

## **ASK NOT WHAT ADDITIVE MANUFACTURING CAN DO FOR YOU...**

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### **Abstract**

The paraphrase of John F Kennedy's famous words is for 2 purposes. Firstly it is to acknowledge that there are some people who have considered that it is a major part of their life's work to promote Additive Manufacturing (AM) technology as primarily a selfless act. AM comprises an outstanding range of technology that should be brought to public attention as a true revolution in how we design and manufacture products. The second purpose is to show that technology development is only one part of this promotion process and that there are other ways in which we can get involved.

This paper describes the author's journey over the (approximately) 20 years since he was introduced to what was then called Rapid Prototyping (RP). It is not a catalogue of research and development projects but rather a list of activities that he has been involved in to help promote and support AM technology over these years. It will describe the conferences, activities, associations and publications that have been created to allow academics and professionals to describe and discuss their work amongst themselves and to the larger society.

### **Introduction**

The motivation for preparing this paper has much to do with the Solid Freeform Fabrication Symposium. Prof. Dave Bourell and his associates at UT Austin are a prime example of the underlying message. If it were not for the selfless organisation of the SFF over all these years, the whole AM community would be considerably poorer. This year (2012), one new objective of this symposium is to explore a new area within the (normally very research oriented) SFF with the assistance of Terry Wohlers, of AM in the wider community. Terry is another prime example of selfless contribution to the AM community. This is not to say that Terry and Davie are completely unknown and uncelebrated for their contributions, but we should also acknowledge that the AM community is very fortunate to have both of these individuals.

It is not the author's intention to try and place himself amongst these lofty individuals; that is for others (and time) to determine. The intention is that by showing how he got involved in different activities, then anyone can. The approach is to follow a timeline that covers his movement over the last 20 years from Nottingham, where he first learnt about Rapid Prototyping, to Singapore where he is now. It is a personal account that pays much tribute to those individuals the author has had the privilege to work with. There have been many more and

no apology is made for omission, but those who are named have had a significant impact on his career in AM.

### **The Early Years: Nottingham (1991-4)**

Tribute must be specifically paid to Phill Dickens, who introduced the author to Rapid Prototyping and who was highly instrumental in the early development of the technology within the UK manufacturing industry, and to a certain extent within much of Europe as well. The latter in particular (in the early years at least) relates to the ‘Nottingham Conference’ (European Rapid Prototyping Conference), which he set up and was the first regular Rapid Prototyping conference in Europe. In the early days this conference was like a hybrid of the SFF and the SME Rapid conference, combining the best of both elements and latching on to the fact that industry and application was key to the sector growth in Europe, rather than the technology itself (like perhaps in the US). Whilst there are a few notable technology milestones in Europe, the European industry has really leveraged on US technology.

The Nottingham conference (of which the author helped organise the first two and which was not always held in Nottingham), served the purpose of providing a focus for those wishing to research into RP and for industry to prove that there was a future for the technology. Europe therefore developed an outstanding reputation for application-based systems for tooling, casting and short-run production solutions; in some ways even better than those in the US. After a few years, the importance of this conference dwindled: Euromold took over as the main European industry show and there became numerous outlets for academic work. It was not the prevailing influence in academia that the SFF was, but it certainly served its purpose.

For academics, journal output has always been a vital performance indicator and with this new manufacturing technology the question started to be asked about where to publish. Certainly there are numerous high quality journals that can provide an outlet for research into materials, processing, software and management. However, when still at Nottingham University, Ian Campbell and the author decided that since there appeared to be an increasing interest in working with these machines, there was definitely room for a journal of Rapid Prototyping.

We investigated a few possible publishers and quickly opted for MCB University Press, who at the time were trying to expand their technology range and who were also very keen on having us on board. I particularly liked the Journal of Integrated Manufacturing Systems (edited by David Bennett), which was one of their titles, and modeled much of the Rapid Prototyping Journal on this. The only real impediment to the journal stemmed from the fact that MCB, who later became Emerald Publishing, were not used to science and engineering journals. It therefore took some time to convey on them the importance of an SCI impact factor and it took more than 10 years before they relented. Whilst the impact factor has see-sawed around 1.0 (which is quite high for a manufacturing journal), the RPJ has been very successful and is firmly established as the top journal for Additive Manufacturing. Readers may be interested to note that the H-Index for the journal is presently around 45, which is extremely healthy. Whilst there are a number of journals now focusing on AM (Journal of Rapid Manufacturing, Virtual and Physical Prototyping, etc.), which are all good journals and fill important gaps in the publishing sphere, it is hard to see why the RPJ should not remain the main outlet provided Ian, Dave (the most recent

US editor after Brent Stucker, who joined a few years after the journal was established, to help deal with the increasing paper load, allowing us to assume regional editor roles) and the author maintain a good ship.

### **The Formative Years: Hong Kong (1994-2005)**

Transferring to Hong Kong University was, like many career choices, a serendipitous rather than calculated move. It turned out that there was little interest in RP at the time of arrival in 1994 but there was excellent support for anyone prepared to put in the effort. This was how the author came to acquire one of the first Selective Laser Sintering (SLS) machines in Asia. The author's enthusiasm for RP was quite intense at the time and the connection to the RPJ enabled him to quickly develop a reputation within Asia.

In 1997 the author and his colleagues organised the 2<sup>nd</sup> Int. Conf. on Manufacturing Automation, ICMA. This allowed them to bring Terry Wohlers over to Hong Kong to present a keynote. A conversation with Terry at the time covered how it may be possible to promote and develop the RP community. The author had just been involved in establishing the Hong Kong Rapid Prototyping and Tooling Association, which aimed to promote the technology in the region. Considering that this association would have grown faster and with greater credibility if it were somehow connected to similar organisations around the world, the idea of GARPA was born.

The Global Alliance of RP Associations has served a purpose in adding value to conferences and allowing fledgling associations to leverage from overseas connections to make it easier to establish themselves. Completely free, voluntary and non-profit, its operations have been limited but nonetheless useful. Starting with around 11 member associations, GARPA has grown to include around 25 countries. Terry Wohlers has been the main instrument of this development but special mention should be made to Deon de Beer (South Africa), Paulo Bartolo (Portugal), Alain Bernard (France), and Olaf Diegel (New Zealand), who have all devoted significant amounts of time and effort to supporting GARPA over the years.

It is probably at this time that the benefits of promoting AM through writing as well as organising activities should be mentioned. Connections with Terry have allowed the author to write about AM in Asia in the Wohlers Report over the years. Increasing interest in this region due to the strengthening economies has made this article more important in recent years. Whilst at Hong Kong University the author organised and wrote 2 research texts that explored specialist RP technology areas. The first one was on Software Solutions for RP, which at the time was perhaps somewhat overlooked in importance with most people focused on developing materials and processes. Later, medical applications were emerging in importance and so a text on Advanced Manufacturing Technology for Medical Applications was written. Both these texts were developed using a workshop format, where chapter authors gathered together (the software book workshop was in Hong Kong but the medical book was held in Singapore) to discuss how their work would combine with others to form a successful book. The workshop itself can prove to be a rewarding experience, even without the resulting book.

## **The Maturing Years: Singapore (2005-)**

With advancing years you tend to feel an obligation to support those causes and people that you feel deserve it and your attention. One thing that seemed to be missing from all the literature available on AM was an effective teaching text on the topic. Whilst there have been some reasonable attempts at producing such texts, there was nothing aimed at high-level graduate and postgraduate education. Brent Stucker, Dave Rosen and the author all found that they were working on a similar teaching text at roughly the same stage of completion. It seemed logical to combine efforts, which resulted in the Additive Manufacturing textbook that seems to have become quite successful with approximately 1000 copies sold and over 65 academic citations to date according to Google Scholar.

The author has been involved as a speaker in many AM conferences over the years. Besides the SFF, he has regularly attended the regular biennial European conferences held in Portugal and Slovenia and the yearly South African RAPDASA conference. The people involved in these conferences have the same drive and commitment of Phill Dickens and Dave Bourell to ensure that AM is at the forefront, with high quality presentations and stimulating dialogue.

The collaborations with Paulo Bartolo in Portugal and Deon de Beer in South Africa have led to long-term involvements with their respective institutions. The author is proud to be a visiting researcher at the Centre for Rapid and Sustainable Product Development at IP Leiria in Portugal and will shortly become a visiting Prof. at Vaal University of Technology, South Africa. Both these institutions are worthy of support. Despite the relatively low academic ranking of these institutions (according to worldwide published metrics – not always the best way to judge an institution), both are involved in ground-breaking work, particularly the medical and other research at IP Leiria and the community development programmes using low-cost AM technology at the South African I2P Labs, pioneered by Deon de Beer.

This concept of AM supported laboratories for the general public is something the author first saw in South Africa more than 5 years ago and has fully supported since. Attempts have been in vain to implement something like this in Singapore for a long time. However, changes in engineering teaching philosophy at NUS has at least achieving part of this goal. Whilst not available to the general public, the Engineering Design and Innovation Centre allows engineering students from any discipline and year to access this technology in a product and systems development programme called the Design Centric Curriculum.

## **Conclusion**

In summary, it is possible to get involved in supporting the AM community in a variety of ways: -

- Journals: whilst it may not often be possible to start something like the RP Journal, it is possible to become a reviewer. Willingness to review leads to guest editorships and invitations to be Editorial Advisory Board members.
- Books: there are an increasing number of books being written. Adding chapters is a common approach if you do not have enough material for a full book.

- Conferences: it is becoming common to not attend conferences and focus on journal articles. I maintain that it is vital to establish a reputation through conference attendance as part of a career development strategy.
- Centres: AM is a multidisciplinary field that must also involve industry at a close level. Development of resource centres of excellence using AM as a focal technology is an excellent way to promote its versatility. Being involved in centres in other countries can also be a mutually beneficial activity.
- Blogs, Facebook, LinkedIn, etc.: Whatever you call them, you could take advantage of the various methods of mass social communication to reach out to the wider community as a form of AM ambassador.

The importance of associating yourself with other active individuals in the field cannot be stressed enough. This is generally done by agreeing to help each other in some way, like writing joint articles, collaborating on projects or just promising to attend each others' conference or workshop activities. Whilst it does help to have a team at your home institution, one can make significant contributions as an individual.

Of course, the critical activity will always involve quality research work, direct collaboration with industry, and (at least for tertiary education institutions) teaching. Being open and willing to get involved in 'indirect' activities is also a very important secondary process that may ultimately reap large rewards if you stick at it long enough.

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