Anthony L. Brooks · Sheryl Brahman ·
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Jane Tyerman · Lakhmi C. Jain *Editors*

Recent Advances in Technologies for Inclusive Well-Being

Virtual Patients, Gamification and Simulation

Springer

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Preface

As co-editors, we welcome you as readers of this volume, in anticipation that you will enjoy the contents and hopefully inform other potential readers of the scope of knowledge across fields associated to 'Technologies for Inclusive Well-Being' that are offered herein.

We, the co-editors, are located at different corners of the globe, from Canada, Australia, UK, USA, and even little Denmark—*now waving the flag for the European Union contribution after Brexit*! While we work in different specific disciplines and industries, we have a common ground in being involved in education, research, and practices associated with health care and technologies targeting human 'Well-Being'. Thus, aligned, we believe a richness of knowledge differences alongside motivational inspirations reside within the works presented in (and between) the pages you have in front of you that we anticipate can inform and inspire, stimulate and even surprise—and we are together, proud to be a part of producing this contribution to the field.

This book on 'Technologies for Inclusive Well-Being' follows on from associated publications, i.e. the 2014 [1] and 2017 [2] volumes, also edited by members of our current editing team. The decision to edit another volume came about through amassed positive responses attributed to the earlier publications as indicated by the near 30,000 downloads at the time of writing (Spring 2020), and we anticipate similar numbers of this volume. Inclusive well-being would seem a hot and growing topic. Associated technologies to well-being continue to advance alongside adoptions in applied practices; as reflected by international conferences around the world, it was clear the demand to expand should include topics as per title herein. In line with this, in this edition, the co-editors team has grown to six, and we are pleased to welcome Dr. Jane Tyerman and Dr. Amy Nakajima, both from Ottawa, Canada (please see the 'About the Editors' material for more details).

This Preface follows the 2017 volume in being titled *Recent Advances in Technologies for Inclusive Well-Being*. The 2020 sub-title informs on wider subjects of virtual patients, gamification, modelling, and simulation, thus building upon the earlier foci of 'Wearables, Virtual Interactive Spaces (VIS)/Virtual Reality, Authoring tools, and Games (Serious/Gamification)' in the 2017 volume that, in

turn, built upon the 2014 foci of Serious Games, Alternative Realities, and Play Therapy.

The vision behind realising incremental volumes was to ongoingly achieve a meaningful contribution for wide readerships across scholars and students; practitioners, administrators, and leaders; across industries and disciplines associated with digital wellness aligned to the evolution in health industry [3]. In achieving such publications, it is acknowledged how it would not have been possible without those authors whose contributions have been shared to the best of our abilities as editors. This, of course, means that behind the scenes, there are many people involved beyond those mentioned herein—from Springer staff who have supported and made tangible this and the other volumes, to the numerous international scholar peer reviewers who gave time to read, reflect, and critique submissions over a long period offering their wise comments to support optimising each text.

This publication covers wide ground, as introduced in the first chapter. Authors covering a gamut of disciplines come together under the inclusive well-being theme, and it is anticipated that there is something for everyone, be they academics, students, or an otherwise interested party. The main aim of the book is to disseminate this growing field through a combined effort to inform, educate, evoke— or even provoke, at least in thought—responses and discussions. While not the sole purpose, the editors, along with the authors, believe it important to bring such work presented out from behind the walls of establishments into the public sphere, so as to impact from a societal level.

The challenge of bringing together a collection of seminal work relating to technology is that it is subject to encroachment—things move fast. We have been aware of this challenge and need to publish a contemporary volume within a schedule, considering the prerequisite for up-to-date(ness) of presented research. The initial timeline had to be extended due to counterbalancing to the editors' different time zones, work and family commitments, and busy lives and distractions of the real world—for this delay, we apologise to authors. However, in stating this, we believe that the extension has resulted in an even stronger contribution, realised in a form to credit all involved.

Acknowledgements are given to all authors for their submitted works and patience and understanding in the editorial team's challenges to realise what is anticipated to be an impactful volume. We thank Springer's publishing team for their input to realise the volume. The editors thank their own families whose tolerance in supporting us in tackling such endeavours to publish is often tested; we are indebted for their support. The last acknowledgement is given to you, the reader, whom we thank for coming onboard from your specific individual perspective; in thanking you for the interest in the work, we anticipate your curiosity being stimulated by individual texts so as to read, not only chapters labelled in line with your position but also to stray and explore chapters not aligned to your discipline. In line with this latter statement, we offer no suggestions about how to read the book.

It is apt to mention at this time that this volume took longer than expected because of various delaying issues beyond our control, and accordingly, we apologise to the early submitting authors who have been patient in their wait to see the

realised publication. Also, the final stages of the volume completion happened at an unprecedented time in the world—after devastating fires in the Australian region, a wider invisible global threat to life and daily activities as we knew it rose out of China in the form of the COVID-19 pandemic. The authors of the contents of this volume mostly contributed prior to the pandemic. Few, upon hearing of the initial incursions in Asia, could have forecast its rampant impact that has devastated societies, communities, and families across nations globally, with much loss of life, traumatic experiences, and irreparable damage to infrastructures and economies. Our hearts and thoughts go out to those affected in whatever situation they find themselves, and we wish the very best to all. Many people at this time are comparing, wonderingly, their life before the onset of COVID-19, and their life as lived experience during this pandemic, and they are asking themselves and others what the world will be like, following the cessations of restrictions after effective vaccines and medicines are invented as they must be. The future is in balance as latest news channels suggest the coming of a second wave, as deaths and cases again rise in some countries. Trepidation and anxiety are pervasive, as healthcare workers and those caring for the aged—doctors, nurses, carers, staff, and all others involved—engage daily at the front-line, battling on behalf of the human race and each individual affected. These heroes should never be forgotten! We extend our thanks to all who are involved in Well-Being issues in this regard and alongside others. Humbly, the co-editors ask: What will human Well-Being entail following the pandemic? How will future societies govern for Well-Being? In what form will future 'Advances in Technologies for Inclusive Well-Being' take? … and more. For now, we pray that to minimise impact, we all respect physical distancing, as advised by experts, we all maintain the highest level of hygiene, and if any signs are suspected, to self-quarantine. In so doing, we all give respect and love and support to others through this challenge for humankind. And … future generations ahead, there should be stories passed down of the heroes in health services worldwide that battled through this pandemic and continue to fight saving lives and caring for others. Their sacrifices should not be forgotten in how they promoted inclusive Well-Being in whatever form and shape that may have taken.

In finally closing we, the editors, extend our warmest regards and encourage you to explore the texts herein, whetting your appetite, and to then dive further into the body of work, and possibly being stimulated to even visit the earlier volume—enjoy!

From us all, we wish you optimal well-being, stay safe and keep healthy.

Esbjerg, Denmark	Anthony Lewis Brooks
Springfield, USA	Sheryl Brahman
Oshawa, Canada	Bill Kapralos
Toronto, Canada	Amy Nakajima
Peterborough, Canada	Jane Tyerman
Sydney, Australia	Lakhmi C. Jain

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About the Editors

Dr. Anthony Lewis Brooks is Associate Professor at Aalborg University, Denmark, where he was director/founder of the 'SensoramaLab' a complex investigating human behaviour, interactivity, interfaces, and technologies for inclusive well-being. He was a founding team member of the original Medialogy education, section leader, lecturer, coordinator, supervisor, and study board member. Originating from Wales, prior to academia in the 1980/90s, he created the concept Virtual Interactive Space (VIS) a flexible/modular/tailorable/adaptable—sensor-based conglomerate system for optimising patient experiences via unencumbered gesture control of media to stimulate interactions. Through this, and resulting afferent efferent neural feedback human loop closure, thus, motivating and optimising human performance potentials in (re)habilitation training engagement and treatment programme compliance—a concept adopted widely in health care. He has international and national awards alongside approximately twenty plenary keynote credits at major international conferences. Brooks is Danish representative for UNESCO's International Federation for Information Processing (IFIP) Technical committee (WG14) He achieved his Ph.D. under the University of Sunderland, Great Britain.

Dr. Sheryl Brahman is the Director/Founder of Missouri State University's infant COPE (Classification Of Pain Expressions) project. Her interests focus on face recognition, face synthesis, medical decision support systems, embodied conversational agents, computer abuse, and artificial intelligence. Dr. Brahman has published articles related to medicine and culture in such journals as *Artificial Intelligence in Medicine, Expert Systems with Applications, Journal of Theoretical Biology, Amino Acids, AI & Society, Bioinformatics, Pattern Recognition, Human Computer Interaction, Neural Computing and Applications, and Decision Support Systems*.

Dr. Bill Kapralos is an Associate Professor at Ontario Tech University. He is also an Honourable Guest Professor at Shizuoka University (Hamamatsu, Japan), and the Technical Lead of the Collaborative Human Immersive Interaction Laboratory (CHISIL), Sunnybrook Health Sciences Centre. His current research interests include immersive technologies, serious gaming, multi-modal virtual environments/ simulation/reality, the perception of auditory events, and 3D (spatial) sound generation. He has led several large interdisciplinary and international medical-based virtual simulation/serious gaming research projects with funding from a variety of government and industry sources. He was recently awarded a Greek Diaspora Fellowship (sponsored by the Stavros Niarchos Foundation), to conduct research in Greece. He is a past recipient of an Australian Government 2018 Endeavour Executive Fellowship to conduct research in Australia, a past recipient of a Natural Sciences and Engineering Research Council of Canada (NSERC) and Japan Society for the Promotion of Science (JSPS) Fellowship to conduct research in Japan, a past recipient of an IBM CAS Faculty Award, and a past co-recipient of a Google Faculty Award.

Dr. Amy Nakajima is an active clinician-teacher and Assistant Professor at the University of Ottawa, in the Faculty of Medicine, providing both didactic and simulation-based teaching at the undergraduate and postgraduate levels. She completed her residency training at the University of Saskatchewan and received her Royal College of Physicians and Surgeons of Canada (RCPSC) certification in Obstetrics and Gynecology in 2000, and more recently, a M.Sc. in Human Factors and Systems Safety at Lund University, Sweden. Her clinical focus involves working with patients who are traditionally considered vulnerable and marginalised.

Dr. Nakajima is the Director, SIM Advancement & Innovation, Simulation Canada, and has developed and delivered Simulation Canada curricula, including their online *Briefing, Debriefing and Facilitating Simulation: Practical Applications of Educational Frameworks* course. She regularly provides faculty development, both locally at the University of Ottawa and nationally, through Simulation Canada, and at simulation and medical education conferences, including SIM Expo.

Dr. Nakajima also contributes to patient safety and quality improvement teaching at the undergraduate, postgraduate, and faculty development levels. One of her interests is the teaching and assessment of patient safety competencies using simulation modalities. She has contributed to the development of national patient safety resources, including the Canadian *Patient Safety Institute's Patient Safety and Incident Management Toolkit*, their *Canadian Disclosure Guidelines: Being Open with patients and families* and their *Canadian Framework for Teamwork and Communication*, and the RCPSC's *Handover Toolkit: a resource to help teach, assess and implement a handover improvement programme*.

Dr. Jane Tyerman is an Assistant Professor at the University of Ottawa, School of Nursing—Faculty of Health Sciences. She comes to the programme with over 25 years of nursing experience in critical care, medical-surgical, and psychiatric clinical practice. Additionally, she has over 15 years' experience involving clinical simulation design, facilitation, evaluation, and virtual simulation game development. Dr. Tyerman is a leader in nursing simulation. She co-founded the Canadian Alliance of Nurse Educators Using Simulation (CAN-Sim), which connects nurse educators and allied health partners from across Canada and internationally to share knowledge, resources and expertise in areas of simulation research and education. She has developed and teaches various specialty simulation course for the Canadian Association of Schools of Nursing (CASN), the Canadian Alliance of Nurse Educators Using Simulation (CAN-Sim), International Nursing Association for Clinical Simulation and Learning (INACSL), and the Ontario Simulation Alliance (OSA). Dr. Tyerman is the 2019 recipient of the CASN Award for Excellence in Nursing Education based on her innovative use of simulation.

Dr. Lakhmi C. Jain Ph.D., ME, BE (Hons), Fellow (Engineers Australia) is with the University of Technology Sydney, Australia, and Liverpool Hope University, UK.

Professor Jain founded the KES International for providing a professional community the opportunities for publications, knowledge exchange, cooperation, and teaming. Involving around 5000 researchers drawn from universities and companies worldwide, KES facilitates international cooperation and generateS synergy in teaching and research. KES regularly provides networking opportunities for professional community through one of the largest conferences of its kind in the area of KES (http://www.kesinternational.org/organisation.php).

His interests focus on the artificial intelligence paradigms and their applications in complex systems, security, e-education, e-healthcare, unmanned air vehicles and intelligent agents.

Chapter 1
Re – Reflecting on Recent Advances in Technologies of Inclusive Well-Being

Anthony Lewis Brooks

Abstract This chapter reflects on 'Technologies of Inclusive Well-Being' related to the evolution of the health sector. The editorial team's three volumes realized to date are overviewed aligned with contemporary related literatures in the field. A reflection on Covid-19 precedes a closing section consideration on the future 'Technologies of Inclusive Well-Being' and digital wellness impact in healthcare.

Keywords Virtual patients · Health 5.0 · Digital wellness · Transforming healthcare

1.1   Introduction

Contextually, an opening chapter of a book on Recent Advancements of Technologies of Inclusive Well-Being typically has foci upon: - offering an introduction to the field, the editors, and reason behind their collaborative effort in realising the book. Then readers are informed on what lies ahead in the volume's pages; and then closing by a summary to lead into the subsequent opening section. However, in this case of writing an opening chapter of a third volume targeting introducing the field, presenting a position, and informing upon work in the field 'Technologies of Inclusive Well-Being', an artistic license is evoked to expand beyond the typical to reflect on what potentials may (speculatively) lie ahead beyond the abyss of the current global crises across health, economy, climate, poverty, and life itself. Thus, instead of following wholly a traditional route in the structure of this chapter a sharing on '*Future Advances in Technologies of Inclusive Well-Being*' sums up to promote and provoke readership debate and discussion beyond the covers of this contribution relative to transforming of healthcare.

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1.2 The Field

The field of *Technologies of Inclusive Well-Being* is posited as running parallel to demographic trends. This is put forward as these are trends of our time that point to increased pressures and demands on healthcare service industry providers addressing growing needs. Health spending by powers that be has, in some countries, correspondingly increased significantly reflecting ageing populations, an epidemic of chronic disease, advances in biomedical knowledge, increased digital healthcare innovations and higher public expectations that place additional demands on services. Over the last decade advances include from *Stem cell banking*[1]; *Robotic surgery*[2]; *3D bio-printing of muscle tissues to complete organs for transplant*[3]; through to *Early cancer detection*[4]…and more including *Rehabilitation Robots*. Many advances utilise mobile computing aligned to wearable sensors for personal monitoring of health condition (e.g. ECG, SpO_2, blood pressure, respiration, blood sugar/glucose, and temperature …) and other body management aspects to amass human data for fast and remote diagnostics. Business models are built upon collection of DNA/genome data that can be analysed to predict future healthcare needs—targeting prevention rather than cure for individuals subscribing to the service. However, the current focus on advancement—at time of writing (June 2020)—relates to an immediate need in respect of the Covid-19/Corona virus pandemic that has had an unprecedented impact and has promoted large corporates to work together with a focus on creating as soon as possible a safe vaccine.

The bigger picture however is even more challenging than ever when one considers availability of healthcare outside of developed countries when even the 'most' developed struggle to contain the contagion. This unprecedented unforeseen enemy Covid-19 is 'invisibly' challenging an already pressured industry and society itself whereby in the immediate there is need for a survival strategy—where urgent medical treatment is needed for those affected to not succumb as a result. Alongside this latter issue for survivors resides a longer-term situation where needed extended rehabilitation, both physical and mental, is forecast as further pressuring those in such healthcare provision. Our series of publications on how such service providers may take advantage of *Technologies of Inclusive Well-Being* is thus timely though not directly aligned to the recent outbreak.

The next section exemplifies a stuttering technology adoption in the healthcare sector that possibly may have been consolidated to a position where healthcare authorities may have been, if not better prepared, able to respond swifter to the Covid-19.

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[1] https://futurehealthbiobank.com/.

[2] https://www.intuitive.com/en-us.

[3] https://organovo.com/.

[4] https://grail.com/.

1.2.1 Editors and Concept Background in This Field

For readers to comprehend the story behind this work a first stop is suggested to visit the profile of each editor where their backgrounds are shared (see TOC for section). From there a visit to the earlier volumes should indicate the commitment and dedication to the field of enquiry that is core of this work as exemplified in the following.

The first volume [3] emphasised how digital technologies play an increasing role in supplementing intervention practices and methods. Substantiating this claim is the rising awareness illustrated by major research funding activities directed at such entities throughout developed countries. These activities have the mission of contributing to knowledge and of realizing emerging enterprise and industrial developments in the area, as well as of encouraging and of informing new educational programs involving technology that proactively look to contribute to a societal "wealth through health" regime. The 2014 volume was the first single volume that was titled and having focus upon '*Technologies of Inclusive Well-Being*'. It brought together the topics of serious games, alternative realities, and play therapy. The focus was on the use of digital media for the therapeutic benefit and well-being of a wide range of people—spanning those with special needs to the elderly to entire urban neighbourhoods. Further it brought together these topics to demonstrate the increasing trans/inter/multi-disciplinary initiatives apparent at that time in science, medicine, and academic research—interdisciplinary initiatives that had already profoundly impacted society. The content shared latest research on emerging intelligent paradigms in the field of serious games, alternative realities, and play therapy. It introduced and described intelligent technologies offering therapy, rehabilitation, and more general well-being care, as written by leading experts in the fields.

The second volume [4] presented innovative, alternative and creative approaches that challenged traditional mechanisms in and across disciplines and industries targeting societal impact associated to '*Recent Advances in Technologies for Inclusive Well-Being*'—the title of the contribution. The title sub-heading suggested the content focus by listing 'From Worn to Off-body Sensing, Virtual Worlds, and Games for Serious Applications'. A common thread throughout the book was human-centred, uni- and multi-modal strategies across the range of human technologies, including sensing and stimuli, extended virtual and augmented worlds; accessibility; digital-ethics and more. A determined focus was on engaging, meaningful, and motivating activities that at the same time offered systemic information on human condition, performance and progress.

The goal of the second book was to introduce and to describe some of the latest technologies offering therapy, rehabilitation, and more general well-being care. Included along with the work of researchers from the serious games, alternative realities (incorporating artificial reality, virtual reality (VR), augmented reality, mixed reality, etc.), and play therapy disciplines were the writings of digital artists who are increasing working alongside researchers and therapists to create playful and

creative environments that were considered safe and adaptive by offering tailored interventions via apparatus, methods and emergent models.

The chapters in the second book illustrated how complementary overlapping between topics had increasingly become an accepted norm. Such acceptance contributed to a readdressing and a questioning of associated values resulting in new themes and topics. Topics were selected to be wide in scope to offer academics opportunities to reflect on intersections in their work. For example, these were anticipated as being specific to the concepts of serious games, alternative reality, and play therapy, or to any number of related topics. The book contents highlighted how, unlike entertainment systems, the goals of alternative realities therapy and serious play demand the addition of sophisticated feedback systems that monitor user progress. These systems must encourage progress and intelligently and progressively adapt to users' individual needs within an environment that is challenging, engaging, and user friendly for patients and health care professionals. Such systems were presented by authors who kindly shared their researches in illustrating how the field requires the evolution of new paradigms in test battery creation that take advantage of the controllable digital framework, embodied data feedback, and other opportunities uniquely offered by virtual interactive spaces. Such invention and adaption of measuring in research practices in this field is anticipated as ongoing towards such interventions as presented elsewhere in this volume.

The earlier books reportedly impacted by both presenting how play therapy (and therapeutic play) typically focused on interactions between a professional therapist and children where the use of toys and other objects, i.e., physical artefacts, are expressive channels for communicating and interpreting a person's condition. In the second volume, additional related opportunities to supplement such traditional practices via the use of digital media were posited. Further highlighted was how serious games linked to games (and gameplay) are used toward a 'serious outcome' to solve a defined problem: In other words, chapters informed on how games can be used 'seriously' in alternative realities, i.e., in computer generated environments that are interactive through embedded virtual artefacts. These computer-generated alternative realities are commonly referred to as extended (covering mixed, virtual, augmented, or artificial reality).

Virtual reality in therapy and rehabilitation is not a new subject: many papers reporting research advancing the field with transfer to activities of daily living have appeared over the last decades.

The second book contributed to the field by acknowledging the impact of digital media such as extended reality and by questioning potentials offered in traditionally 'non-digitized' more traditional practices. For example, using digital media in therapy with aggressive participants, for instance, may reduce destruction, breakages, and damages to physical artefacts. Instead, computer graphic environments are safe, adaptive, and interactive, providing a world where things can be "virtually broken" any number of times and repaired, offering to clinicians both qualitative and quantitative aspects of evaluation alongside a flexibility for creating new tools for developing the clinical outcomes required by therapy and other medical and educational interventions. An example of this in contemporary technologies is how using

virtual reality interactive environments enables a tailoring of content based upon a patient's experience (see [2]). This can be with or without HMD use where human data can be collected and correlated to activities and iteratively content and interface designs can reflect user experiences. In practice, a patient Virtual Reality experience can be designed such that during therapeutic intervention what a patient looks at and their response to what they see is available (via physiological data, e.g. eye pupil dilation, galvanic skin response, breathing, face colour, heartbeat etc.). Depending on such patient experience responses, changes can be made for a subsequent session that reflects content and interface aligned to the targeted therapeutic outcomes. This 'tailoring and adaption technique' implemented correctly and creatively when using technologies for inclusive well-being can personalise and optimise experience of a patient in rehabilitation and other therapeutic intervention within a medical treatment program [2].

Such a bottom-up strategy, targeting optimal patient experience, can be thought to align with 'Health 4.0' and 'Health 5.0' keywords of 'Digitisation' and 'Person-alisation' respectively—as introduced in the contemporary stages in the evolution of the healthcare sector (see Fig. 1.1). However, the 'Digitisation' and 'Personalisation' discussed in Kowalkiewicz's [9] text are wider in range and meaning with a top-down perspective that involves relation to how the largest corporates who are designing the future of the healthcare sector such that the term *Technologies for Inclusive Well-Being* in future needs elaboration and segmentation to specifics aligning to digital wellness as suggested later in this chapter: Thus, Fig. 1.1 is included to evoke reader discussions.
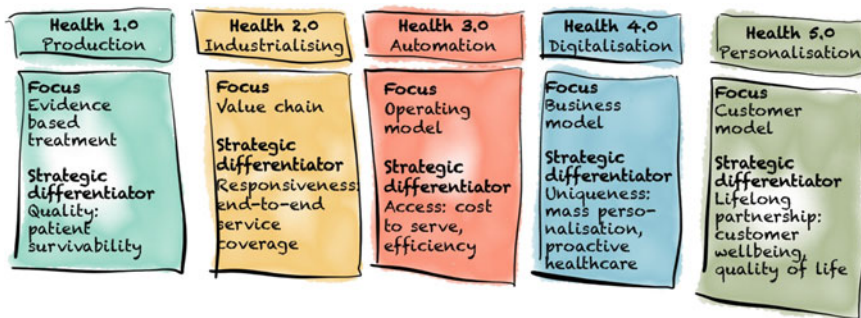
Fig. 1.1 'Five stages of evolution of the health sector' (used with permission—cf. Kowalkiewicz [9, 10] ©)

1.2.2   Current Volume

This third volume builds upon the earlier publications by expanding with content in the healthcare simulations area and more with cutting edge research reported by luminaries in their respective fields.

As the titles of each volume might suggest there was a defined focus of topics when calling for chapters and often these, once collected, offer a slightly different trajectory to follow because of what has been received.

The books, and coining of the common term *Technologies of Inclusive Well-Being*, were conceived to be a catalyst for debate on interactive computer technology, associated apparatus, and methods used in a manner whereby, for instance, creative industries, health care, human computer interaction, and technology sectors are encouraged to communicate with each other, to use different lenses in seeing challenges, and further to stimulate thinking about application design and intervention practices that are needed to supplement and to satisfy the societal demographic service needs of the future. Already posited in this chapter is the need for inter/trans-disciplinary education initiatives to support healthcare sector physiotherapists to get the most out of using such technologies: Stated here with respect as beyond word processors and printers used for administration and also beyond traditional therapy apparatus used in practices—and aligned to exploring through educating with emergent models to optimise motivated use.

By offering a wider perspective, each volume targets to address the need for a series of core texts that can evoke and provoke, engage and demand, and stimulate and satisfy. Debate and discussion alongside uptake and adoption is targeted and communication is promoted should any researchers or students wish.

By presenting recent advances in technologies for inclusive well-being, state-of-the-art research on emerging intelligent paradigms, and the application of intelligent paradigms in well-being, the field of Technologies of Inclusive Well-Being is considered well-presented through various practical applications and case studies. Thankfully, reviewers of the earlier volumes tend to agree (cf Springer sites):

> This book is a sophisticated study of how games, based on a trilogy of multi-disciplinary technologies, are used to benefit the 'well-being' of an extremely diverse population, including at-risk elderly, the disabled, autistic and other problematic children, surgical procedures education, and urban design and architecture projects. … the concepts described can benefit anyone interested in how serious games may be used for learning and change, regardless of application. (Glenn, Computing Reviews, August 2014 [6]).

> The content of this book lies at the intersection of three specialties: medicine, virtual world technology, and research. … This book would be of interest to the general reader who wants to see how these emerging virtual world technologies are being employed in therapeutic applications. It would also be of interest to experts in these technologies who wish to move beyond entertainment, therapists who wish to explore uses of these new technologies …. (Artz, Computing Reviews, May 2014 [1]).

1.2.3 Contributions in This Book—See Table of Contents

The chapters in this book are divided into four parts that reflect major themes currently at the intersection of the field. The titles of each theme are: Part 1: Gaming, VR, and immersive technologies for education/training—Part 2: VR/technologies for rehabilitation—Part 3: Health and well-being, and Part 4: Design and development.

1.2.4 Technology Adoption for Well-Being Intervention

In the next paragraphs, a delimited focus is on therapists (occupational but suggested beyond as earlier in this chapter), which exemplifies how identifying the need for technology adoption was clearly stated three decades ago. Technology uptake by those in power as leaders of educations and healthcare service providers is presumed to have been initiated during these decades with reflections and constructive critique of approach to how technology use was embedded and integrated into therapist's metaphoric toolboxes. Thus, new treatment methods, and technologies have emerged over this period to improve both diagnosis and therapy practices. Such advancements and adoption are ongoing thus align to this series of volumes.

Aligned to technological developments in healthcare and well-being, Rehabilitation Robots are likely in 2020 one of the biggest talking points nowadays whereby their increased use is predicted especially as a result of the Covid-19 situation and pressure on elderly care home residents and staff who come face-to-face with those having the virus. How many 'front-line health/care workers' may have been saved if robotics had been adopted into the industry prior to the 2019 breakout.

Other technologies seem to be appearing every day such as apps that can act as an interactive therapy training system alongside use of Extended (Virtual, Augmented, Mixed) Reality for immersive experiences (with or without Head Mounted Displays) for example when training, or gameplay to alleviate physical and mental conditions—again reportedly impactful from Covid-19. Increased long-term rehabilitation is predicted for survivors, which again burdens the already stretched healthcare providers.

Such recent developments have pushed the industry in new directions and led (some) therapists to update their applied in-practice approaches in a variety of ways as evidence suggests potentials in healthcare and well-being. Alongside stating this however, it can be questioned if this technological uptake should, or could, have been much earlier and even led from within the industry. Behind this questioning we can reflect on three decades ago where the message was made clear of the need by Hammel and Smith [7] who opened their paper titled 'The Development of Technology Competencies and Training Guidelines for Occupational Therapists' with the sentence "*The ability to use technology has become a survival skill in our society*" where they state:

> Occupational therapists have been using and will continue to use technology as part of their functional approach to treatment [11]. Due to the lack of education in this area, however, many occupational therapists are not skilled in or aware of the role they can play in the application of technology, especially within an interdisciplinary service provision team. Additionally, other service providers are rapidly implementing technologies in their practices without an awareness of the potential roles for occupational therapists in this area. These trends demonstrate the pervasive influence of technology in society and the need for occupational therapists and all rehabilitation professionals to be knowledgeable in its application. Access to technology has become as critical a need for persons with disabilities as is access to the physical environment. Therapists must be aware of and competent in the evaluation, prescription, operation, and adaptation of these technologies in order to meet the changing need of persons with disabilities. (7, p. 971).

In reflecting on technology training efforts, Hammel and Smith [7] further explained with examples how several rehabilitation professions were developing technology training guidelines and certification competencies. They point out how The American Occupational Therapy Association (AOTA) stressed the development of technology competence among its members. In the 1989–1991 Strategic Plans (AOTA, 1989–1991), technology training and dissemination were identified as primary goals. However, what actual technologies were being discussed, trained and disseminated must be asked? Those being trained in their disciplines would also likely argue that they didn't have time allocated in their employment to learn new technology and to implement into practices.

The author's experiences (see also [2]) from this period in the early 1990s highlights a distinct lack of knowledge in many (re)habilitation therapist practices about any technologies besides computers for administration (and recreation breaks playing games). Ever present from the institution employees were—(1) worries about technology replacing their jobs instead of supplementing; (2) the costs associated to the institution healthcare provider/economy; and (3) the associated learning curves associated to the adoption of technology and their need to develop aligned knowledge, skills, and competences. Acknowledged is that in the author's case, there were not many that understood the technology anyhow as it entailed introducing (circa early-mid 1990s) of bespoke invisible sensor-based interfaces that were mapped to give digital auditory (later expanding to include multimedia as visuals [VR], games and robotics) feedback responses to movement as a supplement to traditional "non-technology" intervention. This so a person, for example with acquired brain injury (ABI), could be trained to sense their proprioception beyond learnt kinesthetics via alternative channels of stimuli. A challenge was also that the author was not a healthcare professional to have vocabulary fitting uptake/adoption contexts, and neither being a salesperson with economic profile and related vocabulary.

In other words the concept may have been too complex as it was cored on that if a patient had damaged or lost a means to sense—for example in acquired brain injury where sense of balance can be influenced—then he/she could instead 'hear' their various torso, limb and associated balance positions and that this auditory channelling would, internal-to-the-human through afferent efferent neural feedback loop closure, 'train' the damaged proprioception and/or kinaesthetic mechanisms— linked to the brain plasticity to adapt and learn.

Suffice to say that at the start of the second decade of the twenty-first century, many therapists are much more open to such technology supplementing their practices. However, with affordable and availability of pervasive and ubiquitous digital technologies the challenge today is to determine *what* digital technologies are meaningful to adopt… this including issues such as company relationship, trust, etc. Alongside deciding *how* to ensure the finest training for optimum use of the technologies. To this end emergent models for optimising intervention and evaluation have developed from practices that still need to be widely adopted in order to constructively critique to put in place an optimum structured and systematic training model within therapeutic intervention education regards optimal use of technologies—such as Brooks' [2] SoundScapes Emergent Model titled 'Zone of Optimised Motivation' (ZOOM).

Notably (and associated to this position), is that 'The World Confederation for Physical Therapy' (WCPT—which represents more than 625,000 physical therapists in 121 member organisations), which is planned to be hosted in Dubai, in April 2021, has announced twelve confirmed focused symposia, featuring 55 speakers from around the world. One focused symposium event is titled "Technology in physiotherapy education: Technology enhanced physiotherapy education—Global Perspectives": this suggesting that contemporary technology for inclusive well-being uptake and its education for therapists is still in need. This despite the author presenting his research Virtual Interactive Space (VIS) and the need for such educational frameworks at WCPT over two decades ago, prior to the millennium[5] whereby transdisciplinary disciplines (e.g. those who create and those that use) would collaborate to optimise.

1.2.5 Future Advancements

In the process of finalising this book the global pandemic around Covid-19 happened. The editing of a volume titled *Recent Advancements of Technologies of Inclusive Well-Being* promoted thought processes aligned to the pandemic and a questioning of healthcare and meaning of well-being in and post-crisis. In focusing on this volume's topic there is no intention to diminish other crises that are prevalent in the world at time of writing, such as the climate/global warming; poverty; imbalances of global economies; homeland safety; sustainability; and more. The goal of this section is to share knowledge and insight of what may be ahead as well as to provoke readers to consider and discuss similarly.

We are informed how each search Online, each storage in the cloud, and each e-mail exchange and social media posting use energy resources. This analogizing aligns to Lorenz's *butterfly effect* where a seemingly irrelevant flap of a tiny wing can have huge and staggering life changing unprecedented consequences the other side of the world. One can reflect this story to a Chinese wet market (Wuhan) where, if reports are to be believed, such a *butterfly effect (or rather a bat wing effect)* took

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[5]https://www.researchgate.net/publication/257536704.

place as a zoonotic disease instance around the cusp between 2019 and 2020 leading to the current COVID-19 pandemic where, at time of writing, there are no known vaccines nor specific antiviral treatments: This stated with trepidation due to reports that U.S. Secretary of State Mike Pompeo has said there is "enormous evidence" that the virus originated in a lab in Wuhan—thus not from nature.[6] It can be questioned will we ever know for sure about anything with fake news and propaganda a way of contemporary life?

Online activities are tracked with data collected and farmed to inform corporates of one's profile, likes and dislikes, interests and disinterests—we are then bombarded with adverts to fit the profile—marketing to buy this, informing we need this, etc. We surf the World Wide Web (with a smile also considered as a 'wet market' given the surfing pun) with cookies and data packets being placed on the computers that we use—cookies that we need to agree to if we wish to continue to surf and access where we wish….more data collected. We were informed of safety and secure privacy of information collection after the Facebook–Cambridge Analytica (https://en.wikipe dia.org/wiki/Cambridge_Analytica) data scandal, yet after bankruptcy and closure related firms (notably Emerdata) still exist with the same staff and rumours suggest involvement in political elections and such societal changing actions as the United Kingdom – European Union split referred to as *Brexit*: Data collection is big business. Cybercrime we are informed is rising with people losing savings and more through data loss, one can see how one strategy fits with the other here: More data collection— more cybercrime. In the old days one had to be careful in what one threw in the garbage in case some identifying information on paper was retrievable by someone with intent to cheat another human—these days it would seem an industry based upon key presses!

Returning to Covid-19 (https://en.wikipedia.org/wiki/Coronavirus_disease_ 2019) to give a more positive perspective on technology for well-being; in February 2020, a Chinese mobile application (app) was launched where individuals need to enter their name and national identification number. In-built surveillance data to the app can distinguish others in nearby proximity to flag potential risk of infection, recommend self-isolation/quarantine, whilst also alerting health authorities. Else-where in Asia and Israel, other data such as used on mobile phones for facial recog-nition, tracking, and artificial intelligence, are collected and analysed to track those likely infected through similar human–human contact. One would speculate that this is a way to use such profile data collection and analysing technologies towards a positive goal aligned to well-being (see also later in this chapter) rather than to sell or steal from another human-being or otherwise for large corporates to insistently market to an Online user's profile to sell products.

At the other end of the spectrum we have large corporations using 'technology' of different scale and magnitude to destroy the planet from resourcing fossil fuels to eradicating rain forests and polluting seas that are rising in level due to global warming and climate changes that has knock on effects including terminating coral

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[6]https://www.voanews.com/covid-19-pandemic/who-expert-believes-wuhan-wet-market-played-role-covid-outbreak.

reefs. Could Covid-19 be nature's way of getting back at the human race and greedy governments that allow this to take place for money.

Closer to the topic herein the corporations of Amazon, Apple, Google, Microsoft, and others are reportedly, via their subsidiaries (and 'skunkworks' initiatives) in healthcare (and more), including increasing their already huge computer arrays to collect and analyse genome data associated to an individual's DNA (Deoxyribonucleic acid). In doing this they target to predict a person's likelihood of contracting a disease and offering a personal subscription medical service based upon the genome-based prediction towards improved future well-being.

Prof. Ernst Hafen from Eidgenössische Technische Hochschule (ETH) Zürich informs how precision medicine based upon such personal data collection can impact since an individual's genes influence the way he or she may react to drugs. In his text titled "The key lies in the genes" he shares on how such data collection can inform medical doctors on drugs and dosage:

> By identifying the right drug, in the right dose, at the right time for each patient, precision medicine has the potential to make the healthcare system more efficient and to treat patients more effectively. Essentially, precision medicine combines a patient's genetic data with clinical, environmental and lifestyle information to guide decisions for the optimal prevention, diagnosis, and treatment of conditions.

> Pharmacogenomics deals with the influence of a patient's individual genome on the effect of drugs. Using appropriate tests, physicians are able to determine in advance for patients individually which drugs are likely to work for them. The tests analyse key genes in our body involved in metabolism, transport, and elimination of the drug. Since genetics doesn't change over time, a pharmacogenomics report listing all the drugs likely to work for us is valid for our entire lifetime.

Associated, is how Amazon, with impressive business insight and a market valuation of close to $1 trillion,[7] is now licensed (as Amazon Pharmacy), through its acquisition of mail-order online PillPack (and others), to distribute prescription drugs. Aligned with the aforementioned-initiatives and -activities in predictive healthcare requirement subscriptions (e.g. genome DNA analysis) some experts predict disruptive advancements in future technologies and strategies associated to inclusive well-being and consumer-centric healthcare. This where at the end of 2019 the global online pharmacy industry alone was predicted to reflect a compound annual growth rate (CAGR) of 14.26% to reach $107.53 billion by 2025.[8]

There is no doubt that the tremendous advances in intelligent paradigms and cheap and easy availability of computing power have generated enough interests among researchers to develop new tools in virtually every discipline including healthcare. A sample of research reported in the books in 2001 and 2006 [8, 12], mentions the applications of intelligent systems for visually and hearing impaired, use of Virtual Reality, Digital Talking Books, Gait Training System for Computer-aided Rehabilitation and so on. In nearly more than a couple of decades, several technological advances have taken place in the area of well-being. Some of these include cognitive assistants [5] such as *DayGuide*, *Active@Home*, *CoME,DALIA*, *iGenda*, *M3W*,

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[7]https://healthcareweekly.com/amazon-pharmacy/.

[8]https://www.globenewswire.com/news-release/2019/06/18/1870266/0/en/.

MyGuardian, *PersonAAL*, and so on. Online communication technologies will play a greater role in many areas such as business, education, healthcare and so on. We are already witnessing a greater use of Zoom, Microsoft Teams, Google hangout and so on in this Covid-19 pandemic. Further innovations in gaming technologies and Virtual and Augmented Reality in well-being are appearing at a rate which was not imagined two decades ago. It is true that one cannot predict the future fully, but we believe that technologists can create and predict future to a certain extent.

Closure of this chapter are a sharing of current- and a prediction of future- advances in technologies for inclusive well-being where increasingly we are using Online services for data sharing, collecting, analysis, and delivery of predictions, treatment requirements, and medicine. As mentioned earlier, there are many products illustrating the growth and scope of contemporary health and wellness technologies that enable self-monitoring of own health. These products can be as wearables in many forms that collect health, sleep and exercise activities related data. For example: wrist bands such as *Apple Watch, Omron HeartGuide, FitBit* … Self-adhesive wireless lightweight patches such as *Philips Biosensor* for monitoring vital signs and critical data; *The FreeStyle Libre* patch and reader/app by *Abbott Diabetes Care* that measures glucose levels in the interstitial fluid between the cells right under the skin; Pain relieving devices such as *Omron's transcutaneous electrical nerve stimulation (TENS) technology* that uses self-adhesive heat application apparatus offering varying intensities and modes for different body parts to help to block pain messages, trigger the release of endorphins and to improve blood circulation. Other wearable devices are available that communicate wirelessly to apps such as blood pressure arm sleeve monitors by *QardioArm;* and the *Complete™ Evolv®, 3, 5, 7* and *10 Series®* [and more (https://omronhealthcare.com/blood-pressure/)] all by *Omron.* Other non-wearable personalised home apparatus includes *Omron nebulisers* to dispense medicine in pressurised air for respiratory treatment. There is a long list: Some of these systems/apparatus/devices link to apps and/or specific API, some are clinically tested and approved (e.g. FDA in USA) and many utilise cloud-based data collection and/or transfer, including via such communication smart-home devices as the *Amazon Alexa.*

The UN World Health Organization defines health in its constitution as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Health is much more than just a biomedical condition. The Swiss Cause of Health Cohort (Swiss COHCOH), where this clip of text is resourced (https://causeofhealth.ch), consist of a team of scientists from the Swiss Federal Institute of Technology in Zurich (ETHZ) and from the University of Zurich (UZH). At their site the team state the fact that little is known about health because medical research mainly focuses on curing disease. The COHCOH initiative focuses on "the premise that an individual's health is determined by the Health Triangle, a complex interplay between a unique individual (genome), the environment, and the individual's behaviour in the environment". The team further state how standardized longitudinal sets of health data from millions of people are needed to form the basis of "precision health or P4 (personalized, predictive, preventive and participatory) health." (https://cause-of-health.citizenscience.ch/en/cause-of-health)

The products, approaches and strategies in this opening chapter arguably align with Health 5.0 and how future well-being will become increasingly personal and digital (including own monitoring of data via devices). It should also be more affordable and even free of charge due to the corporate digital giants needing us to stay healthy and productive such that they will invest in us to ensure we are feeling well and making enough money to spend on products and services offered and advertised by them. Kowalkiewicz's [9] translation of 'digital wellness' is elaborated as "efforts made to increase, maintain or restore physical, mental, or emotional well-being, delivered at a global scale through the use of digital technologies, rather than by individuals working directly with patients." The final statement on *Future Advances in Technologies for Inclusive Well-Being* is thus given to Kowalkiewicz [9, 10] who, in his insightful publication related to 'digital wellness' and the evolution of the healthcare sector (Fig. 1.1 herein), makes explicit:

> … the titans of the technology industry are focussing on health as the next industry to transform. And if you're not sure what this may mean, just think how it was to be a customer of some other industries before they were transformed. Remember travel and hospitality (trying to book that room in Iceland in 1998)? How about news and media (newspapers were updated only once every 24 h)? Photography changed as well (24 or 36 frames in your camera and "express" development in just one hour).

> The health industry is about to receive a significant innovation push. It will progress toward the fifth stage of the sector: Health 5.0.

> Kowalkiewicz [9].

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