
Contents

Acknowledgments	ix
Foreword	xi
Preface	xv
Introduction	xxix
Part 1. Incremental Innovations and Technologies Pushed to their Limits	1
Chapter 1. Incremental Developments of Processes, Machines and Materials	3
1.1. Introduction	5
1.2. Undertaking non-layered stereolithography	8
1.2.1. Optimizing the light supply within a single-photon process	11
1.2.2. Transparent window	12
1.2.3. Gaseous interface	12
1.2.4. Simultaneous two-photon absorption	16
1.3. Challenging the notion of layers	26
1.3.1. Addition of prefabricated structures	26
1.3.2. Proof of concept	33
1.3.3. Synthesis	34
1.4. Optical-quality surface finish	35
1.4.1. Glasses lenses and contact lenses	36

1.4.2. Microlenses	36
1.4.3. Direct lens manufacture	37
1.4.4. Multi-mode optical fiber	39
1.5. Cold-cast metal 3D printing	40
1.5.1. Electrolytic deposition	40
1.5.2. Metallic ink	43
1.5.3. Laser processes	43
1.5.4. Photochemistry	45
1.5.5. Silver metal	46
1.5.6. Conducting polymers	49
1.6. Colored objects	51
1.7. Conclusion	54
1.8. Bibliography	56
Part 2. Additive Manufacturing Pushed to its Limits	71
Introduction to Part 2	73
Chapter 2. μ-Fluidics (or Microfluidics)	81
2.1. Introduction	81
2.2. Review of microfluidics	82
2.3. Applications	86
2.4. Return to additive manufacturing	89
2.4.1. Comment 1: LIFT process (Laser-Induced Forward Transfer)	91
2.4.2. Comment 2: FEBID process (Focused Electron Beam Induced Deposition)	92
2.4.3. Other methods	93
2.4.4. Hybrid methods	99
2.5. Conclusive outcomes	100
2.6. The converse problem: a potential μ -fluidics application to additive manufacturing	101
2.6.1. 3D sintering	101
2.6.2. Deposition of polymerized particles	101
2.7. Provisional concept	110
2.8. Conclusion	111
2.9. Bibliography	112

Chapter 3. 3D Nanomanufacturing, 3D μ-Electronics and μ-Robotics	121
3.1. Introduction	122
3.2. 3D nano-facturing.	125
3.2.1. Smart material: so-called “DNA origami”	125
3.2.2. Return from additive manufacturing to standard methods	131
3.2.3. Comment: nanomaterials and additive manufacturing	136
3.2.4. Conclusion	137
3.3. 3D μ-electronics.	140
3.3.1. 2D or 3D electronic circuits.	140
3.3.2. Subtractive/additive coupling	146
3.3.3. μ-Electronics	147
3.3.4. Conclusion and aspirations in the sphere	148
3.4. Actuators and μ-robots	148
3.5. Conclusion.	150
3.6. Bibliography.	151
Part 3. How Should We Go That One Step Further?	163
Chapter 4. A Short Reflection on Spheres to Explore Their Conditions for Achieving Success	165
4.1. Introduction	167
4.2. Favored spheres of innovation.	174
4.2.1. How to know where we must anticipate this technology?	174
4.2.2. Opportunities	179
4.3. Some conditions to ensure additive manufacturing reaches maturity?.	183
4.3.1. Moreover where does additive manufacturing sit within this interdisciplinarity framework?	186
4.3.2. Observations	191
4.3.3. Some possible solutions?	198
4.3.4. Proposed solutions?	200
4.4. A positive conclusion.	202
4.5. Bibliography.	203
Chapter 5. Questions of Hope and “Unhope”	213
5.1. Introduction	214
5.2. The “lab-tribe” (LT) approach.	216
5.2.1. Context elements	218

5.2.2. Some results	220
5.2.3. “Scientific excellence”	227
5.2.4. Financing and the orientation of research	229
5.2.5. Prospective opportunities for the research unit	230
5.2.6. Collective projects? Risky projects?	233
5.3. Creativity’s place in research	237
5.3.1. Support to creativity?	238
5.3.2. But all the same, strong brakes on creativity.	240
5.3.3. What to do?	241
5.4. Innovation, a consequence of creativity.	243
5.4.1. Academic system.	247
5.4.2. Between productions resulting from science and responsible conscience	250
5.4.3. Engagement toward a future focused on innovation?	251
5.4.4. Caught between two chairs? Between more than two chairs?	252
5.4.5. Innovation as scientific production: is it born of freedom? What freedom?	254
5.5. What solutions to evoke for additive manufacturing?	257
5.5.1. General framing	257
5.5.2. And if the history of additive manufacturing in France were examined in light of these comments?	264
5.5.3. A bit of creativity?	275
5.6. In the form of a conclusion: a summary of the author’s point of view	279
5.7. Bibliography.	282
Conclusion	297
Index	301