Solid Freeform Fabrication Symposium, An Overview

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In 1990 it was apparent to many of us that Solid Freeform Fabrication(SFF) was going to move forward dramatically as the newest way of doing manufacturing for many applications. With this paper at the 25th SFF Symposium I hope to define many of the reasons this was true and the many factors that were being driven to make it happen. The 1990 Solid Freeform Fabrication Symposium was a clear attempt to bring out to the public the potential that SFF approaches were starting to have and the future of these approaches. ONR started its effort supporting the area in this symposium. This first SFF Symposium followed a meeting in Austin in 1989 involving about a dozen of us that were addressing approaches to freeform manufacturing. The long term growth in this activity is clearly represented by the attendance at this meeting of about 40 in 1990 to over 300 now in 2014 and the 1990 Proceedings of 187 pages going to the 2013 Proceedings of 1087 pages. The SFF meeting during the 25 years has emphasized what were the newest approaches and related problems related to advancing freeform fabrication. It should be clearly noted here that there are now many other meeting primarily based on the applications of freeform fabrication. One of the meetings that started early in the freeform game, 1992, and continues to the present is the Nottingham meeting in Great Britain. An early paper[1] in 1987 indicated "The concept of SFF presents a new interdisciplinary frontier in manufacturing research." It should be noted many of the researchers at the time considered the research area Rapid Prototyping and more recently the field has be identified as Additive Manufacturing. The significance of the SFF meeting and its importance in the area are clearly described throughout the second reference[2] which details NSF involvement. Reference

three gives an overall assessment[3] of the long term development of Additive Manufacturing.

The impact that SFF was projected to have was described in a 1993 publication[4] where the figure below was presented. It was this type of thinking that sustained the SFF Symposium early in its development and over the years.

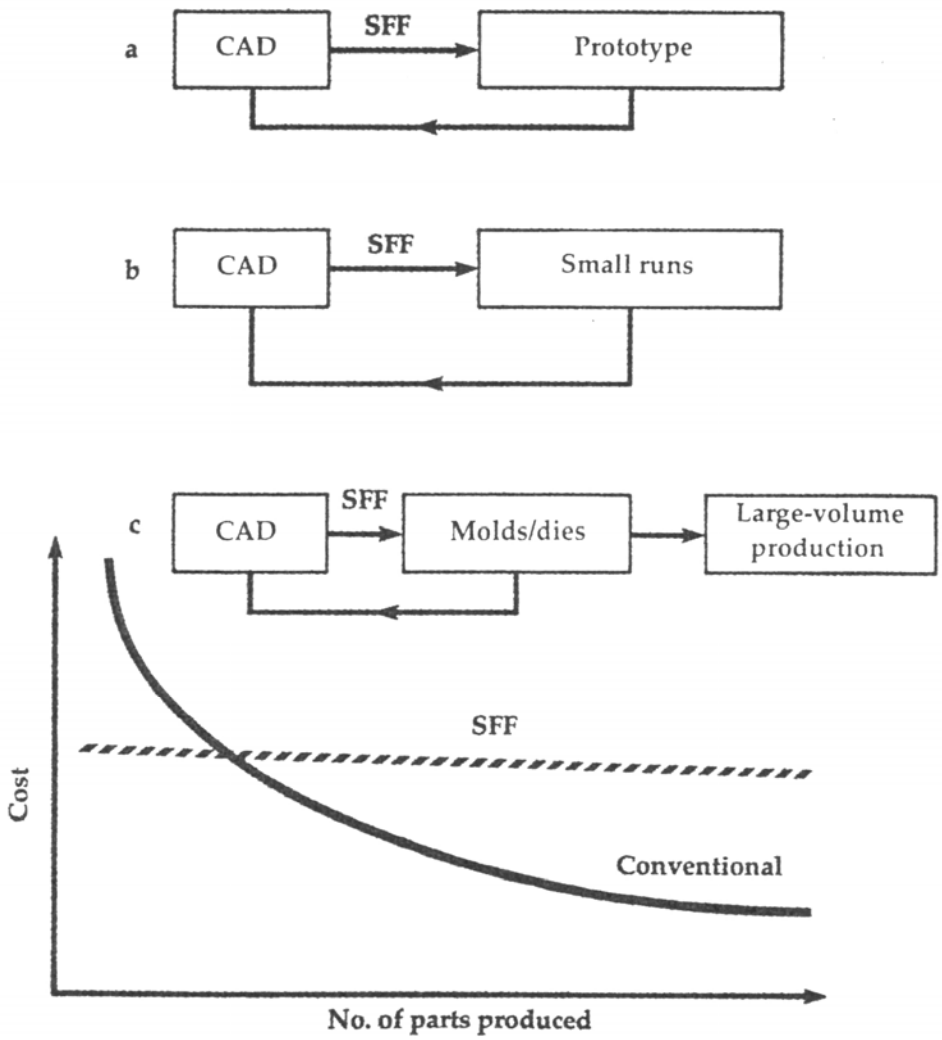

Figure 1

This figure showed the thinking of how SFF was to evolve. The first impact was to make prototypes that were not necessarily structurally sound. This is what led many to describe these new

approaches as “Rapid Prototyping”. When the technology reached the point that SFF could produce structurally sound parts it would then be possible for it to be the choice of manufacturing small numbers of parts. The initial successes were with polymer parts but it was truly believed that structurally sound metal and ceramic would be produced as the technology advanced. Initially to address large volume runs it was projected that SFF would be used to produce the molds/dies that are used to produce large numbers of parts. It was recognized then that the time using SFF approaches to produce new molds/dies would be much less then it was taking at the time that it would allow making small changes in design much more realistic. Ultimately the lower part of Figure 1 shows what was bound to control how far SFF would go, the cost per part. As plotted it showed that for small numbers the SFF approach would be least expensive. The key cost was to be the cost using SFF. The assumption that the cost per part for SFF was basically constant was based on have an SFF machine that could be used for any part and the cost of the machine was factored in for all the parts it would produce, either small in number or much larger. This then led to the advantage of the conventional approaches in cost when many parts were to be made using the molds/dies etc. that were used to produce them. Of course many other variables must be considered such as part size and material to be used.

Not incorporated into Figure 1 was the thinking that SFF approaches integrated into the design process would allow parts to be made that would be very difficult if not impossible using conventional approaches. All of the above were recognized by many of us early in the game and drove the sustained development in approaches that is still occurring.

Another aspect of the first couple of SFF Symposium presentations and papers was the openness with which those involved in terms of describing the technical approaches they

were using. Usually in a developing technology people try to hind there approaches for their advantage. Since all approaches to SFF at the time had the same ideas on what was trying to be accomplished they were willing to give out more on their approaches so all could learn how to address the myriad of new issues associated with the SFF approach to manufacturing. To a large extend this has seemed to continue as new approaches are presented the the SFF Symposium.

In that paper several of the early approaches to SFF/Rapid Prototyping were described and were represented in the early SFF Symposium. Included were Stereolithography, the approach that went commerciallized by 3D Systems; Selective Laser Sintering, commercialized by DTM Corporation; Solid Ground Curing, Cubital America, Inc.; Three-dimensional (3D) printing, commercialized by Soligen; Laminated Object Manufacturing, Helisys Inc.; Fused Deposition Modeling, Statasys, Inc.; and Recursive Mask and Deposit Process, Carnegie Melon. These approaches set the tone for the sustained development of approaches to additive manufacturing.

To summarize the first Solid Freeform Fabrication Meeting is to indicate that the reasons for having the meeting was to clearly indicate the approaches that were available to make it happen. This was successful and has continued to be the driving force for continuing the meeting throughout the consecutive twenty five years it has been offered. The continuing progress on approaches for SFF in the future promise to make the meeting valuable for many more years.

References:

1-Solid Freeform Fabrication and Selective Powder Sintering, Carl R. Deckard and Joseph J. Beaman, 15th North American Manufacturing Research Proceedings, May 1987.

2-TheRole of the National Science Foundation in the Origin and Evolution of Additive Manufacturing in the United States,

Christopher L. Weber, et. al. IDA Paper P-5091, Science and Technology Policy Institute, November 2013.
3-History of Additive Manufacturing, Terry Wohlers and Tim Gornet, Wohlers Report, 2014.
4-SOLID FREEFORM FABRICATION, Finds New Applications, Harris L. Marcus and David L. Bourell, Advanced Materials and Processes, 1993, pp28-35.