

Intelligent Systems Reference Library 196

Anthony L. Brooks · Sheryl Brahman ·  
Bill Kapralos · Amy Nakajima ·  
Jane Tyerman · Lakhmi C. Jain *Editors*

# Recent Advances in Technologies for Inclusive Well-Being

Virtual Patients, Gamification and  
Simulation

 Springer

# **Intelligent Systems Reference Library**

Volume 196

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Editors

# Recent Advances in Technologies for Inclusive Well-Being

Virtual Patients, Gamification and Simulation

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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

Springfield, USA

Oshawa, Canada

Toronto, Canada

Peterborough, Canada

Sydney, Australia

Anthony Lewis Brooks

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Bill Kapralos

Amy Nakajima

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# Contents

<b>1</b>	<b>Re – Reflecting on Recent Advances in Technologies of Inclusive Well-Being</b> .....	<b>1</b>
	Anthony Lewis Brooks	
1.1	Introduction .....	1
1.2	The Field .....	2
1.2.1	Editors and Concept Background in This Field .....	3
1.2.2	Current Volume .....	6
1.2.3	Contributions in This Book—See Table of Contents .....	7
1.2.4	Technology Adoption for Well-Being Intervention .....	7
1.2.5	Future Advancements .....	9
	References .....	13
 <b>Part I Gaming, VR, and Immersive Technologies for Education/Training</b>		
<b>2</b>	<b>Gaming, VR, and Immersive Technologies for Education/Training</b> .....	<b>17</b>
	Anthony Lewis Brooks	
2.1	Introduction .....	17
2.1.1	Experiential Training of Hand Hygiene Using Virtual Reality [1] .....	19
2.1.2	Useful, Usable and Used? Challenges and Opportunities for Virtual Reality Surgical Trainers [7] .....	20
2.1.3	Four-Component Instructional Design Applied to a Game for Emergency Medicine [8]. . . . .	21
2.1.4	Enhanced Reality for Healthcare Simulation [15] . . . . .	22

- 2.1.5 MaxSIMhealth: An Interconnected Collective of Manufacturing, Design, and Simulation Labs to Advance Medical Simulation Training [16] . . . . . 23
- 2.1.6 Serious Games and Multiple Intelligences for Customized Learning: A Discussion [17]. . . . . 24
- 2.1.7 Mobile Application for Convulsive and Automated External Defibrillator Practices [19]. . . . . 25
- 2.1.8 Lessons Learned from Building a Virtual Patient Platform [21] . . . . . 25
- 2.2 Conclusions . . . . . 27
- References . . . . . 28
- 3 Experiential Training of Hand Hygiene Using Virtual Reality . . . . . 31**
- Lauren Clack, Christian Hirt, Andreas Kunz, and Hugo Sax
- 3.1 Introduction . . . . . 32
- 3.2 Hand Hygiene—Related Work. . . . . 33
- 3.3 Virtual Reality for Experiential Training. . . . . 34
  - 3.3.1 Experiential Learning Theory . . . . . 34
- 3.4 Summary and Future Work . . . . . 39
- References . . . . . 40
- 4 Useful, Usable and Used? . . . . . 43**
- Chantal M. J. Trudel
- 4.1 Introduction . . . . . 43
  - 4.1.1 Improving Healthcare Delivery, Patient Outcomes and Training Opportunities . . . . . 44
- 4.2 Design Drivers in Developing VR Surgical Trainers . . . . . 46
  - 4.2.1 Is It Useful, Usable and Used? . . . . . 46
  - 4.2.2 Establishing System Requirements . . . . . 48
  - 4.2.3 Factors Influencing Usefulness, Usability and Use . . . . . 48
- 4.3 Conclusion . . . . . 59
- References . . . . . 60
- 5 Four-Component Instructional Design Applied to a Game for Emergency Medicine . . . . . 65**
- Tjitske J. E. Faber, Mary E. W. Dankbaar, and Jeroen J. G. van Merriënboer
- 5.1 Background and Significance . . . . . 65
- 5.2 Game-Based Learning and Four-Component Instructional Design . . . . . 68
  - 5.2.1 Learning in a Game Environment . . . . . 68
  - 5.2.2 Four Component Instructional Design . . . . . 68

5.2.3	4C/ID in Educational Games . . . . .	71
5.2.4	4C/ID in Medical Education . . . . .	72
5.3	Redesigning a Game for Emergency Care Using 4C/ID . . . . .	73
5.3.1	Learning Tasks and Task Classes . . . . .	73
5.3.2	Support and Guidance . . . . .	73
5.3.3	Supportive Information . . . . .	75
5.3.4	Procedural Information . . . . .	75
5.3.5	Part-Task Practice . . . . .	76
5.3.6	Design Process and Challenges . . . . .	76
5.3.7	Plans for Evaluation . . . . .	79
5.4	Discussion and Lessons Learned . . . . .	79
5.5	Conclusion . . . . .	80
	References . . . . .	81
<b>6</b>	<b>A Review of Virtual Reality-Based Eye Examination Simulators . . . . .</b>	<b>83</b>
	Michael Chan, Alvaro Uribe-Quevedo, Bill Kapralos, Michael Jenkin, Kamen Kanev, and Norman Jaimes	
6.1	Introduction . . . . .	84
6.2	Ophthalmoscopy Examination . . . . .	86
6.2.1	The Ophthalmoscope and Eye Fundus Examination . . . . .	86
6.2.2	Ophthalmoscope Alternatives . . . . .	87
6.3	Simulation and Medical Education . . . . .	88
6.3.1	Standardised Patients . . . . .	89
6.3.2	Computer-Based Simulation . . . . .	90
6.3.3	Virtual/Augmented/Mixed Reality . . . . .	90
6.3.4	Simulation in Ophthalmology . . . . .	91
6.4	Direct Ophthalmoscopy Simulators . . . . .	91
6.5	Discussion . . . . .	99
	References . . . . .	100
<b>7</b>	<b>Enhanced Reality for Healthcare Simulation . . . . .</b>	<b>103</b>
	Fernando Salvetti, Roxane Gardner, Rebecca D. Minehart, and Barbara Bertagni	
7.1	Enhanced Reality . . . . .	104
7.2	Enhanced Hybrid Simulation in a Mixed Reality Setting, Both Face-to-Face and in Telepresence . . . . .	105
7.3	e-REAL as a CAVE-Like Environment Enhanced by Augmented Reality and Interaction Tools . . . . .	111
7.4	The Simulation’s Phases Enhanced by e-REAL and the Main Tools Made Available by the System . . . . .	114
7.5	Visual Storytelling and Contextual Intelligence, Cognitive Aids, Apps and Tools to Enhance the Education Process in a Simulation Lab or In Situ . . . . .	122

7.6 The Epistemological Pillars Supporting e-REAL . . . . . 127

7.7 Case-Study: Teamwork and Crisis Resource Management  
for Labor and Delivery Clinicians . . . . . 128

7.8 Conclusion . . . . . 133

References . . . . . 136

**8 maxSIMhealth: An Interconnected Collective of Manufacturing,  
Design, and Simulation Labs to Advance Medical Simulation  
Training . . . . . 141**

maxSIMhealth Group

8.1 Introduction . . . . . 141

8.1.1 Immersive Technologies . . . . . 143

8.2 maxSIMhealth Projects . . . . . 144

8.2.1 Immersive Technology-Based Solutions . . . . . 144

8.2.2 Gamification- (and Serious Gaming-) Based  
Solutions . . . . . 158

8.2.3 The Gamified Educational Network (GEN) . . . . . 158

8.2.4 3D Printing-Based Solutions . . . . . 164

8.3 Discussion . . . . . 169

8.4 Conclusions . . . . . 171

References . . . . . 171

**9 Serious Games and Multiple Intelligences for Customized  
Learning: A Discussion . . . . . 177**

Enilda Zea, Marco Valez-Balderas, and Alvaro Uribe-Quevedo

9.1 Introduction . . . . . 177

9.2 Multiple Intelligences . . . . . 179

9.3 Challenges to Educators . . . . . 180

9.4 Technology Opportunities . . . . . 181

9.5 Serious Games . . . . . 182

9.6 Conclusion . . . . . 184

References . . . . . 186

**10 A Virtual Patient Mobile Application for Convulsive  
and Automated External Defibrillator Practices . . . . . 191**

Engie Ruge Vera, Mario Vargas Orjuela, Alvaro Uribe-Quevedo,  
Byron Perez-Gutierrez, and Norman Jaimes

10.1 Introduction . . . . . 192

10.2 Background Review . . . . . 193

10.2.1 Early Simulation . . . . . 194

10.2.2 Modern Simulation . . . . . 195

10.3 Mobile Application Development . . . . . 196

10.3.1 Automatic External Defibrillation . . . . . 196

10.3.2 Convulsive Treatment . . . . . 197

- 10.3.3 Design and Development . . . . . 198
- 10.3.4 Game/Learning Mechanics . . . . . 200
- 10.4 Preliminary Study . . . . . 202
  - 10.4.1 Participants . . . . . 203
  - 10.4.2 Pre and Post-test . . . . . 204
  - 10.4.3 System Usability Scale . . . . . 205
  - 10.4.4 Game Engagement Questionnaire . . . . . 205
- 10.5 Conclusion . . . . . 206
- References . . . . . 207
- 11 Lessons Learned from Building a Virtual Patient Platform . . . . . 211**
  - Olivia Monton, Allister Smith, and Amy Nakajima
  - 11.1 Introduction: Simulation and Virtual Patients . . . . . 212
  - 11.2 Virtual Patient Platform Requirements . . . . . 214
  - 11.3 Obstacles and Challenges . . . . . 216
  - 11.4 Lessons Learned . . . . . 218
  - 11.5 A Way Forward . . . . . 218
  - References . . . . . 219
- 12 Engaging Learners in Presimulation Preparation Through Virtual Simulation Games . . . . . 223**
  - Marian Luctkar-Flude, Jane Tyerman, Lily Chumbley, Laurie Peachey, Michelle Lalonde, and Deborah Tregunno
  - 12.1 Background . . . . . 225
    - 12.1.1 Presimulation Preparation . . . . . 225
    - 12.1.2 Virtual Simulations . . . . . 226
    - 12.1.3 Virtual Simulation Games . . . . . 227
    - 12.1.4 Presimulation Preparation Using Virtual Simulation Games . . . . . 229
  - 12.2 Virtual Simulation Game Project . . . . . 230
    - 12.2.1 Rationale . . . . . 230
    - 12.2.2 Objective . . . . . 230
    - 12.2.3 Methods . . . . . 230
    - 12.2.4 Scenario Selection . . . . . 231
    - 12.2.5 Description of the Innovation . . . . . 231
    - 12.2.6 Usability Testing . . . . . 231
    - 12.2.7 Cost Utility and Learning Outcomes . . . . . 232
  - 12.3 Results . . . . . 232
  - 12.4 Discussion . . . . . 233
    - 12.4.1 Strengths and Limitations . . . . . 233
  - 12.5 Conclusions . . . . . 234
  - References . . . . . 235

**Part II VR/Technologies for Rehabilitation**

**13 VR/Technologies for Rehabilitation** . . . . . 241  
 Anthony Lewis Brooks

13.1 Introduction . . . . . 241

13.1.1 Game-Based (Re)habilitation via Movement Tracking [2] . . . . . 242

13.1.2 Case Studies of Users with Neurodevelopmental Disabilities: Showcasing Their Roles in Early Stages of VR Training Development [3] . . . . . 244

13.1.3 AquAbilitation: ‘Virtual Interactive Space’ (VIS) with Buoyancy Therapeutic Movement Training [4] . . . . . 246

13.1.4 Interactive Multisensory VibroAcoustic Therapeutic Intervention (iMVATi) [5] . . . . . 249

13.2 Conclusions . . . . . 251

References . . . . . 251

**14 Game-Based (Re)Habilitation via Movement Tracking** . . . . . 253  
 Anthony Lewis Brooks and Eva Brooks

14.1 Introduction . . . . . 253

14.1.1 Presence and Aesthetic Resonance: As a ‘Sense State’ Continuum . . . . . 254

14.1.2 Play . . . . . 255

14.1.3 Under Used Resource for Therapy . . . . . 255

14.2 Gameplaying and Mastery . . . . . 256

14.3 Method . . . . . 257

14.3.1 Description of Material . . . . . 258

14.3.2 Description of Procedure . . . . . 258

14.3.3 Description of the Set up . . . . . 259

14.3.4 Description of Analysis . . . . . 259

14.4 Results . . . . . 262

14.4.1 Tempo Spatial Movements . . . . . 262

14.4.2 Interface and Activities . . . . . 263

14.4.3 Resource for Therapy . . . . . 264

14.5 Discussion . . . . . 265

14.6 Conclusions . . . . . 266

Appendix 1 . . . . . 267

Appendix 2 . . . . . 267

Appendix 3 . . . . . 268

Appendix 4 . . . . . 269

References . . . . . 273

**15 Case Studies of Users with Neurodevelopmental Disabilities: Showcasing Their Roles in Early Stages of VR Training Development . . . . . 275**  
 Yurgos Politis, Nigel Newbutt, Nigel Robb, Bryan Boyle, Hung Jen Kuo, and Connie Sung

15.1 Introduction . . . . . 276

15.2 Neurodiversity and Participatory Design . . . . . 277

15.3 Ethical Considerations . . . . . 279

15.4 Case Study Presentations . . . . . 279

15.5 Case Study 1: Engaging Users in the Potential of Virtual Reality Opportunities for Learning in Schools . . . . . 280

15.5.1 Brief Overview/introduction . . . . . 280

15.5.2 Aims and Objectives . . . . . 280

15.5.3 Context/Setting . . . . . 282

15.5.4 Case Study Group/Characteristics . . . . . 282

15.5.5 Findings . . . . . 284

15.6 Case Study 2: Participatory Design Approach to Co-Create Training Materials on a Daily Living Task for Young Adults with Intellectual Disabilities . . . . . 289

15.6.1 Brief Overview/introduction . . . . . 289

15.6.2 Aims and Objectives . . . . . 289

15.6.3 Context/Setting . . . . . 290

15.6.4 Case Study Group/Characteristics . . . . . 290

15.6.5 Findings . . . . . 291

15.7 Overall Discussion and Conclusions . . . . . 294

15.8 Implications for Practice and Further Work . . . . . 296

References . . . . . 297

**16 AquAbilitation: ‘Virtual Interactive Space’ (VIS) with Buoyancy Therapeutic Movement Training . . . . . 299**  
 Anthony Lewis Brooks

16.1 Preamble/Introduction . . . . . 299

16.1.1 Simulation and Targeted End-Users/participants . . . . . 300

16.1.2 PoC—Design Justification . . . . . 301

16.1.3 Technology and End-Users . . . . . 301

16.2 Technologies and Terminology: From Virtual Reality (VR) to Virtual Interactive Space (VIS) . . . . . 302

16.3 Background and Concept—Fieldwork and Theoretical Framework . . . . . 305

16.4 Fieldwork . . . . . 308

16.5 Hydrotherapy (with Innate Multimedia-Driven Causal Cycles of Action-Interactions) . . . . . 308

16.6 Aquatic and Virtual ‘Immersion’ (Pun Intended) . . . . . 309

16.7 Set-Up of PoC . . . . . 310



- 16.8 Software Examples for Non-Aquatic Movement  
Tracking-Environments (Typically Dance) . . . . . 310
- 16.9 Techniques—for Example with EyesWeb and EyeCon  
Software . . . . . 311
- 16.10 Lighting . . . . . 313
- 16.11 Projected Image Versus HMD . . . . . 313
- 16.12 Conclusions . . . . . 315
- 16.13 Summary . . . . . 316
- 16.14 Further Challenges, Critique, and Reflections Toward  
Future Research . . . . . 317
- 16.15 Closing Summary . . . . . 320
- References . . . . . 321

**17 Interactive Multisensory VibroAcoustic Therapeutic  
Intervention (iMVATi) . . . . . 325**

Anthony Lewis Brooks

- 17.1 Introduction . . . . . 325
- 17.2 Biofeedback . . . . . 326
- 17.3 Multisensory Stimulus: Sound, Sound Therapy, Music  
Therapy, Vibroacoustic Intervention . . . . . 328
- 17.4 Soundbeam and Sound Therapy . . . . . 329
- 17.5 Multisensory Stimulus: Visuals—Case Studies 1 and 2 . . . . . 332
- 17.6 Multisensory Stimulus: Tactile/Haptic = Vibroacoustic  
Therapeutic Intervention . . . . . 333
- 17.7 VIBRAC and Review of the Field . . . . . 336
- 17.8 Conclusion . . . . . 337
- 17.9 Future Research in Interactive Vibroacoustic Therapeutic  
Intervention . . . . . 337
- 17.10 Postscript . . . . . 338
- Bibliography . . . . . 339

**Part III Health and Well-Being**

**18 Health and Well-Being . . . . . 345**

Anthony Lewis Brooks

- 18.1 Introduction . . . . . 345
  - 18.1.1 Current Trends in Technology and Wellness  
for People with Disabilities: An Analysis of Benefit  
and Risk [1]. . . . . 346
  - 18.1.2 Electrorganic Technology for Inclusive Well-being  
in Music Therapy [2] . . . . . 346
  - 18.1.3 Interactive Multimedia: A Take on Traditional Day  
of the Dead Altars [3] . . . . . 348
  - 18.1.4 Implementing Co-design Practices for the  
Development of a Museum Interface for Autistic  
Children [4] . . . . . 349

18.1.5	Combining Cinematic Virtual Reality and Sonic Interaction Design in Exposure Therapy for Children with Autism [10] . . . . .	351
18.2	Conclusions . . . . .	351
	References . . . . .	352
<b>19</b>	<b>Current Trends in Technology and Wellness for People with Disabilities: An Analysis of Benefit and Risk . . . . .</b>	<b>353</b>
	Hung Jen Kuo, Connie Sung, Nigel Newbutt, Yurgos Politis, and Nigel Robb	
19.1	Introduction: Technology as Daily Routine . . . . .	354
19.2	Benefits . . . . .	355
19.2.1	Technology for Mainstreaming Assistive Device . . . . .	355
19.2.2	Technology for Education and Employment . . . . .	356
19.2.3	Technology for Service Delivery . . . . .	357
19.2.4	Technology for Social Interaction and Recreation . . . . .	357
19.3	Risk . . . . .	360
19.3.1	Assistive Technology Being Abandoned . . . . .	360
19.3.2	Technology as Ethical Concerns . . . . .	361
19.3.3	Technology as Social Disincentive . . . . .	363
19.4	Conclusion . . . . .	365
	References . . . . .	366
<b>20</b>	<b>Electrorganic Technology for Inclusive Well-being in Music Therapy . . . . .</b>	<b>373</b>
	Anthony Lewis Brooks and Carl Boland	
20.1	Introduction and Background . . . . .	373
20.2	Music and Music Therapy . . . . .	374
20.3	Technology Empowered Musical Expression in Therapeutic Settings . . . . .	375
20.4	Alternative Musical Instruments and the aFrame in Music Therapy . . . . .	376
20.5	Musicality and Nuances of Expression . . . . .	377
20.6	ATV Electrorganic aFrame . . . . .	378
20.7	Adaptive Timbre Technology . . . . .	379
20.8	The Electrorganic aFrame in Use . . . . .	382
20.9	European Music Therapy Conference (EMTC), Aalborg Denmark 2019 (See Brooks [3]) . . . . .	383
20.10	Proof of Concept and Feasibility Trials in Practice . . . . .	385
20.10.1	Next Steps—A Speculation . . . . .	387
20.11	Conclusion . . . . .	388
	References . . . . .	389

**21 Interactive Multimedia: A Take on Traditional Day of the Dead Altars** . . . . . 391

Ramón Iván Barraza Castillo, Alejandra Lucía De la Torre Rodríguez,  
 Rogelio Baquier Orozco, Gloria Olivia Rodríguez Garay,  
 Silvia Husted Ramos, and Martha Patricia Álvarez Chávez

21.1 Introduction . . . . . 392

21.2 Day of the Dead . . . . . 393

21.3 Literature Review . . . . . 394

    21.3.1 Technology-Enhanced Exhibitions . . . . . 394

    21.3.2 Exhibitions, Interventions, and Mental Well-being . . . . . 395

21.4 Method . . . . . 396

    21.4.1 Traditional Altars . . . . . 397

    21.4.2 Narrative Elements . . . . . 399

    21.4.3 Interactivity and User Experience . . . . . 401

    21.4.4 Altar Installation . . . . . 405

21.5 Exhibition . . . . . 412

21.6 Conclusion . . . . . 416

References . . . . . 417

**22 Implementing Co-Design Practices for the Development of a Museum Interface for Autistic Children** . . . . . 421

Dimitra Magkafa, Nigel Newbutt, and Mark Palmer

22.1 Introduction . . . . . 421

22.2 Literature Review . . . . . 423

    22.2.1 The Emergence of Interactive Technologies for Children with Autism . . . . . 423

    22.2.2 Research on Co-Design Technology for Autistic . . . . . 424

22.3 Study Design . . . . . 425

    22.3.1 Design and Development . . . . . 426

    22.3.2 Stage 1 Discovery . . . . . 428

    22.3.3 Stage 2 Concept Development . . . . . 432

    22.3.4 Stage 3 User-Testing- Evaluating the Interface . . . . . 434

    22.3.5 Stage 4 Re-Design the Platform . . . . . 434

22.4 Discussion . . . . . 435

    22.4.1 Engagement and children’s Input Based on Their Abilities . . . . . 435

    22.4.2 Building Rapport . . . . . 437

    22.4.3 Individuals . . . . . 437

    22.4.4 Suitable Environments . . . . . 438

    22.4.5 Creativity Potentials . . . . . 438

    22.4.6 Teacher’s Involvement . . . . . 439

22.5 Conclusion . . . . . 440

References . . . . . 441

**23 Combining Cinematic Virtual Reality and Sonic Interaction**  
**Design in Exposure Therapy for Children with Autism** . . . . . 445  
 Lars Andersen, Nicklas Andersen, Ali Adjorlu, and Stefania Serafin

23.1 Introduction . . . . . 445

23.2 State of the Art . . . . . 446

23.3 Design . . . . . 447

    23.3.1 Space . . . . . 448

    23.3.2 Multiplayer . . . . . 450

23.4 Recording Session . . . . . 451

23.5 Evaluation . . . . . 451

    23.5.1 Setup . . . . . 451

    23.5.2 Target Group and Sampling . . . . . 452

    23.5.3 Evaluating the Children . . . . . 453

    23.5.4 Evaluating the Guardians . . . . . 454

    23.5.5 Microsoft Desirability Toolkit . . . . . 455

23.6 Ethical Issues . . . . . 456

23.7 Conclusion . . . . . 456

References . . . . . 457

**Part IV Design and Development**

**24 Design and Development** . . . . . 461  
 Anthony Lewis Brooks

24.1 Introduction . . . . . 461

    24.1.1 Participatory Technology Design for Autism  
 and Cognitive Disabilities: A Narrative Overview of  
 Issues and Techniques [1] . . . . . 462

    24.1.2 Exploring Current Board Games’ Accessibility  
 Efforts for Persons with Visual Impairment [6] . . . . . 463

    24.1.3 An Extensible Cloud-Based Avatar: Implementation  
 and Evaluation [7] . . . . . 464

    24.1.4 Frontiers of Immersive Gaming Technology:  
 A Survey of Novel Game Interaction Design  
 and Serious Games for Cognition [8] . . . . . 464

24.2 Conclusions . . . . . 466

References . . . . . 466

**25 Participatory Technology Design for Autism and Cognitive  
 Disabilities: A Narrative Overview of Issues and Techniques** . . . . . 469  
 Nigel Robb, Bryan Boyle, Yurgos Politis, Nigel Newbutt,  
 Hung Jen Kuo, and Connie Sung

25.1 Introduction . . . . . 470

    25.1.1 Participatory Design . . . . . 470

    25.1.2 Participatory Design and Neurodevelopmental  
 Disabilities . . . . . 472

- 25.2 Transfer of Tacit Knowledge: Communicating the Lived Experience . . . . . 473
- 25.3 Active Co-creation . . . . . 474
- 25.4 Making Ideas Tangible: Prototyping . . . . . 476
  - 25.4.1 Prototyping Techniques . . . . . 477
- 25.5 Empowerment Through Decision-Making . . . . . 479
- 25.6 The Importance of Setting . . . . . 480
- 25.7 Use of Proxies . . . . . 480
- 25.8 Ownership . . . . . 481
- 25.9 Conclusion . . . . . 481
- References . . . . . 482
  
- 26 Exploring Current Board Games’ Accessibility Efforts for Persons with Visual Impairment . . . . . 487**
  - Frederico Da Rocha Tomé Filho, Bill Kapralos, and Pejman Mirza-Babaei
  - 26.1 Introduction . . . . . 487
  - 26.2 Selection Classification . . . . . 490
  - 26.3 Accessible Digital Games . . . . . 492
  - 26.4 Accessible Board Games: Community and Industry Efforts . . . . . 494
  - 26.5 Game Accessibility Guidelines . . . . . 495
  - 26.6 Immersive Technologies (VR and AR) and Related . . . . . 496
  - 26.7 Conclusions . . . . . 498
  - References . . . . . 499
  
- 27 An Extensible Cloud Based Avatar: Implementation and Evaluation . . . . . 503**
  - Enas Altarawneh, Michael Jenkin, and I. Scott MacKenzie
  - 27.1 Introduction . . . . . 504
  - 27.2 Previous Work . . . . . 504
  - 27.3 Building the Avatar . . . . . 505
    - 27.3.1 Lip-Syncing Spoken Words . . . . . 507
    - 27.3.2 Building a Realistic Utterance State Transition . . . . . 508
  - 27.4 Rendering the Avatar . . . . . 509
    - 27.4.1 Distributed Rendering in the Cloud . . . . . 510
  - 27.5 User Study . . . . . 511
    - 27.5.1 Method . . . . . 512
    - 27.5.2 Results . . . . . 515
    - 27.5.3 Discussion . . . . . 519
  - References . . . . . 521

**28 Frontiers of Immersive Gaming Technology: A Survey of Novel Game Interaction Design and Serious Games for Cognition . . . . . 523**  
Samantha N. Stahlke, Josh D. Bellyk, Owen R. Meier,  
Pejman Mirza-Babaei, and Bill Kapralos

- 28.1 Introduction . . . . . 523
  - 28.1.1 Review Process . . . . . 524
- 28.2 Novel Game Interaction Using EEG and Eye-Tracking . . . . . 525
  - 28.2.1 Brain-Computer Interfaces . . . . . 526
  - 28.2.2 EEG in Games . . . . . 527
  - 28.2.3 Eye-Tracking Technology . . . . . 531
- 28.3 Limitations and Design Recommendations . . . . . 532
  - 28.3.1 Design Considerations for BCI and Eye Tracking in Games . . . . . 533
- 28.4 Conclusion . . . . . 534
- References . . . . . 535

**Glossary and Acronyms . . . . . 537**

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**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.



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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*.



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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*<sup>1</sup>; *Robotic surgery*<sup>2</sup>; *3D bio-printing of muscle tissues to complete organs for transplant*<sup>3</sup>; through to *Early cancer detection*<sup>4</sup>...and more including *Rehabilitation Robots*. Many advances utilise mobile computing aligned to wearable sensors for personal monitoring of health condition (e.g. ECG, SpO<sub>2</sub>, 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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<sup>1</sup><https://futurehealthbiobank.com/>.

<sup>2</sup><https://www.intuitive.com/en-us>.

<sup>3</sup><https://organovo.com/>.

<sup>4</sup><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 adaptation 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 ‘Personalisation’ 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.

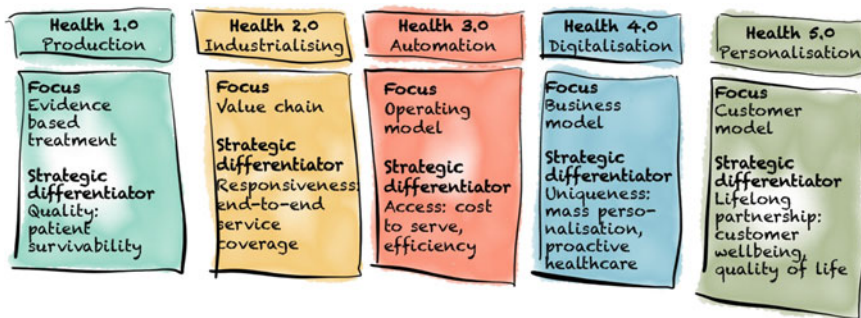


Fig. 1.1 ‘Five stages of evolution of the health sector’ (used with permission—cf. Kowalkiewicz [9, 10] ©)

## 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<sup>5</sup> 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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<sup>5</sup><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.<sup>6</sup> 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.wikipedia.org/wiki/Cambridge\\_Analytica](https://en.wikipedia.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](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. Elsewhere in Asia and Israel, other data such as used on mobile phones for facial recognition, 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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<sup>6</sup><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,<sup>7</sup> 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.<sup>8</sup>

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*,

<sup>7</sup><https://healthcareweekly.com/amazon-pharmacy/>.

<sup>8</sup><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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