Low volume, agile, additive manufacturing and capital costs.

Rutter, A. Sharma, V. November 2014

Abstract:

As the industry transitions from rapid prototyping to rapid production technologies [1]. Low cost, high quality Free Form Fabrication machines such as the Type A Machines Series 1 become viable alternatives to conventional injection molding services. The following is a comparative study among low volume injection molding services, external service bureaus (using multiple machine additive manufacturing systems), industrial additive manufacturing systems purchased for internal use, and low cost (sub $5,000) multiple machine additive manufacturing systems such as the Series 1 3D Print Cell. To answer the question, can Additive Manufacturing Clusters compete With Injection Molding?

Key Factors:

- A new wave of multiple machine additive manufacturing systems, such as the 3D Print Cell, comprised of units in the $2500-$5000 range can compete with existing industrial additive machines ($30-60k) and so must be considered as viable alternatives.
- New additive manufacturing tools change the game, due to substantially lower capital investment costs, and can offer productivity rates of 10-20 times greater than that of existing industrial systems for similar capital expenditure.
- In analyzing the costs per part, this paper assumes that the machines are purchased. So while a low cost service bureau is included for comparison, the

analysis should also consider that an in-house production capability is assumed as part of this projection.

This white paper does not analyze the following additional advantages:

- In-house additive manufacturing allows direct control of lead times and other aspects of production.
- Additive manufacturing restructures risk within business planning, by removing tooling costs and therefore the risks otherwise inherent to iteration and innovation.
- High volume production of identical parts will be more cost effective using traditional highly optimized processes (part volumes of over 10,000).
- Additive manufacturing can produce part geometries that traditional manufacturing cannot, often in materials that are difficult to work conventionally.
- The tooling costs of Injection molding can dramatically increase when changes are required, or when complexity is high.

Data:

The following data is based on a sample of three different 3D printed parts. Using tooling and part costs from a rapid turnaround, low cost injection molding service. And print times generated from Type A Slicing software to calculate amortized per part costs.

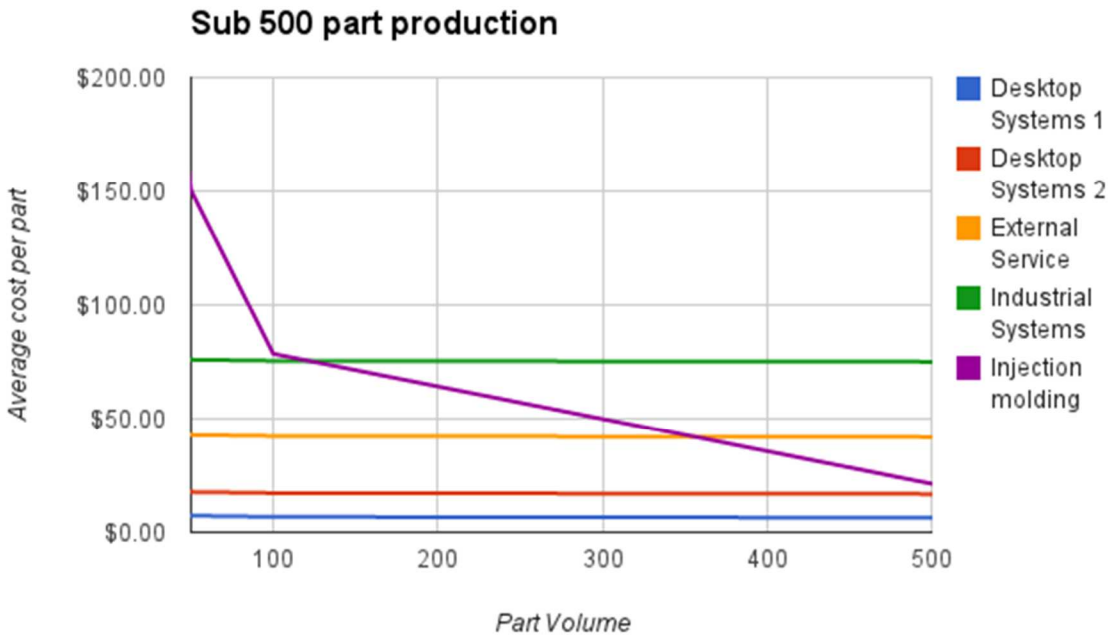

Figure 1.

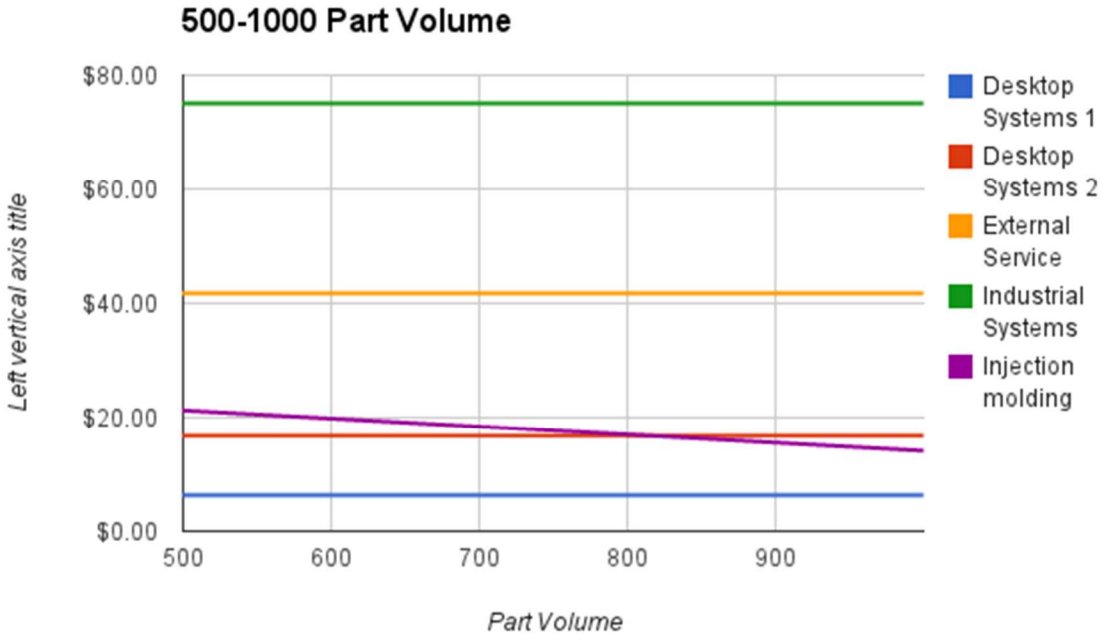

Figure 2.

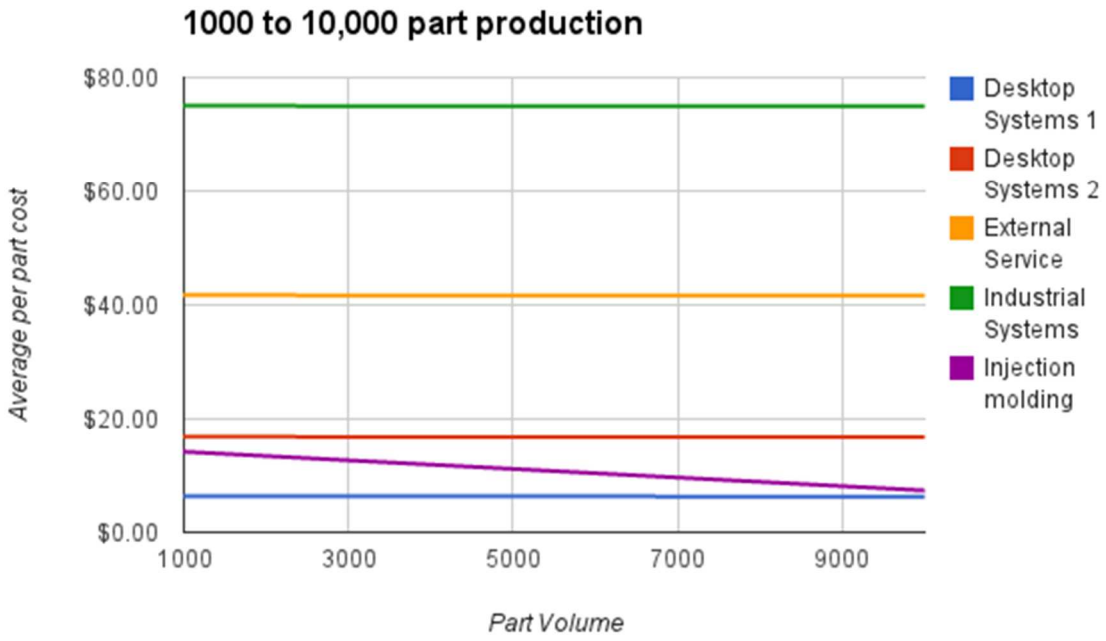

Figure 3.

Diagram Information Figures 1-3:

Injection Molding
Volume costs drawn from average quotes from injection molding service bureaus.

Industrial Systems
Machine cost of $60,000, amortized over 1 year with projected 3,900 hour annual usage. 1/10th person operator burden (1 operator for 10 systems).

External Service
An external service bureau at $10/hr (current market rate for low-cost services).

Desktop 3D Print Cell Systems 2
Machine cost of $2795 and identical usage and labor to industrial systems

Desktop 3D Print Cell Systems 1
Machine cost of $2795, identical usage, but more efficient labor (20 machines per operator and 50% ‘lights-off’ running).

Analysis:

The reality that 3D printing outperforms injection molding is not surprising in the sub 100 part volume. With all classes of Additive manufacturing being significantly cheaper on a per part basis than injection molding. However the much higher capital costs of the additive industrial systems mean that they cease to be price competitive at volumes between 100 and 200.

Most people would be surprised to see that even an external service bureau can be competitive out to around 350 parts.

With the dramatically lower costs per part that can be realized with an in-house 3D Print Cell, additive manufacturing is cost competitive out to around 800 parts.

And with the labor savings that can be realized with reliable, network managed machines like the Series 1, its possible for additive manufacturing to be cost competitive out to 10,000 units. This is the kind of volume production that most people would have thought impossible.

Further comparison:

These projections do not cover the following factors that must be considered when comparing 3D Printer Cell systems with industrial additive manufacturing:

- Material costs are typically 4 times greater for industrial systems.
- The dramatically lower cost of a 3D Print Cell system means that for similar investment ($60,000), a cell of 20 systems can be purchased in comparison to a

single industrial system. This allows for far high rates of production, more efficient use of labor, and better resilience to failure.

- A number of small manufacturers are already switching to low-volume production using multiple machine additive systems, reaping benefits like being able to ship a product as early as possible that meets minimum function, and then iterating during production to make their product even more competitive.
- The accessible nature of multiple unit 3D printer systems such as the 3D Print Cell must also be considered. With custom applications, modifications to machines and proprietary materials all being seen and used successfully by customers of Type A Machines. These are all options that are not available when working with industrial additive systems.

References:

[1] Bak, David. "Rapid prototyping or rapid production? 3D printing processes move industry towards the latter." *Assembly Automation* 23, no. 4 (2003): 340-345.

Sharma, V., Rutter, A., Type A Machines (2014). Injection molding comparison model with Series 1 3D Printers compared to Industrial printers [Raw data]