

3D PRINTING

THIRD EDITION

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PREFACE

BEYOND THE HYPE

3D printing transforms digital models into physical reality by building them up in layers. When the first edition of this book was published in May 2013, the idea of ‘additively manufacturing’ things in this manner had just started to capture the public imagination, with the popular press reporting that it would soon be possible for anybody to 3D print almost anything. Indeed, in another 2013 book called *Fabricated: The New World of 3D Printing*, Hod Lipson and Melba Kurman wrote that the field was moving ‘faster than the speed of light’, with technological advances taking place ‘in huge leaps and bounds’.

By the time that the second edition of this book was published in November 2014, the mainstream appraisal of 3D printing had changed dramatically. To industry insiders it remained clear that innovations were accruing at a steady pace. But the popular perception was that all of those claims made in 2013 had been no more than hype. Most journalists subsequently abandoned ship, apparently surprised that personal fabricators capable of producing anything they could imagine were not yet on sale. Since late 2014 investors have also been spooked, with the share prices of many 3D printing companies having fallen dramatically.

The now-widespread view that 3D printing has been over-hyped remains to the field’s detriment. As one of those who

strove to bring 3D printing to mainstream attention, it is also a matter that I feel a need to specifically address. Back in 2013, I gave the first edition of this book the subtitle *The Next Industrial Revolution*. It is therefore not a surprise that, a year or so later, I ended up in the firing line of those journalists and academics who believed that false hopes had been raised.

While labelling 3D printing as the Next Industrial Revolution, in both the first and second editions of this book I nailed my futurist colours to the mast in a fairly precise manner. Specifically, I noted that:

. . . 3D printing is not going to replace all forms of traditional manufacturing. 3D printing will be ‘revolutionary’ even if it changes how perhaps 20 per cent of things are manufactured, transported and stored. The key thing for us to try and foresee is therefore just which industrial activities 3D printing is most likely to ‘revolutionize’, as well as those which are more probable to remain untouched.

The idea that a technological development should be labelled ‘revolutionary’ if it changes how 20 per cent of things are manufactured, transported and stored is, I think, a very reasonable proposition. Back in 2013, I was also very strongly of the opinion that, within two decades, 3D printing would be used directly or indirectly in the manufacture of about 20 per cent of products. Occasionally in 2014 and 2015 I did start to believe the naysayers and to doubt whether this will actually occur. But the more that I study the development of 3D printing technologies and the 3D printing industry, the more convinced I become of my previous ‘20 per cent in 20 years’ prediction. Today, I am therefore once again staunchly of the view that a 3D printing revolution is on the cards.

There are two reasons that I have cast my doubts aside. Firstly, it is clear that the composition of the 3D printing industry is in transition. For its first few decades the sector was dominated by ‘pure play’ startups – like 3D Systems and Stratasys – who created and brought to market the world’s first 3D printing technologies. Such companies also continue to innovate. Yet they are no longer alone, with very large, traditional manufacturing corporations – including Canon, Groupe Gorgé, HP, Kinpo, Ricoh and Toshiba – now entering or about to enter the fray. These companies are already bringing a great deal of financial and innovative muscle to the table, and will subsequently help to make 3D printing more widely utilized and cost-effective. The fact that all of these firms have chosen to enter the marketplace *since 2013* also has to signal their belief in a large and profitable near-future 3D printing industry.

The second reason for my rekindled faith is the continued invention of new technologies. Not least, in May 2016 a 3D printing method called nanoparticle jetting (NPJ) was showcased by Israeli pioneer XJet. As we shall see in chapter 2, this can directly produce highly accurate metal parts via an inkjet-style process. Nanoparticle jetting may therefore prove transformative in the low-run production of certain metal components. Even more significantly, the very recent announcement of nanoparticle jetting ought to provide a powerful reminder that the 3D Printing Revolution is likely to be based, at least in part, on technologies and processes that are yet to be invented. There are going to be many more watershed innovations in the next 20 years.

In 1939 the first TV sets to go on sale in the United States were showcased at the World Fair in New York. These early TVs cost between \$200 and \$600 (or about the same as an automobile), and had rather fuzzy, five inch, black-and-white screens. Most of those who attended the World Fair subsequently dismissed television as a fad that would never

catch on. After all, how many people could reasonably be expected to spend a large proportion of their time staring at a tiny, flickering image?

The mistake made by those who dismissed television in 1939 was to judge a revolutionary technology on the basis of its earliest manifestation. Over 75 years later, those who believe that 3D printing has been over-hyped are in danger of making exactly the same error. Current 3D printing methods are certainly far too niche, too slow and too costly to change the world. But this will not stop next generation technologies from transforming the manufacturing landscape.

With this last point firmly in mind, the goal of this book is to explain the practicalities and potential of 3D printing both today and in the future. From the outset, I am unashamedly assuming that 3D printing will help to drive a revolution in local, on-demand and highly customized manufacturing. Even if you disagree, I trust that you will find my work a valuable guide to the 3D printing industry, its current technologies, and their existing applications. But over the following seven chapters, I hope to more broadly convince you that we stand on the brink of something very special indeed.

Christopher Barnatt,
November 2016.

THE REST OF THE BOOK

The remaining contents of this book are as follows:

Chapter 1. The Revolution Continues

Explaining the benefits of 3D printing and its four key marketplaces.

Chapter 2. 3D Printing Technologies

Detailing every additive manufacturing method on the market or in the lab.

Chapter 3. The 3D Printing Industry

Analyzing the leading printer manufacturers, software providers and services.

Chapter 4. Direct Digital Manufacturing

Reporting on those pioneers who are already 3D printing final products of parts thereof.

Chapter 5. Personal Fabrication

Overviewing personal 3D printers, personal 3D scanners and the Maker Movement.

Chapter 6. Bioprinting

Exploring how organic 3D printing may transform medicine and manufacturing.

Chapter 7. Brave New World?

Predicting the future of additive manufacturing technologies and the 3D printing industry.

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