Intersect360 RESEARCH

Modeling and Simulation among U.S. Manufacturers: The Case for Digital Manufacturing

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Comprehensive Research Study, in partnership with NCMS

This executive summary is presented as an overview and excerpt. The full report, data set, and analyst inquiry time are available from Intersect360 Research.
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EXECUTIVE SUMMARY

Overview

In partnership with Intersect360 Research, the National Center for Manufacturing Sciences (NCMS) conducted a broad-based survey of U.S. manufacturers regarding the current state of digital manufacturing technologies and the drivers and barriers to expanding adoption. This study reveals the desire and potential benefits of digital manufacturing for a broad range of companies, particularly the assistance needed by small and medium-size manufacturers (SMMs) and the partnerships they would seek.

The web-based survey received 321 qualified respondents from the U.S. manufacturing community. 258 (80%) of respondents came from some industrial or commercial manufacturing sector, with the other 63 (20%) coming from the supporting communities in academia, government agencies, or trade organizations. (See Table 1.) All respondents were asked a foundation of questions concerning the drivers and barriers to the adoption of advanced technologies. Commercial organizations were asked additional questions about the role they play in product design and the current level of digital manufacturing technologies they have deployed, among other topic areas.

Digital manufacturing is the use of advanced computing technologies to employ modeling and simulation techniques for engineering, testing, or design purposes. By creating a digital model of a product, a manufacturer can perform a wide range of tests, such as manufacturability analysis or performance testing, before physically building a new design. Some of the potential benefits are improved product quality, shorter time to market, and reduced manufacturing costs.

Table 1: Survey Participants by Industry / Sector
Source: Intersect360 Research, NCMS, 2010

Industry / Sector	Count
Aerospace	47
Automotive	31
Consumer Products	5
Defense / Homeland security contractor	49
Health Care / Pharmaceuticals	2
IT and electronics	14
Other (industry)	110
Total industry	**258**
Academic	12
Government agency	30
Other (non-industry)	11
Trade or industry association	10
Total non-industry	**63**
TOTAL	**321**

The largest automotive, aerospace, and heavy equipment manufacturers in the U.S. have used high performance computing (HPC) technologies[1] for digital manufacturing for decades. In fact, large-product manufacturing is the largest consuming commercial vertical market for HPC.[2] Application areas at these companies run through the full cycle of computer-aided engineering (CAE), from conceiving new products to failure testing and maintenance of older ones.

Intersect360 Research estimates about half of CAE usage at automotive and aerospace companies to fall into various categories of solids testing and engineering, including concepts such as structural analysis and crash testing. About half of the rest goes to computational fluid dynamics (CFD), including aerodynamics testing in virtual wind tunnels. The remaining workflow is mostly spent on environmental analysis, such as noise, vibration, and harshness (NVH) testing, but also on process engineering, statistics analysis, and other tasks.

Despite the wide range of available applications and the well-established precedent of large companies successfully employing scalable HPC for engineering, there is a significant gap between the digital

[1] High performance computing (HPC) is the use of servers, clusters, and supercomputers – plus associated software, tools, components, storage, and services – for scientific, engineering, or analytical tasks that are particularly intensive in computation, memory usage, or data management. HPC is used by scientists, engineers, analysts, and strategic information gathers, both in research and in production, across industry, government, and academia.

[2] Intersect360 Research HPC market advisory service, "Intersect360 Research Traditional HPC Total Market Model and Forecast: 2010 to 2014," July 2010.

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manufacturing capabilities of large manufacturers at the deployment (or lack of deployment) at SMMs. Table 2 shows a breakdown of usage of digital manufacturing technologies among commercial respondents, by number of employees.

In this table, "Mod/Sim HPC" represents respondents who said they run modeling and simulation applications on scalable systems – usually clusters of servers. "Mod/Sim Desktop" represents respondents who are running these digital manufacturing applications, but at the desktop (PC or workstation) level only, not on larger systems. "3D Tools" is users of 3D drawing, usually computer-aided design (CAD), on desktop systems, but not modeling or simulation, and "2D Tools" includes respondents doing CAD only in 2D, or not at all.

Table 2: Digital Manufacturing Usage among Commercial Respondents, by Number of Employees[3]
Source: Intersect360 Research, NCMS, 2010

	Mod/Sim HPC		Mod/Sim Desktop		3D Tools		2D Tools		Total	
Employees	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
1-20	4	6.1%	15	20.8%	17	25.0%	23	56.1%	63	24.4%
21-100	5	7.6%	11	15.3%	22	32.4%	12	29.3%	51	19.8%
101-500	5	7.6%	15	20.8%	12	17.6%	3	7.3%	35	13.6%
501-2000	9	13.6%	8	11.1%	6	8.8%	0	0.0%	24	9.3%
2001-10000	6	9.1%	6	8.3%	7	10.3%	1	2.4%	20	7.8%
10001 or more	37	56.1%	17	23.6%	4	5.9%	2	4.9%	65	25.2%
Total	**66**	**100.0%**	**72**	**100.0%**	**68**	**100.0%**	**41**	**100.0%**	**258**	**100.0%**

Overall respondents were spread fairly evenly by employee size, with less than a one percentage point difference between the smallest category (one to 20 employees) and the largest (over 10,000). However, their digital manufacturing levels are markedly different. Over half of HPC users (56%) came from the largest company size category, while over half of those not even employing 3D visualization (the same percentage, 56%) came from the smallest companies. Overall, 40% of survey respondents had 100 or fewer employees, but of the HPC users, less than 15% were below this threshold.

Viewed another way, overall there were 109 respondents from companies with 100 or fewer employees (and also specifying a level of technology deployment). Only nine of those (8%) reported any HPC usage. From the 60 responding companies with over 10,000 employees (not counting five unspecified levels), 37 (61%) reported using HPC.

This disparity exists despite an apparent need for digital manufacturing technologies, even among small companies. Of the 135 responding organizations (both commercial and non-commercial) who had 100 or fewer employees/members, 80 (59%) were solely or mostly responsible for product design, as opposed to being reliant on a customer or partner for the design.

Furthermore those using only 2D tools still see a need for improvement. They significantly cited "high product quality" as the characteristic most critical to their companies' core business strategies, and they indicated "long development cycle" as the most common limitation to their development and production processes. Cost of these systems, including both hardware and software, is certainly one of the factors in limiting adoption, but it is far from the only one. Lack of expertise, either internal or external, is also significant, as is the coordination of digital and physical processes.

[3] "Total" column is not an exact sum of other columns due to a small number of respondents who did not specify a level of technology usage.

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Some critical insights came from companies who are doing modeling and simulation at the desktop level. 46 out of 64 (72%) felt that increased adoption of advanced computational methods would lead to competitive advantage for their companies, and 51 out of 62 (82%) felt there should be greater opportunities for companies like theirs to be able to test new technologies at lower cost and lower risk. This same group ranked "not-for-profit manufacturing centers" as the venue where they would most prefer to access new or experimental technologies.

Respondents from companies performing modeling and simulation at the desktop level ranked "not-for-profit manufacturing centers" as the venue they would most prefer for accessing new technologies.

Intersect360 Research believes that most small-company managers are risk-averse with regards to new technologies. It is difficult to convince them to invest significant capital and personnel expenses – along with the time and dedication for a multi-year project – into a new area of technology where they have little to no experience. Digital manufacturing capabilities may be a good investment for most of them, especially for those who have a focus on design capabilities, high quality, or fast time-to-market. (HPC may be wasted on a manufacturing company that sees itself only as a follower.)

There is a potential, untapped benefit to digital manufacturing technology usage among U.S. manufacturers, particularly SMMs. For these companies to get over the hurdles inherent in the adoption of advanced technologies, they will seek partners and programs that mitigate risk and help defray costs, so that they can make the investments required to improve their competitiveness technologically.

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