ourselves and the world around us[67]:

Oral Society

The first major revolution in the history of mankind was the appearance of the Cro Magnon. This revolution was caused by evolution rather than by human innovation, but it marks the dawn of modern man and is closely connected with the advent of language. It seems highly likely that the language and abstraction capabilities of the Cro Magnon were the key competitive factors that led to their displacement of all other humanoids and to our eventual World domination as a species. The ability to communicate abstract thought enabled us to plan, organize and innovate and thus formed the prerequisite for all subsequent developments, and we must therefore see symbolic representation as one of the most fundamental and important aspects of communication and communication technologies. Pre-historical humans were hunter-gatherers, but it was abstraction and language that made us different from other species and allowed us to develop into what we are today.

Bureaucratic Society

Agriculture largely appeared as a result of climatic changes and the settling of humans around large rivers. While it is true that agriculture and settled life created the conditions for and necessity of specialization, trade, laws and other artifacts of ordered society, it was writing that made these things possible on a larger scale and allowed us to transition from small villages to actual city states with formal economic, political and cultural structures and the accumulation of knowledge necessary for systematic development. The ability to preserve information over time and spread it over space was what

enabled us to create what we today call civilization, and without writing we would never have developed beyond agriculture.

Writing represents important changes to both representation and production, but the most important lesson to be learned from bureaucratic society is, that there is an intimate link between power and communication infrastructure.

Scientific Society

In the traditional view the next revolution is the industrial, but industry could never have evolved without abstract science, which in turn could not have evolved without written representation – and specifically that of a very limited set of signs that can be connected to form all possible concepts. It was arguably alphabetic writing, or perhaps rather alphabetic thinking, that led the Greeks to begin systematic inquiries into nature and the nature of man, and thus to create the basis for all modern science. Again - It was a leap in representation that led to a leap in human development, and the leap happened with the alphabet rather than with the spinning jenny.

Knowledge Society

Unfortunately the knowledge of the Greeks was limited to the privileged few in a fairly small society, and the lack of a technology for the reproduction of information prevented the knowledge from spreading and enabling the large-scale innovation necessary for the development of an industrialized society. A leap of scale was necessary, and it came with the printing press, which not only helped revive science, but also enabled the Reformation, the nation state, the modern school system and modern democracy. The printing press created a society that became completely dependent on widespread knowledge and literacy, and it did this simply by enlarging the scale and reducing the ambiguity of communication.

The Next Step?

Each transition is characterized by a change in representation, scale or both, and the conclusion with respect to the framework is, that scale is the most important factor in the development of power structures while symbolic representation has crucial implications for the development of culture and

thought. The impact of production is a little bit more subtle, but nevertheless extremely important. We laud our freedom of expression, but our technologies determine not only the form and permanence of the expressions, but also who has access to express himself and be heard.

But, if the knowledge society started already with Gutenberg, what do we make of the information society (or knowledge economy), which supposedly appeared some time around 1970? Well, from a communication perspective information is central to any form of society. The transitions between the different eras have all had to do with changes in how we represent and exchange information, and we therefore have to come up with a different term for the era we are in the process of entering. To do so we must turn our attention back to digital communication and examine history in the making, and since Section 4 has demonstrated, that the theoretical framework can help us determine the potential for qualitative change inherent in any given communication technology, we should be ready to face the claims made about digital technology.

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[1] Merriam-Webster, http://www.merriam-webster.com/dictionary/culture, Oct 2008

[2] Wendt 1996

[3] Parry 1971, p. 450

[4] Interestingly, what we consider the aesthetic or poetic aspect of both oral and written art has most likely grown out of practical concerns specific to oral communication. The use of storytelling for transmitting and maintaining history and shared values required mnemonic devices for the storyteller, and these would often take the form of verse and clichés, which are today perceived as poetry.[4] Even up to the present day the art of rhetoric borrows greatly from the aesthetics and tricks emanating from what was originally a mundane task of remembering, but there is of course no reason to believe that ancient cultures were less enthralled by great oratory than we are today.

[5] See for instance Illich 1988, p. 84

[6] Wendt

[7] Ong 1982, p. 79

[8] Johns 1998

[9] Ibid, p. 31

[10] Ibid, p. 39

[11] Ibid, p. 50

[12] http://en.wikipedia.org/wiki/History_of_copyright_law, Jan 2009

[13] Illich 1998, p. 94

[14] This was for instance seen in the events leading up tio the second Gulf War, when even most opponents of the war were convinced that Iraq actually possessed weapons of mass destruction.

[15] Illich and Sanders (Illich 1988, p.7) claim that learning cannot take place in oral society either, but I prefer to see learning as a broader concept than education.

[16] Schmandt-Besserat 1998

[17] Papert 1991

[18] http://www.greatscott.com/hiero/eye.html, Feb 2009

[19] IEEE 2004 /timeline%203000BCE_1500CE/egyptians.html

[20] Ibid p. 87

[21] Logan 2004. p. 81

[22] Havelock 1976, p. 44

[23] Logan 2004, p. 82

[24] Ibid, Chapter 8

[25] Ibid, Chapter 12

[26] Ibid, p. 86

[27] Smith 1998

[28] Ibid, p. 113

[29] Ibid, p. 122

[30] Logan 2004

[31] Nisbett 2003

[32] Johns 1998, p. 43

[33] Eisenstein 1979, p. 193

[34] IHP 1995, /sumerian_culture

[35] Wikipedia.org, http://en.wikipedia.org/wiki/History_of_education, July 2008

[36] IHP 1995, /sumerian_culture

[37] Illich 1998, p. 15

[38] Ibid, p. 23

[39] Postman 1980

[40] See for instance (Ashdown 2000)

[41] Numerous writers including Levinson and Logan make claims to this effect.

[42] By exclusive monotheism is meant belief in one God to the exclusion of rather than above all other gods. See (Monotheism. Encyclopædia Britannica. Retrieved February 16, 2004, from Encyclopædia Britannica Premium Service.

<**http://www.britannica.com/eb/article?eu=117390**>)

[43] One possible exception to this is Zoroastrianism based on the teachings of Zarathustra that were transmitted orally for centuries before being written down.

[44] See http://en.wikipedia.org/wiki/Akhenaten

[45] Akhenaton. Encyclopædia Britannica. Retrieved July 9, 2004, from Encyclopædia Britannica Premium Service.

<http://www.britannica.com/eb/article?eu=5329>

[46] A hymn written by Akhenaton, for instance, bears strong resemblance to Psalm 104 in the Bible.

[47] http://www.jaars.org/museum/alphabet/people/moses.htm. There are even sources that claim Moses to be identical with Akhenaton. See for example http://www.greatdreams.com/moses.htm

[48] Monotheism. Encyclopædia Britannica. Retrieved July 8, 2004, from Encyclopædia Britannica Premium Service.

<http://www.britannica.com/eb/article?eu=117390>

[49] See for example (Valle 1992), (Fore 1982) and (van Leewen 1964)

[50] Goodie 1975

[51] Ong 1970, p. 54

[52] Foster 1991

[53] Descartes 1637

[54] See for instance Levinson 1997, p. 49

[55] Dadalos

[56] Tocqueville 1835, Chapter 13

[57] Eisenstein 1979, p. 690

[58] See Eisenstein 1979, p. 646

[59] For an account of the bucket shop wars, see Hochfelder

[60] Telemuseum 2004, http://www.telemuseum.se/historia/telegraf/spoken.html

[61] Levinson 1997, p. 78

[62] Cavin 2006

[63] I saw these during a visit to Ghana in 1987.

[64] Friedman 2001

[65] Levinson 1997, p. 56

[66] See for example http://en.wikipedia.org/wiki/Cut-up_technique, July 2009

[67] Niels Ole Finnemann (Finnemann 2005) makes a similar destinction with his five information societies. He defines the different societies in terms of their media matrix, but, where I see a qualitative difference in alphabetic writing, he focuses on the analog, energy-based media of the 19th Century.

Section 5
Digital Media

Section 5 revisits digital communication technology in view of the theoretical framework presented in Section 2. Digital communication technology is shown to be the first communication technology ever to present us with qualitative changes in infrastructure, representation and production and thus with a greater potential for radical change than any technology since the advent of writing.

5.1 The Characteristics of Digital Media

So far, describing the fundamental character of the different technologies has not been too difficult, but with digital technology the story gets more complicated. The fundamental problem is that digital technology is so powerful and versatile that it is rapidly entering into a broad range of everyday objects and in many ways it can today be seen as a raw material like plastic or electricity. Digital technology can be examined as an isolated phenomenon, but in order to understand its current and potential impact we have to take the examination one step further and look at applications – not least in relation to our previous information and communication technologies. Digital technology not only introduces completely new forms of communication, but also changes production, storage, reproduction and distribution of all previous communication forms. In fact, where other communication technologies have been extensions or simulations of single senses, digital technology with its multiple representations and its power of computation is more like a model of man than an extension of his senses.

In the context of this thesis, however, only the aspects of digital technology that are directly related to communication are relevant, and the following section therefore takes a two-step approach. First it discusses the fundamental character of digital information, computation and communication in isolation, and then it goes on to look at its character in various embodiments.

5.1.1 Infrastructure

Digital media are absolutely unique in that they cover the full communication space. This means that digital media enter every area covered by previous communication technologies, but, more importantly, it means that entirely new communication territories are claimed, namely many-to-many communication in real-time and over time as well as many-to-one communication in real time. While we are experts in understanding and dealing with one-to-one and one-to-many communication these new territories are alien to us and will require many years to fully comprehend – especially since they undermine our current

understanding of communication and of the power of information and knowledge.

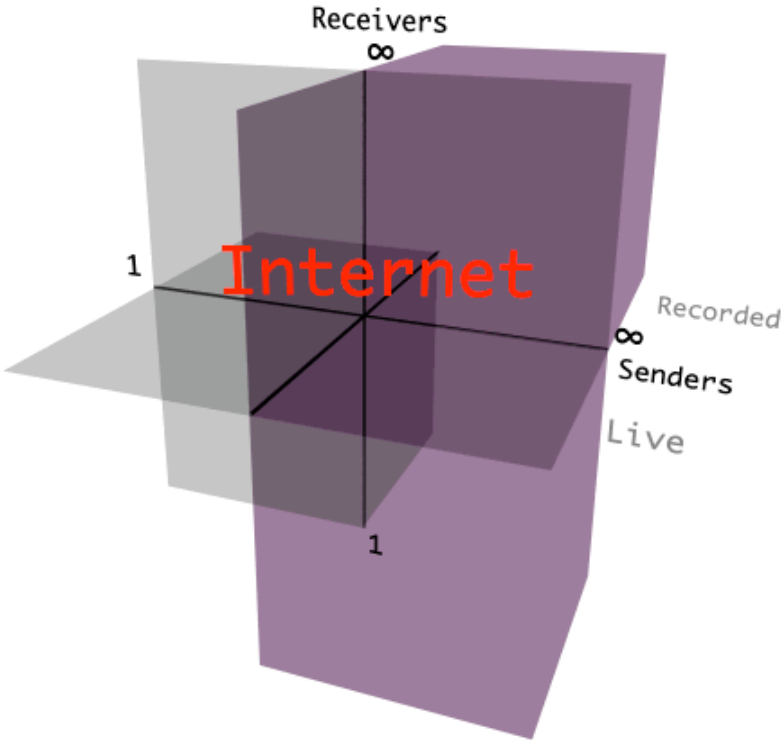

Figure 13. Digital communication covers all infrastructure supported by earlier technologies, but adds many-to-many communication as well as real time many-to-one communication.

As thoroughly argued by Harold Innis[1], it is clear that governance and coherence of a society is to a large degree determined by the range in time and space of its communication technologies, but in my view the balance of communication is an even more important factor. The democracy that we value so highly depends upon each and every person to contribute to the development of society and the discourse of its values and decisions, and the more imbalanced our communication becomes, the further we move away from that ideal. Ever since the introduction of writing almost every technological invention has added to the imbalance, and the continuous ambiguity in the relationship between government, business and the arts when it comes to control of the media is a clear testimony to this schism.

The Internet at least in principle enables balanced communication. We should, however, bear in mind, that the Internet depends on a hardware infrastructure inherited from telephony and therefore cannot entirely break free of the economic, political and technical structures built up around a centralized, one-to-one communication system. Had it not been built on an existing infrastructure it may never have extended beyond universities and the military, but the fact that it was will surely come to haunt us for years to come.

5.1.2 Representation

With digital media we have finally reached what might be called the ultimate symbolic representation. The number of symbols have now been reduced to two – zero and one – that are completely removed from any reference to sound, image or anything else and can thus be used to describe just about anything. With digital information we have reached the limit of discrete representations and therefore enabled the closest description of reality possible with discrete means.

If this is true, why has it taken us this long to reach this ultimate communication construct? The answer is that the binary description has existed for a long time, but that it gives little meaning as a general symbolic language without a machine to help us interpret it. It is simply too general and simplistic to be of any use to us rendered in its basic form. Since there are only two symbols in the system it is very easy to learn, but obviously very hard to use in practice. If this thesis was written in a binary rather than alphabetic representation it would be something like 5 to 10 times as long and virtually impossible to read[2]. We are thus faced with a representation so abstract that it has no meaning without an automated interpretation and only becomes a tool for communication when rendered in another form.[3]

As a symbolic representation, binary is the ultimate, but is it the ultimate representation? The main issue here is that it is a discrete representation and thus fundamentally unable to represent analog data or continuous phenomena in anything other than an approximate fashion. This limitation has been the source of endless debate among for instance hi-fi aficionados, but does it have any real implications? The discussion goes all the way back to

Zeno and the story of Archimedes and the Tortoise as recounted in Section 4. The flaw in his argument is of course that we cannot describe motion as a finite sum of points in time or for that matter distance as a finite sum of points, since points have no extension. But we can create an approximate description, and as the number of points increase the approximation becomes more and more accurate.[4] In the context of communication the distinction ceases to have any meaning, when the points are too close for our perception to discern, i.e. when the resolution of the description is higher than the resolution of perception. Actually, as illustrated in the use of 24 or 30 still pictures per second to produce moving images, fooling the senses often suffices. So, whereas a binary representation will never be more than an approximate description of analog phenomena, this limitation has no practical implications when it comes to communication.

In fact, we are rapidly approaching the point where the distinction between analog and digital representation becomes purely academic, since our senses are unable to tell the difference. This has arguably already happened in the areas of photography, video imagery, and audio, and chances are that it will happen in other modalities as well.

The symbolic nature, linearity and modularity of writing and especially alphabetic writing has been central in the development of Western thought processes and, as a consequence, in the development of science, technology and society – for better and for worse. Yet, every communication technology developed between the telegraph and digital technology has served to reduce symbolic detachment and in this sense the alphabet has contributed to its own destruction. Those who see the alphabet as a sign of mankind's recession into the twilight of the idols must see this as a positive development, whereas those who laud the alphabet as a cause of human progress must lament the return to inuitive communication it has led to. Both groups, however, may finally reunite in digital media, which is not only the highest form of symbolic representation, but can find expression at any level ranging from the intuitive image or sound to the most abstract and intricate procedural description.

My personal view is, that the alphabet was a necessary intermediary in the development of human abstraction, and that it possibly strikes the perfect

balance between versatility and comprehension and between freedom and constraints. The bit provides a much higher degree of versatility and freedom, but it is only useful as a description tool when combined with the power of computation, and it will of course never replace the alphabet. There will never be a digital script read by everyone, and in fact more and more of us will only encounter digital technology and communication in various, increasingly intuitive disguises. Where the alphabet confronted us with ourselves and demanded its own place in our consciousness, digital media always come cloaked in sheep's clothing, and only the most dedicated programmer encounters its bare bones.

Marshall McLuhan predicted that electric media would bring us beyond the alphabet and eventually into a post-verbal state of global consciousness[5]. There certainly are no signs of that happening any time in the near future, and, in fact, digital communication has so far caused a revival of text. Although the Internet supports every known representation of information the by far prevalent mode is still text, and our manipulation of digital data through programming also happens predominantly through alphabetic representatin.

Niels Ole Finnemann[6] argues, that text culture has conquered the image, since digital representation can be seen as a textual representation, but I would reserve the use of the term 'text' to representations of spoken language and argue, that binary representation is qualitatively different and not merely an extension of print culture.

5.1.3 Production

Production of digital information is unique due to the ability of the computer to deal with information as a dynamic entity and to transform information from one format or expression to another.

First of all, digital technology brings information back to life after millennia of static texts and images. Due to its unique combination of memory, processing power and abstract representation the computer is able to hold information in a dynamic form that allows it to be freely copied, modified and amended, and it thus combines the dynamic aspects of oral communication with the permanence and accuracy of writing and the reproduction capabilities of print.

So in a sense, now we can have our cake and eat it, but we must be aware that the consequences of editable media reach way beyond the mere convenience of not having to rewrite the whole page if you make a mistake.

Secondly, the binary representation combined with software and hardware enables entirely new input and output methods. We tend to think of information as text and have therefore concentrated a lot of research on the character of word processing and hypertext, but the world of digital information is far more complicated and rich. Input and output of information depends entirely on the digital application and hardware used, and our current dependency on the keyboard and the screen is to a large degree a legacy from the typewriter and the television. We are still at the stage of the horseless carriage, but a closer examination clearly shows that as digital technology becomes a commodity, our interface with it changes radically.

Thirdly, the computational power of the digital machine allows it to engage in active dialog with us as it interprets and transforms our information acts. Every previous information technology has merely been a mechanical or electronic extension of our body, with the only exceptions being mechanical calculation and the fairly simple and straightforward filtering methods in analog audio and video recording technology used mainly by professionals to edit material. With digital computation the machine becomes an active partner in the production of information.

The availability of a machine to process and render information in one stroke makes binary the simplest and most versatile encoding useful for us. With the use of the machine we cannot only render digital information in just about any form we desire; we can also add any number of layers of meta-information on top of the actual data, and we can even process data to produce new information. We can structure, search, copy, modify and render our information in an infinite variety of ways, and we can save it for posterity in a digital or any number of analog formats. In fact, with digital technology we are able to imitate all the previous communication technologies while adding the power of digital representation, computation and communication.

With digital technology we can not only produce and reproduce information in any sensory modality. We can also retain the digital representation in abstract forms that allow us to analyze, manipulate and render in new and emerging forms. With abstract representation we are able to keep the data separate from the rendering and are thus fundamentally independent of the temporary limitations of our current rendering technologies and media.[7]

To understand the qualitative difference between rendering and digital representation think of a realistic 3D rabbit bouncing across your screen. What you see is basically no different from a video image of a real rabbit, but whereas the video image is merely a sequence of pictures with no abstract notion of rabbit or bouncing, the computer animation can have been generated from a model of a rabbit and all its constituent parts including its fur, bones, muscles and even behavior patterns as well as a model of the environment in which it lollops about. The rendering on your screen is just one representation of the rabbit, and the same information could be used to create a mold for a plastic rabbit toy, create a whole rabbit family, allow you to see the world from rabbit-perspective, or perhaps render a bouncing kangaroo instead. Just like the written word is not the word itself, but an abstract representation, the bits describing rabbit, scene and movement are an abstract representation – but an infinitely more complex, versatile and pliable one than the word 'rabbit'. In fact, in spite of the fact that the actual embodiment is in the ultimate symbolic form, the versatility of representation in the computer allows a much more direct reference between the representation and a real rabbit than any written representation, and in digital form we can imbue the simple word 'rabbit' with all we know about rabbits. In this way what used to be a dead, printed word, which could only be brought to life by the reader, suddenly becomes a reference to an elaborate and dynamic description of everything rabbity.

The possibilities are, indeed, endless, but so far we have only scratched the surface of digital interaction, and the same applies to the way we organize and retrieve data. The defining element of the web, for instance, is the hyperlink, and it is and will probably for some time to come remain its most important feature, although we have come to take it for granted and made it

part of everyday parlance. It is a simple yet extremely powerful tool for organizing information, but unfortunately it is also increasingly showing its weaknesses. The decision to link only one way has resulted in millions of dead links around the web, and the web of links is a chaotic mesh with none of the structure that we are used to from encyclopedias, books and newspapers. Following links we are invariably sent off on tangents or outright goose chases that may be inspiring, but are more likely to waste our time in view of the task at hand. We have increasingly come to rely on search engines as navigation tools, but they do not provide much coherence either, and it is clear that we are in the very early stages of global organization of dynamic data. It took centuries for print to find its format, and it will certainly take decades for the Internet and the mindsets of its users to converge on some stable form.

Due to its discrete, binary character digital information is quite easy to store. Any medium capable of distinguishing between two values (e.g. presence and non-presence) can store digital information, and the only real issues are density, portability, accessibility and durability. The last couple of decades have seen a tremendous development in storage technology, and the price for digital storage continues to fall by at least 50% per year. In 2008 a terabyte of storage space, which in 1992 would have cost around 1 million dollars, could be purchased for less that 500 dollars, Meanwhile most of the storage media are or are becoming infinitely rewriteable making them the most flexible storage medium ever.

Durability of digital storage media is a concern, mainly due to the rapid change of standards, but in my view a much larger issue is the dynamic character of the medium. When a book is published its manifestation in that particular form is given a unique ISBN number, and a copy is sent to the national library in the country of origin, thus ensuring its existence for posterity. But when is a web site published? And what does the publication consist of? During the first few years of web development it seemed possible to at least take snapshots of the web, and several library projects attempted to tackle the issue, but with the rapid increase of the number of database driven web sites, even this approach has become unviable. Today the surface web

comprises less than 2 percent of the total information on the web, which means that the vast majority of information on the web is dynamic and virtually impossible (and in most cases probably irrelevant) to preserve for the future.[8]

Reproduction of digital information is very different from all previous information reproduction. In principle digital information is just as dependent on a physical embodiment as any other, but in practice this dependency is becoming increasingly irrelevant to us. Through a simple Internet connection we have access to a virtually infinite information repository, and even locally on our laptops we have space for the equivalent of several hundred meters of shelved books. The information can be reproduced without loss of quality and without any cost save for that of the storage space and a bit of electricity, and it can at any time be rendered onto a screen or a physical medium.

So, with digital technology we are finally able to mimic the combined storage and processing capability of the human mind – with the great advantage that, unlike our brain, the computer is able to separate storage and processing and thus to serve our need for permanence and flow at the same time.

5.1.4 Summing up

We are now in a position to address the second claim of this thesis: *That digital technology represents the most important qualitative development in communication technology at least since the advent of writing.*

If we line digital technology up next to previous technologies, we see that we are facing not only one, but at least three qualitative changes to the communication landscape: Many-to-many communication, dynamic representation, and virtually infinite and free storage and reproduction capability.

	Infrastructure	***Representation***	***Production***
Speech		*Symbolic*	
Writing	*Distance and time*	*Lasting and fixed*	
Alphabet		*Atomistic*	
Print	*One-to-many*		*Accurate reproduction*
Digital	*Many-to-many*	*Binary and dynamic*	*Malleable* *Limitless, error-free reproduction*

Table 2. Comparison of digital communication technology with previous technologies

Speech is in a sense the yardstick by which we measure all subsequent communication technologies. Unsurpassed for multimodal, intuitive, real-time, local, one-to-one communication, unaided speech lacks the ability to communicate over distance, time and to more than a very limited number of people. Writing introduces a fixed representation that allows communication over distance and time, but lacks the real-time capability of speech and – without efficient reproduction techniques – one-to-many communication. Alphabetic writing only changes the representation of language, but, as we have seen, this seemingly innocent change was to have a major impact on the development of Western culture, which also applies to the printing press and its introduction of mass media.

I have shown that each of the three parts of the framework represents qualitative aspects of communication technologies, and that changes in either of them can have an important impact on human culture and society. It thus stands to reason, that a technology, which changes not just one, but all three parts in a fundamental fashion is bound to have complex and far-reaching effects on society. The fact that digital technology enables a transition from mass media to many-to-many communication and from fixed and static representation of speech to malleable and dynamic representation of virtually anything clearly makes it at least as important a development as the alphabet and the printing press. So in the grand scheme of things only writing remains

a real contender due to the enormous importance of the ability to share information over time and distance through a fixed representation.

In the following section I will examine the likely effects of digital communication upon central aspects of human culture.

Section 6
The Digital Society

'McLuhan's famous observation that "the new electronic interdependence recreates the world in the image of a global village" (1962, p.43) speaks to that need, even though that global village of radio listeners and television viewers was and still is more metaphoric than real, consisting as it does almost entirely of voyeurs, not creators, of information. In contrast, the real village consists of denizens who are senders as well as receivers, who participate in its communication and community on many levels. By that criterion, the online community is the first truly global village.'

Paul Levinson[9]

Having established the validity of the theoretical framework and the revolutionary nature of digital technology we are now in a position to address the third and final claim: *That the fundamental properties of digital technology will promote a society and culture, which is radically different from the one we have developed in the Western World since the advent of the printing press and, in fact, bears close resemblance to oral society, albeit on a much grander scale.*

Before digital technology we had created global, instant one-to-one and one-to-many communication with symbolic representation of speech and direct representation of image and sound – and we had shaped our societies accordingly as shown in Table 3.

Speech	*Symbolic representation*	*Village* *Separation of labor*
Writing	*One-to-one communication over space and time*	*City-states* *History* *Bureaucracy* *Literature* *Organized religion* *Truth and lies* *The individual*
Alphabet	*Atomistic representation of speech*	*Science* *The atom* *Western Philosophy* *Monotheism*
Printing press	*One-to-many communication*	*The nation state* *Enlightenment* *Industrialism* *Individualism* *Reformation*

		IPR *Collaborative science* *Separation of producer and consumer*
Digital Communication	*Many-to-many communication in real time and over time* *Dynamic representation*	

Table 3. Comparison of digital communication technology with previous technologies

The question now is what kind of society will be promoted by digital media with its many-to-many communication capability and many dynamic qualities.

In his book "The Network Society", Manuel Castells in 1996 identified four cultures on the Internet[10]: The techno-meritocracy, the hackers, the communitarians and the entrepreneurs. While it is true that these four cultures quite well defined the culture at the turn of the Millennium, the situation looks different only a few years later, and one might compare the characterization to an observers identification of four cultures in California at the height of the Gold Rush: The gold diggers, the bartenders, the farmers and the whores. Today all except the gold-diggers are still there, but apart from that the description of 1850 will bear little resemblance to the Californian reality of 2008. Retrospectively we might see that the Gold Rush was a defining moment in California history and an important factor in the formation of the unique Californian culture, but to foresee, how the culture would evolve would of course have been impossible in 1850.

While new communication patterns and direct effects on existing media and industries are fairly easy to identify, it is far more difficult to say anything conclusive about the wider and more long-term effects on society and culture. History shows us that predictions concerning even straightforward technologies have often been completely off mark, and in this case we are dealing with the creation of a highly complex communications network, where in principle everyone can be a producer of content for everyone else. The properties of a structure of this complexity will be emergent and therefore much harder if not impossible to predict. We are already seeing a number of changes beginning to happen, but we cannot assume that we can extrapolate them, as they represent a struggle between old and are not necessarily indications of more permanent changes. Initial indicators may turn out to be

misleading, and although some evidence is available we cannot refrain from a certain reliance on conjecture when discussing the impact of digital communication upon society and thought.

Nevertheless, the theoretical framework and the historical account has provided us with some important tools for investigating possible futures. On the following pages I thus return to the issues of knowledge, behavior and belief systems in order to address the question of which kind of society and culture will be promoted by digital communication technology. Once again – the aim is not to predict the future, but rather to identify the possibilities and threats introduced by digital communication technology.

6.1 Knowledge

6.1.1 Truth and credibility

As we have seen, the structure of the Internet has no inherent imbalance. This means that everyone in principle can be a contributor of information and opinion, and that it is virtually impossible to control the information flow. Unfortunately it also means that our traditional means of assessing credibility and enforcing accountability fall short. As users of the web we are more or less in the same situation as readers in the 16th Century Europe. When searching for information we can only use our own judgment to determine the credibility of a given web site, since the web is not controlled by any kind of publishing system. The web is already an immense source of information, but the problem is that you can find just about any answer to any question, and that it can sometimes be very difficult to determine who is the source of the answer and what his agenda might be. Like in the 16th Century world of books, piracy, fraud and misleading information are rampant on the web, and it will certainly take a long time before we develop and implement satisfying solutions to these problems.

It is said that a man with one watch always knows the time, but a man with two never knows, and it is of course much easier to deal with only one answer to your question. Yet, as anyone who has had occasion to study any subject in some depth will know, there is rarely a single, unequivocal answer to any

question, and this is very clearly laid out before our eyes on the web. When everyone can offer their opinion on whatever they desire, and when text and other information can be freely copied, modified and redistributed we must accept ambiguity and a wide quality spread. In principle this is completely in line with the democratic aim of pluralism and freedom of expression, but currently we have virtually no systems for evaluating information on the net. A web site is never really published in the traditional sense, and it can change content without notice. More and more sites are dynamic and database driven, which can mean that they change continuously, and we do not even have proper and secure methods for referencing sites.

We can of course lean on what we are used to from the world of print and other mass media, but if we do so, we risk falling back into the world of centralized media and failing to discover the true potential of the new technology. The problem is that we have built all our structures of legitimacy and credibility as well as our political, religious and economic systems around an old and increasingly obsolete communication model.

In a historical perspective the current credibility problems of the internet are little different from those of print media 500 years ago, but the issue today is much more fundamental than that of whether a person has really written something or not. Wikipedia serves as an excellent example: A Wikipedia article basically has no author and thus no individual upon whom to assign credibility. It is written and edited by anyone who feels passionate about the subject or thinks she has a valuable contribution to make. In terms of every traditional standard, Wikipedia therefore has a serious credibility problem, and there has been no shortage of highly esteemed academics decrying its value. In 2004, for instance, the former editor-in-chief of Encyclopedia Britannica, Robert McHenry, wrote a scathing review of Wikipedia in which he points out some serious mistakes and likens the average article to a C-grade high school student paper.[11] Like many others he claimed that quality content could never be achieved when laymen have as easy access to writing and modifying entries as experts. A year later the highly respected magazine Nature subjected both Encyclopedia Britannica and Wikipedia to a traditional peer review, where 42 articles on science were checked for errors and

omissions by experts. On average the reviewers found 4 errors per Wikipedia entry compared to 3 in Britannica, and the conclusion was that there was little substantial difference between the articles[12]. This is no small feat for an encyclopedia that started from scratch less than five years before, and to top it off the Wikipedians reacted immediately with extensive discussions and corrections, whereas Britannica is of course unable to bypass its good old editorial process. So, Wikipedia is not only larger than Britannica, it is also faster on its feet and it completely eliminates the distinction between producer and consumer.

How come Wikipedia has not converged on the lowest common denominator as expected by many experts? I believe that the reason can be found in the unique combination of many-to-many communication and the nature of the encyclopedia as it has developed in print culture. Encyclopedia articles are expected to be objective and factual, and they leave no room for unsubstantiated speculations or personal opinion. These requirements are fairly simple and universally recognized, which means that encyclopedia articles are perfect, shared objects for collaborative creation. In fact, as can be seen in the accompanying discussion and history pages of many articles on controversial subjects, the encyclopedia can become a powerful tool for conflict resolution. Wikipedia represents the meeting between the objectivity of print and the subjectivity of oral communication, and it clearly shows, how our concepts of truth and credibility have been and will continue to be shaped by technology.

Wikipedia is not without problems, of course. A more thorough examination of the encyclopedia shows numerous examples of how it is struggling to find new ways to ensure credibility and accuracy. In December 2005, for instance, the founders were compelled to temporarily stop anonymous editing due to threats of libel suits and allegations of what has been called vanity edits, and for a while they were considering producing stable versions resembling editions of Wikipedia as well as experimenting with voting systems to let users rate articles.

Perhaps the most important reason for the success of Wikipedia is its simplicity. Every page has the same fundamental structure and is editable by

anyone. Censorship and manipulation of information is kept at a minimum, and there are no complicated rules or fixed directory structures. Other systems that use more advanced filtering or reputation functions suffer from the fundamental problem that every algorithm is a manipulation and that all manipulations are based on some underlying assumptions that are invariably political, social or cultural in nature. Computation is a powerful tool, and like all-powerful tools it introduces new dangers of deliberate or inadvertent abuse.

In summary, the internet is causing a fundamental shift in our concepts of thruth and credibility. The days when truth can be monopolized by political, religious or educational leaders are rapidly coming to an end, and all political, social and educational structures will have to search for new grounds for credibility.

6.1.2 Knowledge and the development of thought

> *'As technology changes, we change. As computers evolve, our philosophical approach to thinking about the brain will evolve.'*
>
> Daniel Dennett[13]

In previous sections I have argued that the alphabet and the printing press were important influences in the development of thought and of science. The atomistic character of the alphabet and the linearity of writing have promoted atomistic and causal thought patterns, which have turned out to be extremely powerful, but nevertheless limited as tools for analyzing the world.

Over the centuries we have been conditioned to think of not only society, but also the world as such as hierarchical in nature, and our atomistic, alphabetic mind has led us to look for the simplest and most local explanations of all phenomena. We place the individual at the centre and develop classification systems and reductionistic explanations of everything to maintain our mechanistic world view, but in doing so we fail to see the richness that emerges from the complexity of the heterogeneous network and the importance of the contribution of all parts of the system. Only during the last 50 years have we started to complement our logical, empirical paradigm with more holistic approaches, but today a more balanced view is beginning to

take shape. We are starting to see our mind, our body, our societies and all of nature as systems of collaborating entities where the seemingly chaotic network couplings are as important as the architectures of the systems in which they take exist.

The 20th Century was the era of confrontation between atomistic and holistic thinking in Western Science. In biology the discussion was already sparked by Charles Darwin, and many current discussions within other fields borrow from our understanding of biology. In philosophy and cognitive science our age-old individualistic notion of a little man (homunculus) in our head responsible for cognition and decision-making is being challenged by Daniel Dennett[14] and others, who favor a purely distributed explanation, while neuro-psychologists like Merlin Donald[15] argue that a distributed, holistic model is simply not sufficient to explain consciousness. In physics the conflict was exemplified in the discussions between Niels Bohr and Albert Einstein about closed systems[16].

The computer, however, provides us with a framework for consolidating the two views as well as with means for experimentation, and it has become increasingly important in highlighting both the differences and the synergies between the worldviews. In itself the computer with its binary representation and formal languages is the ultimate, atomistic modeler, but computation, especially with networking and parallel processing, allows us to model and simulate complex and chaotic systems to observe and study their emergent and thus holistic properties. These experiments have challenged our views and enriched our understanding in virtually every field of knowledge, and they have helped us to become much more pragmatic in our thinking about real-world phenomena.

Computation itself also fosters new ways of thinking in science. The search for better, more efficient or more intuitive programming paradigms has led computer scientists to experiments with fundamentally different descriptions of the world[17]. The paradigms have parallels and precursors in philosophy or natural science, and when used to implement systems they give us important empirical clues to the strengths and limitations of the different perspectives.

In procedural programming the world is seen as sequential processes, in object oriented it consists of objects that basically just react to external stimuli, in functional languages the focus is on transformations, and logic programming uses the methods and linguistic structures of formal logic to evaluate statements and propositions. Each programming paradigm has its own advantages and limitations, but even though they represent very different ways of modeling real world phenomena, they are fundamentally equivalent, since they can all be implemented on the universal Turing machine. And their extensibility as models beyond the world of computing can of course always be questioned, since they are constrained by the limitations of the discrete and of computable functions. This fundamental and inescapable constraint becomes particularly clear, when computer science pursues its ultimate goal – artificial intelligence.

The Golem dream[18] of creating an artificial human has existed throughout human history, and with the development of computers the dream suddenly seemed to be within our grasp. The field of artificial intelligence has explored virtually every philosophical, psychological and neuroscientific avenue in its pursuit of its goal. So far without truly remarkable results, but in the course it has provided empirical challenges to theories of previous centuries, and new theories have appeared.

Warren McCulloch already in 1943 spawned neural network theory in which each individual neuron in the mind is viewed as a simple, digital processor receiving, processing and transmitting signals, and where intelligence and consciousness emerges from this connection of billions of simple elements[19]. His description turned our understanding of the human brain upside down, and it would take four decades for it to gain the prominence it deserved. The Cartesian notion of the individual as the indivisible unit of human existence would lead us to think of the brain as a processor rather than a large, seemingly chaotic collection of independent processors collaborating to create conscience and intelligence, and the bottom up description seemingly evaded proper scientific treatment, since there simply were no scientific models for emergence. Later digital simulations of the human brain as a neural network showed empirical evidence of the viability of the models, but gave no formal

proof and were thus widely discarded by the research community. Today, however, very few people doubt the power of connectionism, and we all live with McCulloch's theories in our daily use of the Internet. Several models in artificial intelligence use a mixture of top-down and bottom-up architectures, and our understanding of the brain has evolved along very similar lines[20].

The area of communication theory in discreet mathematics in particular has had important implications for science. During the 1940s the American, Claude Shannon, developed his mathematical theory of communication, which not only became one of the pillars of computer science, but strongly influenced cognition, biology, linguistics, psychology, economics, and physics as well[21].

Shannon focused on signals and separated them completely from their meaning. This meant that he was able to ignore the complexity of semantics and focus strictly on efficiency of signal communication. This separation was immediately adopted by other sciences, and it led to a vastly increased attention to relations between entities.

Physiologists started to focus on the ability of the human being to perceive and decode information and came up with the surprising result that while our five senses feed our brain with more than 11 million bits per second, our conscious mind is apparently only able to process around 50 bits per second[22]. Reducing bandwidth this drastically requires an enormous amount of selection and compression, i.e. information processing, which clearly happens outside our consciousness, and empirical studies have shown that this processing takes considerable time. External stimuli take upwards of half a second to be recognized by our conscious mind, yet we are able to react within less than a tenth of a second, suggesting that our body is only to a very limited extent controlled by our consciousness.

These observations of course severely jolted the age-old assumption that consciousness dominates and led to fundamental shifts in our thinking about not only biological, but also social and economic systems. The idea that our body is not a hierarchical system controlled by a central processing unit called the conscious mind, but rather a vast network of communicating entities with

an ability to filter information and even invoke action without involving the conscious mind, became one of the cornerstones of systems theory, a truly interdisciplinary science focusing on systems and relations rather than atomistic entities[23].

Systems theory, in turn, influenced computer science. Computers had been modeled over the prevailing notion of the conscious mind as an atomistic, sequential processor, and early computers and programs were not designed with parallel processing and inter-process communication in mind. As theories of distributed systems in biology and social sciences developed, computer scientists such as Paul Baran and Rod Brooks[24] began creating systems as communicating, computational entities.

Daniel Dennett writes that the idea of computation begins to eliminate the need for a middleman in our models of consciousness, because you no longer need a clever homunculus at the control panel doing the work[25]. The counter argument to this is that you need a programmer to program a computer, but that the brain seemingly programs itself, and we thus have to move beyond the basic notion of computation to the idea of self-organizing networks to really eliminate the middleman. Neural networks and the Internet have, however, done exactly that, and particularly the Internet has provided us with a completely unique symbiosis between man and machine to form a structure without center and without hierarchical control.

So, it seems that all the qualitatively new elements of digital technology lead us in more or less the same direction: The binary representation led Shannon and others to focus on efficiency in communication, which again led to theories of biological entities, societies and economies as distributed systems of semi-autonomous, communicating elements. Digital computation made us look at the world in terms of process and confronted us with the limitations of our mechanistic understanding of mental processes, and the Internet itself provides us with a physical implementation of a distributed system very similar in structure to biological systems like our own brain.

Digital technology is in essence implementation of formal, discreet logic, and it is therefore a wonderful litmus test of all theories. Theories built on incomplete

or faulty logic will invariably fail when tried implemented in a computer, but at the same time theories seemingly lacking in logical completeness or coherence can be empirically tested with the use of computers. Digital technology thus both defines and pushes the boundaries of discreet logic, while at the same time moving logic from the realm of pure theory to the empirical, and this empirical testing ground can be and is being used within just about every area of science.

In this fashion digital technology represents the pinnacle of logical empiricism, while at the same time promoting knowledge systems that are fundamentally different from our traditional top-down thinking and search for unifying laws. The development of computers and the Internet has caused us to think about relations as much as we think about entities and process as much as about structure, and it has thus brought Eastern and Western thinking on a possible unification path.

A Few Notes About Artificial Life and Consciousness

The bottom-up thinking about intelligence and consciousness has interesting implications for our thinking about the Internet itself. If large numbers of (what we assume to be) fairly simple entities like neurons can form structures that exhibit intelligent and conscious behavior, what happens when millions of complex people and slightly less complex computers form a completely connected network? Are we on the verge of creating a conscious network? And if we are – how will we know it, what forms will it take, and what consequences might we suffer?

In 1997 I was asked to take part in a session with experts on constructing and growing life-like entities. The workshop was called “Beyond the Made and Born”[26], and the intention of the organizers was to elicit ideas for how the widely different approaches could be combined to create new and interesting research on artificial life. We were all asked to bring a project idea. My idea was that all the brilliant neurologists, psychologists and computer scientist present in the room should be able to come up with a definition of consciousness and a way to measure whether the Internet had achieved

consciousness. My proposal was ridiculed, and I was told that the Internet was merely a tool and that the notion of Internet consciousness was ludicrous.

Obviously things have changed since then, and in edge.org Question of the Year for 2006, the computational neuroscientist, Terrence Sejnowski, gives a lengthy account of how the internet resembles the brain, and how the evolution of the internet has come to resemble biology much more than engineering. He ends his contribution with the following statement:

> *'How would we know if the Internet were to become aware of itself? The problem is that we don't even know if some of our fellow creatures on this planet are self-aware. For all we know the Internet is already aware of itself.'*[27]

During the 1990s the zoologist, Thomas Ray, was attempting to enlist the idle cycles of computers around the World for the creation of digital wildlife reserves. He was constructing simple digital creatures and letting them breed and evolve with the stated intention of creating a being more intelligent than himself[28]. In a discussion with him in 1996 I asked him to speculate, what such a being would think about being confined to a reserve. It seemed to me that the first thing it would do would be to try to break out to roam freely on the net, but Thomas assured me that it would not be possible, since he controlled the code that ran the environment. But, if his creation should actually turn out to be more intelligent than him, how long would it take for it to bypass his control measures?

6.1.3 Education and Learning

With digital technology we have become able to share, manipulate and compute vast amounts of data allowing us to start playing with phenomena of a complexity way beyond our previous reach. We are today able to play with DNA structures, visualize complex molecules, make advanced weather predictions and create large-scale simulations of dynamic structures giving us access to experimenting phenomena that we could only deal with theoretically before. These abilities open up new territories for human knowledge and enable us to shorten the distance between idea, validation and implementation – making full use of an integrated, global environment, where digital data is shared and manipulated by multiple competencies.

We are, however, slow to discover these changes, and one of the areas lagging behind the most is teaching and learning. School appeared on a larger scale with the printing press, and it still reflects all the characteristics of a mass media paradigm. Our children are still taught in schools dominated by classrooms designed to let children absorb knowledge from teachers, books and computers, and even the most advanced e-learning systems seem to have learned little from the technology they are embedded within. During the last couple of decades computers and the internet have presented increasing problems to this model, starting with children becoming masters of a technology, which their teachers had difficulty understanding. Schools have slowly discovered the power of the computer and the internet, but like all other established organizations they at least initially tried to mold the tools in their own image, creating computer rooms, instructional software and even learning games, where children are tricked into solving mathematical problems or answering history questions to enter the next level.

Things are starting to change, but school is stuck with a conundrum: How and what do we teach children, when all information is available to them on the Internet? Much in the way that calculators in the 70s were seen as creating future generations of youth unable to calculate on their own, the Internet is seen as a threat to personal knowledge. Why remember the year of the French Revolution or the formula for sulfuric acid when you can find it in seconds on the net? But even worse, the Internet threatens the authority of the teacher and of schoolbooks, and it does so without any apparent quality assurance of the information available on it.

What is needed is an entirely new view of education. Basic skills like reading, writing and math will not become obsolete any time soon, but it can be argued, that knowing how to acquire knowledge is already now becoming more important than actually acquiring it, and, clearly, the ability to tell good from bad information will become increasingly important as the all-knowing teacher and the strictly censured school books give way to the diverse and often contradictory information found on the net.

Neil Postman[29] feared that television marked the end of childhood, because children suddenly had access to vast amount of information without even

needing to be able to read. Television has, indeed, helped to break down the kingdom of the teacher and the protection from the real world previously provided by parents and school, but it does not seem to have fundamentally affected childhood, and there is no reason to assume that the Internet will have that effect either. Yet, where television just replaced one authority with another, the Internet challenges the very concept of authority. The focus must and will shift from the transmission of knowledge to critical thinking and the mastering of the tools of knowledge, and from the child as a consumer of information to the notion of every person as a co-creator of the collective body of knowledge. In my view, educational models previously reserved for higher-level university studies and research will have to find their way down to the lowest primary school grades.

And, in fact, academic research is in some areas doing remarkably well in using digital communication to enhance the spread of knowledge. As a gift economy[30] the academic world is far from ideal, but overall it remains true to the ideals of creating a shared body of knowledge. The computer and the Internet grew directly out of academia, the Internet was created with the explicit intent of enabling distributed research and efficient sharing of knowledge, the World Wide Web was created within and for academia, and the academic world has always been at the forefront of internet usage for knowledge dissemination. Indeed, as mentioned previously, academic knowledge sharing was a primary motivator for the development of the internet.

And academia needs the net. With the amount of scientific knowledge doubling roughly every 15 years[31] it is simply unacceptable that it can take up to 2 years to get an academic article published, and scientific journals have experienced increasing pressure to improve the objectivity and speed of the review process. Digital communication allows for a much wider and more democratic peer-review process as well as for almost instant publication, and since the mid-90s we have seen an explosion in the number of electronic journals, a number of which are based on open review processes rather than anonymous reviews by selected reviewers[32]. Experience with various forms of open review processes is so far mixed, but over time these new processes

could gradually make the actual publication less and less important and allow researchers to share their newfound knowledge at a much earlier stage of the discovery process – with obvious benefits to the collaborative creation of a body of knowledge.

On the other hand, academic publication is big business accounting for a turnover of 45 billion dollars in the US alone in the year 2000[33], and in some fields new discoveries can make or break industries. Some universities obtain a considerable portion of their income from research publications and commercially funded research, which creates an inherent conflict with open publication. The academic world is therefore at the forefront of the struggles between open communication and patents, copyright and economic interests.

The Open Courseware project at MIT broke new ground in the area of educational content, and the university now houses and supports the Science Commons project modeled over the Creative Commons model. Already in 1991 Paul Ginsparg created the e-print archive arXiv.org, where scientists can prepublish their work and which has grown to more than 4500 submissions per month.[34]

In October 2003, a large number of esteemed European research institutes signed the Berlin Declaration to Open Access to Knowledge in the Sciences and Humanities, which states the following:

> *'The Internet has fundamentally changed the practical and economic realities of distributing scientific knowledge and cultural heritage. For the first time ever, the Internet now offers the chance to constitute a global and interactive representation of human knowledge, including cultural heritage and the guarantee of worldwide access.*
>
> *…*
>
> *In order to realize the vision of a global and accessible representation of knowledge, the future Web has to be sustainable, interactive, and transparent. Content and software tools must be openly accessible and compatible.'*[35]

Eventually this revolution may lead to the demise of ordinary academic journals, but more importantly it sets precedence for the treatment of knowledge in a digital society.

6.2 Belief systems

If it is true that the alphabet was instrumental in bringing about monotheistic religions, what might be the effect of the bit and of truly networked communication?

With the loss of truth and authority described above our religions will suffer along with all other institutions dependent upon maintaining a uniform following with shared beliefs. As we grow increasingly weary of anyone monopolizing the truth, we will be likely to veer away from the traditional and centralized religious bodies, but this does not mean that we will loose religion – in fact quite the opposite. Perhaps the most important role of religion throughout the ages has been to create certainty where uncertainty exists, and in a world where the whole concept of truth is eroding there will be plenty of need for someone to provide certainty, trust and truth. What is likely to happen is a diversification of religious beliefs following the increasing information about the various belief systems and a general tribalisation trend. We may even see a revitalization of the polytheistic religions characteristic of oral society.

Could the Internet become the source for one or perhaps several religions? Absurd as it may seem, I do not find it particularly unlikely. In fact, the Internet has a number of the features that gods are made of: It is an omnipresent, mysterious 'being' without center. It can be examined in its parts, but never as a whole, and it seems very real, yet elusive and hard to fathom. So far it has not spoken directly to us, and to attribute consciousness to it is of course highly speculative, but such deliberations have never kept religions from forming in the past. And should the Internet some day appear to answer back with consciousness and intent, we would most definitely be in for some religious upheavals.

6.3 Behavior

6.3.1 The Individual

> *'We cannot conceive facing each other except as selves. The image of the self that we have inherited seems to us fundamental for western culture. But we notice*

that some of our students are bred on electronic text composers. "Text" means something entirely different for them than it does for us. And thus we sense the extreme fragility at this moment. We fear that the image of the self made in the image of the text could fade from society, together with the self-destruction of the text.'

Ivan Illich[36]

During the last couple of centuries we have become increasingly obsessed with the individual, and the technologies themselves with their lopsided communication balance and their increasing emphasis on the individual creator have contributed to this individualism. But with the obvious co-creational aspects of digital technology this might be about to change.

We assume that a certain focus on the individual is necessary for motivating people to produce for instance new ideas and innovations, but do we know this to be true? When we can freely share our creations without loosing them, and when all work so clearly builds upon the work of others as seen in the software world, the notions of creativity and innovation take on new meanings. As indicated by some of the examples of collaborative creation given earlier, we may be on the verge of discovering in practice that individualism is merely a social artifact.

An example from the open source world of software may help to clarify the changing role of the individual in a world of open information exchange: The software company Mathworks runs a semi-annual open source programming competition using their mathematical programming system, MATLAB. Contestants from all over the world are given a task, for which solutions are quantifiable in terms of CPU time used and accuracy oroptimum of the solution. When a contestant submits an algorithmic solution it is automatically rated in terms of both parameters, and the contestant's name, solution and ranking is published on the web site. This means that contestants can compete either by coming up with their own solutions or by optimizing previous solutions created by others, and the results are fascinating. As described by Ned Gulley[37], the contests tend to progress through consecutive leaps and tweaks, where a given new solution is rapidly optimized through tweaks by others until a promising, qualitatively new solution is discovered

and draws all the tweaking attention. The end result is typically an extremely efficient algorithm and of course always one that has gone through numerous tweaks. The contests are very popular, but they have also caused a lot of discussion between participants. The big question is: Who should be the winner? The person creating the qualitative leap that led to the winning solution, or the person creating the final, most efficient tweak? The issue here, of course, is that no solutions are made by one person alone. This, in a sense, is counter to the idea of a competition, but the competition is what motivates people to participate. According to Ned Gulley the solution to the problem is to give away only small prizes!

If we, when reading a book, discover that a long section has been taken word by word from another book, we find it annoying and unethical, but for programmers recognition is an advantage, and finding your own code in someone else's program is more likely to cause a feeling of pride than anger. Today no programmer creates anything from scratch, and the notion of ownership of a specific piece of code is something only lawyers and CFOs care about. So, although a program can certainly be considered an artistic expression, it is much more like the collective endeavor of a medieval cathedral or an orally transmitted epic than an 18th Century masterpiece.

In my view programmers are an avant-garde for a new way of thinking, which is already spreading to the Internet world at large. Open source software has become the model for open content projects like the MIT Open Courseware project, Wikipedia and Creative Commons, and a new generation of musicians, artists, writers, entrepreneurs and thinkers are growing up with a very different view of the value of personal creation. They largely still have to live within an economic sphere that only recognizes individual production, but the net is spawning new economies and new social structures, which increasingly undermine Western individualism and which, if allowed to exist and grow, may very well herald a neo-collectivist society where all forms of information and creative works are considered a collective endeavor and a part of our commons.

Such a development naturally strikes at the heart of our economic systems as well as Western philosophical and political foundations, and powerful forces

are already in the trenches defending the territory they have won over the last half millennium. The question of what will be our future commons is indeed a constitutional one as argued by Lawrence Lessig[38], but it is more than that: It concerns not only the balance and relationship between individual and society or between individual and value, but also our very self-perception as creative and unique individuals.

6.3.2 Power and Organization

> *'Did we really believe we could collaboratively build and inhabit virtual worlds all day, every day, and not have it affect our perspective? The force of online socialism is spreading beyond electrons – perhaps into elections.'*
>
> Kevin Kelly[39]

The communication model I have presented in this thesis clearly shows that the Internet is at least in principle the first truly democratic communication technology since the emergence of human speech. The Greeks invented a democracy that was based on the ability of every citizen (in their definition of citizen, of course) to participate actively and directly in the political debate, but since then every single communication technology invented has been favoring the few and contributed to the separation of participant and bystander. Over the last century politics has become victim of mass media, and citizens are increasingly alienated from the political process, but the computer and the Internet are rapidly reducing the barrier of contribution to almost nothing, and finally the free speech so highly valued in democratic constitutions around the World seems to be within grasp.

In theory one should expect democracies everywhere to welcome this development with open arms. But, as with everything else, we have built our political and social institutions to fit the constraints set by our communication technologies, and few structures are harder to break down than political and bureaucratic ones. We have constructed representative democracies, because it was impossible to allow everyone a voice beyond the occasional mute vote. Our technologies from script to television have removed us from the Greek notion of democracy to the implicit assumption that only a few of us were created to rule, while the rest are better off sticking with job and family.

During the age of the Iron Curtain, Eastern Block countries were at least partially able to jam radio signals from the West and thus keep their populations from free access to information. But even in mass media societies it is impossible to contain information, and in an internet world where the information routes itself to its destination and finds even the smallest hole only the most naïve can believe in the sustainability of national information policies.

Mass media have been instrumental in the fall of dictatorships around the World, but they have also been partly responsible for the spread of Western and especially American cultural norms. We have long been able to receive instant news from around the globe, but the balance of communication has been increasingly skewed by Western dominance. It might seem that the Internet with its predominantly American origins and content contributes little to change this, but when we start to dig a little deeper, we find that this may not be the case.

Due to the low threshold to Internet publication everyone is joining in, and it takes little more than a couple of Google searches to find out, that Internet content is infinitely more varied than what can be found in any other medium. Every conceivable opinion can be found on the net, and virtually every cultural group in the World is represented. No event of any significance passes unnoticed or uncommented on the net, and even the smallest, local news item might suddenly reach worldwide attention through blogs and other forms of individual expression.

When a Danish newspaper published the by now infamous Muhammad drawings it was hoping to provoke a reaction, but most certainly not expecting violent demonstrations and long term damage to the reputation of Denmark around the globe. Initially the debate was local, but when the Danish government refused to listen and respond to protests from local Muslim communities and the diplomatic community, mass media, the Internet and sms-networks kicked in. A mixture of fact and fiction spread to all Muslim countries and sparked an unprecedented expression of anger from Indonesia to Morocco.

Mass media were probably the most important factor in this development, but it is entirely possible that peer-to-peer communication will become the instrument for solving this kind of cultural conflict. Frustrated with how Danish media and politicians were handling the situation, Danes created web sites and email campaigns collecting signatures in support of tolerance and cultural understanding, and the controversy sparked a great number of discussions around the net. Some mass media chose to republish the drawings, while others refrained, but nobody could prevent the images from spreading around the Internet, from where they will most likely never disappear. Sites like zombitime.com (now defunct) included the cartoons in a larger collection of Muhammad depictions showing that they were in no way an isolated phenomenon, and once again Wikipedia showed its power as a conflict resolution tool. Once the conflict reached international proportions, a Wiki page was created and became an important source for relevant information and lively discussion. Within one month the page had been edited more than 1000 times, and the discussions had become so extensive and heated, that the Wiki editors had to close the discussion page for a while and encourage only discussion of editorial relevance rather than general debate about religion, tolerance and freedom of speech. The page now stands as probably the most factual and unbiased piece of information about the conflict available.

What is not clear is whether the democratization of communication can eventually lead to a new and truer form of democracy, where every voice can be heard in every decision. Could laws be written in a similar way to Wikipedia articles? Could international disputes be solved in this way? Could societal leadership be determined by continuous popular vote as described in Bruce Sterlings novel Distraction[40]? From our current vantage point this may seem ludicrous, but so did a community-edited encyclopedia just a few years ago.

The 20th Century brought us the notion of super powers and led to a gradual transition from nation states to large political and economic entities in competition with each other. The United Nations showed early promise of a new World unity after the Second World War, but were quickly marginalized in favor of competition and imperialism, and today the prospects of a truly global

village appear further away than ever before. Yet, the interests of nation states and federations are not necessarily in line with those of their inhabitants, and once popular movements are given a global voice, they can be very hard to ignore.

During the months leading up to the presidential election in the US in 2004 there was a growing sentiment in the press and on the Internet, that the election was not only a domestic affair, but concerned everyone across the globe. A couple of initiatives even went as far as to create websites like us-election.org and theworldvotes.org to let people from all over the World cast their vote, and the result was a clear if not unexpected victory for Kerry with some interesting national differences. The influence of these initiatives was probably limited, but there is no doubt that such new democratic initiatives can eventually become powerful political tools.

To believe that new forms of communication can change the political structure of the World overnight is of course ludicrous, but when the perspective is even just a few decades, the picture looks quite different. It took several hundred years of print before Europe became a continent of mostly democratic nations, but at that time the starting point was an illiterate population with no tradition of participation. Perhaps all it takes today is for a new generation to grow up with a new communication paradigm and a multinational and multicultural network.

The next question is of course, what kind of society they will wish to create. Will they dispense with national states in favor of transgeographical tribes, or will they try to unite to form true global unity? Will there be a 'they' at all, or will the pluralism in communication translate to political and social pluralism?

It would be tempting to claim that we have evolved our communication technologies to a stage where we are truly a global village, in which everyone will become aware that all parts need to thrive for the whole to prosper, and where all conflicts can be resolved through polylog. Eventually this may become true, but I am afraid that the realistic scenario is quite different.

6.4 Concluding remarks

In the introduction I claimed, that the fundamental properties of digital technology will promote a society and culture, which is radically different from the one we have developed in the Western World since the advent of the printing press and, in fact, bears close resemblance to oral society, albeit on a much grander scale.

In this section I have shown, that digital communication is in the process of challenging some of the central assumptions and values characterizing Western society. The combination of global, real-time, many-to-many communication and a dynamic representation is about to undermine key aspects of the way we think and organize, and digital communication holds the promise of a less hierarchical and centralized society with an emphasis on social relations over individualism, critical thinking over blind acceptance of doctrine, and creativity over consumption. We might choose to continue on the course that we have been following for the last few centuries, but we no longer have a technological excuse for doing so. Digital communication vastly increases our social, political and intellectual repertoire, and it is up to us to make the best of these new opportunities.

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[1] Innis 1995

[2] A binary description could of course take many forms, but a simple mapping of alphabetic characters to their 7-bit ASCII representations provides a reasonable example of, how it could be done. The word 'Polylog' would in binary ASCII representation look like '01010100 01000001 01001100 01001011 01001001 01010010 01000110 01000010 01001001 01001000'

[3] Of course, the true digital nerd and assembly language buff would completely disagree with me, but the fact is that the vast majority of computer users and programmers will never be faced with a binary representation, even though we are dealing with nothing else when working with computers.

[4] In fact, the Nyquist-Shannon Theorem states that we can create an accurate reproduction of an analog signal from a digital description if our original sampling rate was more the twice the frequency of the highest frequency in the signal.

[5] McLuhan 1964, find page

[6] Finnemann 2005, p. 29

[7] Contrary to what you may have been led to believe, Al Gore did not invent the concept of algorithms ☺

[8] Data from 2002 can be found in SIMS 2003

[9] Levinson 1997, p.129

[10] Castells 2000

[11] http://www.tcsdaily.com/article.aspx?id=111504A (Feb 2006)

[12] For a list of reviews of Wikipedia, see http://en.wikipedia.org/wiki/Wikipedia:External_peer_review

[13] Dennett 1995

[14] Dennett 2003

[15] Donald 2001

[16] Whitaker 1996

[17] For a brief overview, see http://en.wikipedia.org/wiki/Programming_paradigm

[18] http://en.wikipedia.org/wiki/Golem, July 2009

[19] McCulloch 1943

[20] For a discussion of the advantages and disadvantages of bottom-up and top-down models see for example (Crespi et al 2008)

[21] Shannon's Master Thesis (Shannon 1940) was lauded as perhaps the most influential master thesis of the century.

[22] Information Theory. Encyclopædia Britannica. Retrieved August 26, 2004, from Encyclopædia Britannica Premium Service.

<http://www.britannica.com/eb/article?eu=108475>

[23] http://en.wikipedia.org/wiki/Systems_theory

[24] Brooks 1991

[25] Dennett 2003, p. ?

[26] And led to the EU 5th Framework IST research initiative called "neuroinformatics for Artificial Life"

[27] Edge http://www.edge.org/q2006/q06_8.html#sejnowski, Jan 2006

[28] Thomas Ray made this statement at the 'Mind Over Matter Conference' at Louisiana Museum, Denmark in 1996. For more information see his website http://life.ou.edu/, July 2009

[29] Postman 1980

[30] In gift economies, goods and services are given away without any explicit payment. See http://en.wikipedia.org/wiki/Gift_economy, July 2009. Many internet services bare strong resemblances to gift economies.

[31] Kelly 2006

[32] http://en.wikipedia.org/wiki/Open_peer_review

[33] Medeiros

[34] http://en.wikipedia.org/wiki/ArXiv, (Feb 2006). Ginsparg is also credited with the quote "The problem with the global village is all the global village idiots"

[35]http://www.zim.mpg.de/openaccess-berlin/berlindeclaration.html (Feb 2006)

[36] Illich 1988, p. 74

[37] Gulley 2001

[38] Lessig 2001

[39] Kelly 2009, p. 121

[40] Sterling

Conclusions

Digital communication has already changed our lives and societies in more ways than can be covered in one book, let alone a single chapter. My aim, however, has not been to give a comprehensive account of the influence of the technology on our daily life, but rather to look for some of the more fundamental changes that we may fail to notice as we move blinded by the presence into an unknown future. My perspective is not months or years, but decades and centuries, and I have therefore focused on fundamental structural changes to the way we think, share and organize. The question, which remains, is whether I have managed to substantiate the claims made in the introduction:

Claim 1: We can find important clues to the development of past and future cultures in the fundamental properties of their communication technologies.

The investigation in Section 3 and 4 into communication technologies from speech to television has shown how they have had an important impact on some of the most important aspects of human culture. Our power structures, belief systems and our understanding of knowledge, truth and even of ourselves have changed with each major change in communication technology, and in each case the cause can be identified using the framework introduced in Section 2 – with each aspect of the framework playing its own, important role.

The development of communication infrastructure has been instrumental in the transition from family over village and city-state to nations, and mass media from print and onwards have been absolutely crucial in the development of modern day consumer society.

Symbolic representation has been shown to affect how we think about virtually everything – even what we can think about - and to continually influence the power structure in society. And I have demonstrated, how virtually every communication technology after speech has served to separate

creation from consumption, and how they have been some of the central instruments of power.

I would thus claim, that the theoretical framework can serve as a guideline for exploring a given communication technology and its potential effect upon society and culture,

Claim 2: Digital technology represents the most important qualitative development in communication technology at least since the advent of writing.

As shown in Section 5, binary representation is the ultimate symbolic description of discrete phenomena and enables us to create abstract and persistent encodings of virtually all kinds of dynamic and static information. Digital computation allows us to bring binary representations to life in any number of forms and lets us copy and edit information freely and without loss of the original. And, last but not least, digital communication finally takes the power of dialog to a global scale and turns it into what we might call polylog or many-to-many communication. In combination these three qualitative changes to representation, production and communication represent a force that cannot be resisted, and so far we have only scratched the surface of the possibilities and see only the initial and fairly superficial signs of changes that will inevitably penetrate to the core of our self-perception and social structure.

When we consider the effects of the alphabet, which was merely a new symbolic representation, and the printing press, which changed only the production of information and scale of communication, it seems fair to assume that digital technology holds the promise of a more radical change than either of the two.

Claim 3: The fundamental properties of digital technology will promote a society and culture, which is radically different from the one we have developed in the Western World since the advent of the printing press and, in fact, bears close resemblance to oral society, albeit on a much grander scale.

Section 6 discusses the impact that digital technology is already having on our lives and uses the framework to speculate about possible future effects. No

attempt has been made to predict the future, and I have made it clear that people, not technology change the World. But I have shown that communication technology can be instrumental in driving development in a specific direction, and my examination of digital technology indicates important shifts away from the culture of mass media:

- Digital technology makes it possible to virtually eliminate the separation of production and consumption and thus liberate the creative potential of a the entire population.
- The fact that digital information can be freely copied, distributed and modified enables it to promote a culture of dynamic co-creation and thus a new understanding of creativity as well as of the individual
- Many-to-many communication will promote a culture, where relations are more important than individuals and where truth and knowledge become increasingly relative concepts dominated by our ongoing negotiation of meaning.
- Computation shifts our focus from object to process and thus promotes a philosophical and scientific perspective that is radically different from the one we have inherited from Ancient Greece.

In combination these factors indicate the development of a culture, which to a large degree resembles what we find in oral societies – and certainly a radical shift away from the atomistic, egocentric consumer society developed over the last five centuries.

So, to return to my underlying question: Have I shown that there is a way for us to understand digital technology from the perspective of the future rather than the past? Only the future can tell, of course, but the future is created by people, not technology, and I believe that this thesis provides a map, a compass and a set of tools that can guide and help us to look forward rather than back as we stumble along.

Final (Personal) Remarks

What emerges from my investigations is a vision of changes in communication that are more fundamental and sweeping than anything we

have seen in more than 2000 years. Digital communication is changing the way we do business, share information, spread news and organize work, but much more importantly it will change the way we think about ourselves as individuals and as social beings in a world where everyone is connected to everyone else and has a chance to participate, create and be heard.

All in all, I believe that we need a new period of enlightenment in which the mantra is creativity and connectivity and the scope is global rather than national. By allowing creativity to flourish at all levels in a connected world we may finally unleash the potential of humanity as a living organism and reach an understanding of each individual as a unique and creative contribution to a greater whole. We might call this the Creative Society – a society in which each individual is valued for his or her active and creative contribution to a greater whole.[1]

To leave you with an image of what this society might be like I will turn to a form of communication, which I have barely touched upon, but which has existed in all cultures and all time, probably since before the advent of speech. It is social and intuitive in nature, and it exhibits numerous forms of collaborative creation that can inspire us in the innovation of new forms of global co-creation. Interestingly enough a disproportionately large number of the inventors discussed in this book have excelled in this form of communication and taken much inspiration from it, and in itself it represents, like architecture, a meeting between disciplines and between science, technology and art. It speaks to our most innate emotions, yet inspires some of our most sophisticated mental and physical constructions. It transcends the symbolic nature of speech and text and spans both cultural and linguistic differences, and it satisfies the individual creator as well as the cultural co-creation.

I am of course referring to music. Written, directed, performed, jammed, danced to, reflecting the rhythm of the heart and the rhythm of nature. Inherently democratic and inherently social. If we could let our development and use of technology inspire by the qualities of music, I think we would be a lot better off; so to finally put things a bit in perspective, let me leave you on a musical note with the words of the groupie Mary From the Bus:

Information is not knowledge
Knowledge is not wisdom
Wisdom is not truth
Truth is not beauty
Beauty is not love
Love is not music
Music is the best

Frank Zappa, Joes Garage

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[1] I have borrowed this term from the Next Generation Forum (rather than from Ronald Reagan who used it in a somewhat different fashion when running for governor of California), and I completely concur with their statement that 'The Creative Society is built on the fundamental belief, that human creativity is the vital turning point of any development as well as for human self-esteem.' (www.ngf.org.uk/downloads/Towards%20the%20Creative%20Society.pdf)

Appendix 1:

Perspectives on Innovation, Power and the Future

'Those in power will normally make no effort to support a new invention, unless it can help them to augment their power; and even when they do support it, their efforts are usually insufficient to allow the new ideas to be fully exploited

Ignazio Chappet, 1824'[1]

History shows, that revolutions in communication technology tend to migrate from the place where the foundation is laid to more pristine territory where they encounter less resistance from conservative forces and old paradigms. It stands to reason that inventions with potential to threaten established structures will meet with fierce resistance from these, and in the few cases where technologies radically change the most important aspects of communication, they need to migrate to succeed. In this way they become instrumental in shifting competitive advantages and momentum of development to new regions of the World.

The first clear example of this was the alphabet, which was invented, but suppressed by the Egyptians, and only turned into a true innovation when subjected to a Greek culture coming out of 300 years of isolation and orality. The result was that the Greek and subsequently the Roman culture became dominant in the region, while the hieroglyphic culture declined in the face of a superior paradigm. An earlier, yet somewhat more ambiguous, example may be that of Egypt vs. Mesopotamia, where a writing system was invented by the Sumerians, but where the Egyptians (if that is indeed what they did) rapidly adopted and expanded it and became the first to manage to build an empire and a sustainable culture based on it.

Similarly the printing press was invented by the Chinese and movable type by the Koreans, but due to political and linguistic conservatism never reached their potential in either country. When printing finally broke through, it

happened in another region emerging from centuries of isolation and oral dominance – Western Europe.

The inventions of the 19th and early 20th century were less radical than writing and printing, but together they show a clear transition from Europe to the younger, less settled and considerably more entrepreneurial United States. Beginning with the telegraph, which in Europe was seen and employed mainly as an extension of military semaphores and in the States used for expansion towards the west, we see a repeated pattern of technologies, where the scientific foundation is created in Europe, but the innovation and mass market creation happens first and most successfully in the States – ultimately resulting in a global domination of the American mass media industry.

Adopting and adapting to mass media was not overly painful to Western culture, which was already dominated by the mass media of print, and the last 150 years have only led to an increasing domination of one-way communication. Until the advent of the Internet all feeble attempts at breaking the mass media paradigm and dominance have been effectively suppressed, and whereas new and powerful players have emerged, they have tended or been made to fit well in the existing overall market models.

From this we can conclude that knowledge is not sufficient to produce innovation. As an example every single invention in the 19th Century and the beginning of the 20th was based in scientific knowledge created before the 19th Century, but in every case the final breakthrough happened only when multiple skills joined forces. Scientifically based inventions require some level of scientific knowledge, but more importantly they require a deep understanding of the use domain, irreverence towards established paradigms, and an entrepreneurial spirit seldom found in scientific circles. Our romantic notion of the single, genius inventor simply does not correspond to reality, and we can clearly see that radical innovation has always happened in regions and times with the right mixture of knowledge, radical thinking, entrepreneurship, wealth and belief in the ability of the individual to change the World.

We can also observe that innovation breeds innovation. Great innovations seem to have come in clusters indicated by for example the sudden appearance of a wealth of inventions in Egypt around 3000 BC, Greece around 450 BC, China around 1000 AD, Korea around 1400 AD and Western Europe during the 17th to 20th Century. The Royal Society in London from 1660 onwards created a unique forum for exchange of ideas and promotion of experimentation. Its mixture of scientific thinking and sometimes amateurish tinkering attracted the best minds in Europe and led to some of the discoveries, which would make 19th Century innovations possible. Equally the environment around Edison and Bell became one of the most fertile, innovative and entrepreneurial ever.

These two last examples are highly different in nature however. The Royal Society was motivated by knowledge and created an open atmosphere of shared knowledge and creativity, whereas the environment that created the telephone, the phonograph and a host of other innovations was highly competitive, secretive and driven by business. The competitive environment brought innovative products to the market, but in many ways it also stifled creativity, and the endless disputes concerning inventorship and rights raise some fundamental questions about the role of intellectual property rights in the development and deployment of new inventions. Daguerreotype photography was given freely to the public and spread like wildfire, but this apparent success of an open strategy also most likely delayed the dominance of the far superior Talbot method by 20 years. On the other hand some of the most proliferate inventors like Bell and Edison spent valuable time on fighting with other inventors with whom they could have cooperated to create perhaps much more spectacular results. They established what would become some of the Worlds largest companies and were instrumental in the creation of an industry dominated by a distrust and lack of collaboration still apparent today

The computer was developed in parallel with television, but for somewhat different reasons. Whereas television gained momentum after World War II due to the need for using the excess resources in the electronics industry, the computer and later the Internet were developed as a direct result of the war and its aftermath. World War II saw the introduction of missiles traveling

hundreds of miles, of nuclear weapons capable of destroying nations, and of computation and communication as primary factors in determining the outcome. It also took the Western World out of a huge depression and gave the United States a position as one of only two super powers and a great national pride and self-confidence, but also a growing concern over a real or imagined threat from the Soviet Union. Post-war United States experienced perhaps the largest economic growth in its history – a progress that was to some degree built on the discovery or invention of this new, external enemy. As a young nation and a newly emergent super-power the United States needed (and needs) mirrors to illuminate and reflect its own culture and promote social and cultural cohesion amongst its diverse population. The Second World War had provided the ultimate enemy of democracy and freedom, but it had also left the United States and other countries with a large military apparatus and whole industries that had appeared or expanded due to the war. When the war ended there was therefore not only a need for a new national cause, but also for ways to use the surplus resources in both industry and military.

The confrontation with the Soviet Union in Europe and the threat of nuclear missile attacks on mainland United States from this new enemy of democracy provided the perfect opportunity, and, as we have seen, virtually all early developments in digital technology grew directly out of the war effort and the subsequent deployment of resources to counter the communist threat.

These circumstances, however, turned out to have only marginal influence on actual developments, and there is little doubt that the open and egalitarian operating and communication systems that resulted were a far cry from the wishes of the security-crazed military of the 50s. The main explanation for this apparent paradox is most likely to be found in the launching of the Sputnik in 1957, which took America completely off guard.

1957-58 had been dedicated the International Geophysical Year by the International Council of Scientific Unions, and the White House in 1955 had announced that it would launch a satellite during the IGY. A tender had been made to the different government institutions and a proposal from the navy adopted, when the Russians suddenly announced that they had already

launched a satellite of their own. This unexpected turn of events of course hurt American pride, but also created a widespread fear of the Russian ability to launch intercontinental missiles. Radical measures were called for, and the United States acted quickly with a launch of their own satellite as well as the establishment of both NASA and ARPA in 1958.

As established military organizations had appeared unable to compete with the Soviets, ARPA "*was designed to be an anathema to the conventional military and R&D structure and, in fact, to be a deliberate counterpoint to traditional thinking and approaches.*"[2] As a result, ARPA became a flat and flexible organization, largely run by its program managers, who were typically zealous and entrepreneurial individuals who pursued their goals with minimal interference from bureaucracy, and there are numerous examples of projects and results that did not conform with military doctrine or had any immediate military impact.

The development of the PC was also related to the post-war era, but in a very different way. The baby boomers of the 1950s grew up during one of the most prosperous periods in American history. Their parents were focused on career and material goods and had a liberal attitude to a number of things including the raising of their children. The result was a whole generation of young people, especially on either coast of United States, who, much like the people in ancient Athens, had an affluent life with few cares but also few goals in life. Many young people developed alternative lifestyles, a critical, political stance, and dissatisfaction with big government and the arms race, and among the results were the Vietnam War protests and the hippie movement of the late 60s and early 70s. It was in this environment that the Homebrew Computer Club and the MIT hacker community, the Model Railroad Society, existed, and although many of their members were driven by enthusiasm for technology rather than a desire to change the social or political environment, there is no doubt that they were influenced by the libertarianism and other radical notions flourishing around them. Certainly both environments were characterized by a freewheeling, anarchistic spirit and a strong belief in the value of sharing and in the ability of individuals and small groups to make a difference; a spirit and belief that would spill over into the applications and products they created.

Even the Internet was heavily influenced by grassroot network communities, and we have seen how the same spirit carried Tim Berners-Lee's vision of the web. In fact we arguably owe the continued openness and egalitarian character of the fundamental social and technological structure of the Internet to the kind of thinking that developed around San Francisco and MIT in the 60s and 70s.[3]

The struggle between the radicals of the Homebrew Computer Club and the more traditional Bill Gates is an early example of the confrontation between fundamentally different philosophies that still rages in the digital world today. Bill Gates obviously found an excellent business models in the control of the operating systems running personal computers, but his attitude concerning ownership of software was fundamentally different from the hackers'. Whether development of the field has been delayed or accelerated by the dominance and proprietary attitude of Microsoft is hard to say, but there is no doubt that the computer industry has been heavily influenced by the fact that its dominance came from Harvard rather than MIT.

Europe, of course, was not without its influence on developments, but on the network side it lacked the equivalent of ARPA, and network development was largely controlled by public post and telecommunication companies that favored the X.25 communication standard, which let them maintain control. This is by and large equivalent to the difference in attitude towards the telegraph a century earlier, where Europe saw it as an extension of military communications technology, and the United States jumped at the opportunity to create a whole new business area, and in this case the open system eventually won, because it was, well, open and designed to integrate different networks rather than create a standardized infrastructure at all levels.[4]

The openness in the development and subsequent structure of the Internet is very much a result of academic traditions of sharing results, and the development was in fact driven by the desire to share computing power among universities. The academic world has played the role of information dissemination for centuries, and virtually every invention in communication technology since 1800 has its roots in academic research, but the Internet marks the first invention of a system that actually reflects the open exchange

of knowledge in the academic world, and there is no doubt that the entire digital revolution owes a great deal to the strong academic institutions and traditions in both the United States and Europe.

Seen in a broader perspective, the United States was and is a clear example of a new territory, which was able to adopt new technologies from the printing press to the 19th Century communication technologies faster and with more radical impact than anywhere else. The United States was the first to build public libraries and a public school system, and its readiness to adopt new technologies is to no small degree responsible for its political, economic and scientific dominance in the 20th Century.

With digital technology, however, we are once again witnessing a threat to all established social, economic and media structures, and the big question is, who will be able to break free of old boundaries and reap the social, economical, political and cultural benefits of digital media.

A Shift in Power ?

The moment we started growing crops rather than hunting and gathering our food, we were faced with a complexity that went beyond the scope of face-to-face communication, and we were forced to create chains of command, rules and regulations, and – eventually – more advanced communication technologies. And each new technology we invented in its own way constituted an advance over the previous ones. All of them have helped us create and cope with societies of increasing size and complexity, and we have finally reached the point where virtually no spot on Earth is untouched by what we have come to term the global society. Yet, in the process we have created a society of increasing one-way communication where the few can dominate the many – even on a global scale.

The fundamental glue that holds together both companies and countries or regions is competitiveness, and there is no political or economic logic in our current society that would make any of them strive for global unity. The entire global economy is based on inequality and competition, and the internal logic and inertia of the system is such that it will most likely take centuries to break it down.

If history can teach us anything, we are once again facing a situation where a new communication paradigm will benefit some and leave others in the dust, and chances are that the winners will not be those who are in the driver's seat today.

To the casual observer it may seem that the United States is nowhere near the pinnacle of its success. It has established its status as the only super power (pending the rise of China to true super power status), its economy is the largest in the World, its industries are among the largest and most prosperous, and its research and entrepreneurship is second to none. Yet, there are cultural issues that may stand in the way of progress.

The US is more than any other place on Earth the country of mass media and especially television. Nowhere else does television play such an important role in building and maintaining national identity and unity, and in no other country is television as important for success in sports, politics and business alike.

You might argue that the American dominance of the Internet will save it from the mass media dependence. But the problem goes quite a bit deeper than that. The American society is more than any other place on Earth built on individualism and materialism, and, as shown by Richard Nisbett[5], the American mind is conditioned to focusing on objects rather than relations. All these things run completely counter to current developments, and even though Americans have so far been successful in creating and using digital communication, they are currently the best candidates for the loosing position in the long run. Like Egypt, Greece and China before them, they may become victims of their own success.

But, where should we look for the potential winners then? Again, judging from the historical account, what we have to look for is a virgin territory with newfound wealth and a potential for understanding and using a communication paradigm based in relations rather than entities, in community rather than individual and in collaborative creation rather than passive consumption. Nicholas Negroponte[6] has repeatedly pointed to countries in Africa and South America, which have a much stronger focus on relations and

networks than North America and Europe, and it would in fact be tempting to look to predominantly oral societies, where dialog and myth has not been replaced by monolog and rationalism.

It would certainly be good to see things turning better for indigenous populations and lesser-developed nations, but it seems clear that none of them have the size, strength or newfound prosperity necessary to present a realistic threat to the existing powers in a foreseeable future.

East Asia, however, is quite a different matter. Coming out of 500 years of economic and political hibernation, the Chinese giant is finally coming to life and asserting its place in the global arena. With an average annual growth of more than 9% from 1991 to 2007[7], the Chinese economy is poised to become the largest in the World, and the country is forging ahead at an unprecedented pace on all fronts. Digital technology finally enables a proper representation and manipulation of the elaborate Asian character sets, and the digital mindset is well aligned with Asian culture and thought patterns as mentioned previously. As of the end of 2007 more than 37% of all internet users were in Asia, and internet usage was growing at a much faster rate than in Europe and the US, albeit from a much lower level.[8] The highest penetration of broadband usage was in South Korea and Hong Kong with the US in 15th place,[9]

China is still a centrally controlled communist state, and while the country is eagerly promoting the commercial use of the net, Chinese authorities are blocking efficient development of digital communication with a combination of laws and advanced filtering.[10] But, as my John Perry Barlow says, '*trying to stop the spread of a really robust piece of information is about as easy as keeping killer bees South of the Border*'[11]-.

Countries like South Korea and Japan are way ahead of the rest of the World in various digital communication technologies. While the Wap phone standard flopped in Europe and the US was far behind in mobile phone integration, NTT DoCoMo introduced the highly successful, Internet-based iMode phone in 1999 in Japan, where it now has 45 million subscribers. Japan was also first with the so-called 3G phones and in 2005 40% of all mobile phones in

Japan were third generation with full Internet integration. In addition more than 10 million phones in Japan contained GPS systems, and the hotbed for development of mobile Internet services is beyond doubt the Far East.

Now, Japan and South Korea have long been part of the economical elite, but judging from the other communication revolutions most of East Asia is prototypical of an emergent power region. Like Europe in the 15th Century it is experiencing a newfound awakening concurrent with the influx of a radically new communication technology. Rather than being forced to innovate itself out of complacency, China and most of its neighbors are driven by a struggle to escape poverty and work their way towards the center of a global value network. Their mindset and focus match a technology invented elsewhere, and they approach the new technology with a freshness of mind that cannot be matched in Europe or the US.

Europe is probably even worse off than the US, having already at least partly lost the mass media domination, yet still living with the self-confidence and prosperity gained from being the region of renaissance, print, democracy and so forth. Contrary to the US, most of Europe is only now learning to live with a multicultural and multiethnic population, so where the States may suffer from self-sufficiency, Europe lives with xenophobia and a long tradition of internal strife.

What could save Europe in the end is that its mindset lies somewhere between the American and the Asian. Europe still holds traces of its oral past and is less influenced by mass media. If the clue to a digital future is to be found in a meeting between Eastern and Western thinking, it is possible, but not particularly likely, that Europe could be the place where the two can meet.

Creating the Future

Digital communication offers a unique opportunity for creating a truly networked society, where many-to-many communication becomes the basis for global conflict resolution and governance, but with the current state of the World the chances do not look too good, and one has to adopt a very long-term perspective to envision global unification. Perhaps hierarchical and geographically based organization is part of the nature of human society, and

perhaps no technology can or should change it, but personally I think it is a waste of the amazingly complex and rich being that we are. The behavior of any complex organism is a function of the individual parts and their connections, and the complexity and number of connections thus define the behavior that reaches beyond the ability of each individual part. We can educate the individual human being, but there are no signs of qualitative changes in the makeup of the individual, and the qualitative development of the totality of the organism of humanity must therefore happen at the level of connections. Many-to-many communication represents a quantum leap over mass media in this respect and thus a magnificent opportunity for increasing the complexity and scope of humanity.

And, as Peter Drucker (or Alan Kay depending on what source you trust) said, “The best way to predict the future is to create it”. We are not helpless victims of either technological or political determinism. We have created a technology that provides us with a unique opportunity for reconciling different cultures and mindsets and exploiting the combined potential, and it is up to us to grab that opportunity. We can influence our future by knowing our past and understanding our present condition, and while some of us are obviously better positioned to take advantage of the digital revolution than others, it is only he who acts that makes a difference. The technology is here for everyone to use, and we all have the potential to bring it to productive and positive use.

I have presented a sketchy map of the world of digital communication and a set of tools for navigating it. I have painted with a very broad brush and left numerous waters unexplored and uncharted, but a fairly clear image is emerging, and it provides us with some important clues to what it will take for individuals, companies, institutions and societies to prosper in the new world.

First of all we should understand that our infrastructure for digital communication is at least as important as our roads, our plumbing and the electrical grid. How we design it and who controls it will affect the balance of communication in our society, and we must recognize that this is primarily a political and not a commercial matter. Infrastructures that are vital to the maintenance and development of society cannot be left to the laws of the free

market. And I do not just refer to the physical infrastructure, but also to protocols, platforms and applications.

Political and administrative systems will be responsible for securing free and open access to the infrastructure and to information, but developers of digital communications, systems and applications have an important responsibility, because they are the ones who determine how and how much we can interact with information. We owe the openness of the Internet and in fact the entire many-to-many communication paradigm to idealistic and visionary individuals and institutions, and we must see to that the next generations of developers understand their responsibility and the possible consequences of their design decisions.

It took centuries, but print media fostered public schools and public libraries. These were fitting structures for a technology like books, but the Internet is real time and omnipresent. It is not something we bring home or should go to school or library to access. It is a learning and information tool for virtually every life situation, and it is a tool for expression and creativity. Like roads it should be freely and equally accessible to everyone.

We need to learn from each other and share our knowledge on a global scale. The solution to a global mindset for a digital era lies in a synergy between seemingly opposites like object/relation, top-down/bottom-up, and static/dynamic. The foundation may have been laid by Western science, but it could seem that we are about to come full circle and will find out most important inspiration in cultures that are not dominated by reductionism and individualism. Just like ancient Greek thinking flourished in the confrontation between oral and script culture, our way forward lies in an open and open-minded clash of paradigms.

We need to teach our children how to find, evaluate, use and share information rather than see them as passive vessels to be filled with knowledge. In a society where relevant information about virtually any topic can be found at the click of a button, critical thinking and creativity will become infinitely more important than the ability to list the US presidents. The school must teach children the importance of networks and broaden their horizon to

include their peers across the globe, and like all other institutions living with the legacy of print culture it must do away with the distinction between producer and consumer. The child of the digital era must above all be raised as a critical and creative participant in a global society.

In the marketplace we are facing the difficult balancing act of building a virtual economy that does not deprive us of the necessary global dissemination of knowledge and information. Information itself should not necessarily be free, but we need to come up with economic models that reflect our ability to copy, distribute and manipulate information freely. Trying to prevent the spread of information through censorship, encryption or other means is a loosing proposition, but numerous examples show that people are willing to pay for convenience, reliability and timeliness – as long as they do not feel exploited by intermediaries that charge for little or no added value. On the other hand there are many kinds of information that should be freely available to the public and should not be subject to the dynamics of a free-market economy – and especially one that is based in a physical economy with completely different characteristics.

So far the free-market economy has shown greater adaptability than any other system in business or politics. Capitalism has led the way in globalization, and it may well mutate to create a truly digital economy, but as always and perhaps more than ever before, we need political systems that can ensure that society as a whole benefits.

According to Winston Churchill *"It has been said that democracy is the worst form of government except all the others that have been tried."* and there is no reason to believe that this will not be the case in the future as well. Yet, the form of democracy we have been used to for centuries is a far cry from the democratic ideal of rule by the people. As Jean-Jacques Rousseau remarked, the people of a democratic state are only free before the election. After having chosen their representatives they are, once again, slaves. Due to technological constraints, true democracy has so far only been possible in small communities, but with the many-to-many capabilities of digital communication it has at last become possible to experiment with direct rule by the people.

It is hard to imagine a state run solely by popular opinion, but lack of imagination should not prevent us from experimenting with new democratic methods. Certainly we should be able to come up with ways to create more direct public influence on political decisions, and individual politicians will do well to find new ways to faithfully represent their constituents on a daily basis.

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[1]Quoted from Holzmann 1994.

[2] DARPA - http://www.darpa.mil/body/overtheyears.html

[3] See for instance (Castells 2003) p. 23 ff

[4] Ibid p. 26f

[5] Nisbett 2003

[6] For instance in (Negroponte 1996)

[7] http://www.chinability.com/GDP.htm, Jan 2009

[8] http://www.internetworldstats.com/stats.htm

[9] http://www.websiteoptimization.com/bw/0511/

[10] http://www.opennetinitiative.net/studies/china/

[11] Barlow

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