Challenges and Solutions for Electronics and High-Tech Product Development

CIMdata Commentary

Key takeaways:

- *Complex electronics and software are now a critical component of many consumer and business durable goods.*
- *Traditional manufacturing companies must now have high-tech product development competency, which requires managing complex engineering tradeoffs.*
- *A borderless development-information environment is a critical capability for durable goods manufacturing.*
- *End-to-end coverage of the systems engineering process is mandatory for product development information systems.*

High-Tech Product Development Trends

Electromechanical product (e.g., appliances, computers, automobiles) market leadership now requires that those products be digital and interactive, communicating with people and other devices, connecting to the Internet, incorporating sensors, collecting data, displaying more information, and being autonomous, among a host of desired features. Approximately 40% of CEOs believe technology will have the biggest impact on their organization in the next 3 years.[1]

Mainstream manufacturers must now have high-tech product development competency to compete successfully. Even home appliances are becoming high tech. Ten years ago, for example, washing machines were electromechanical units with simple motors, transmissions, and mechanical timers. Now a modern washing machine is a sophisticated blend of sensors, electronics, and over a million lines of software code. This sophistication is necessary to deliver the differentiated consumer experience that drives purchases, while meeting other design requirements such as government regulation compliance.

Consumers and businesses alike demand and expect products that perform flawlessly; provide continually improving experiences; anticipate their needs; are small and lightweight; and are fast, interactive, and simple to operate. This is nothing new. But the standard for excellence is ever higher because of global competition and continually growing high-tech competency. Of course manufacturers must still engineer products that have superior capacity, energy use, usability, aesthetics, vibration and noise limits, among other attributes.

The complexity of these products requires manufacturers to have engineering competency in a wide range of areas including software, mechanical, structures, electrical, electronics, fluids, thermal, airflow, vibration, and noise. Blending this knowledge to meet requirements, solve problems, and make technology tradeoff decisions is difficult but is also a critical necessity for business success.

[1] Source: IBM, “Capitalizing on Complexity: Insights from Global CEO Study” 2010

Leading manufacturing companies now provide great products by:

- Delving deeply into the experiences that customers desire. They seek insight not simply on product attributes, but on the aggregate experience and derivative perceived benefits. Not only do they want to know the preferred physical sensations such as touch, feel, and appearance, but also how they affect customer emotions and actions.
- Using big data to uncover hidden preferences that customers have for their products and for other similar products.
- Decomposing customers' insights and experiences into actionable product attribute targets, such as performance, capacity, energy consumption, and usability.
- Automating the distribution of attribute specifications across software, electronics, and mechanical system design teams simultaneously.
- Using qualitative and quantitative analytics systems to clarify tradeoff decisions on how design targets will be met whether by software, electronics, mechanical, or some other means.
- Using a combination of workflow and social collaboration tools to shorten development cycles while meeting the challenge of complex, simultaneous, globally distributed development.
- Real-time assessment and monitoring of design and manufacturing costs.
- Virtual simulation of product prototypes to accelerate fine-tuning and lower development costs.

High-tech manufacturing companies must build a critical mass of knowledge in the organization, and must bring this multi-disciplinary knowledge together quickly in order to make the tradeoff and product decisions that result in a profitable product.

Many manufacturers are trying to become high-tech product development companies, but their processes are based on a traditional phase-gate method, which is not particularly well suited to high-tech product development. Many companies have evolved with a tradition of developing strictly mechanical or electrical products and are not as efficient as they should be for high-tech product development. Further, they often rely on outdated and manual processes, methods, and systems.

In a collocated environment, combining complex knowledge, managing the tradeoffs, and solving engineering problems can be fairly straightforward. It takes place through an informal, reciprocal, and iterative process of interaction, bolstered by shared context and norms, and the language of a single location. The knowledge is typically "pulled" by a person approaching another person and asking questions, and interacting as the knowledge is delivered, exchanged, and built upon.

However, modern manufacturing leaders now depend upon globally distributed skill centers to gain cost and competency advantages. Processes and tools developed for collocated development are insufficient for this new global development model. When product development innovators are separated by distance, time, and culture, communication and collaboration become serious challenges. The process of setting, evaluating, and tracking product attribute tradeoff decisions across the many engineering disciplines is chaotic and error prone. Product flaws can unknowingly be introduced. Duplication of effort becomes

common as people develop the same knowledge in different locations. Rework increases as people discover problems due to disconnected decisions. For most high-tech companies, the result includes higher-than-expected product costs, missed customer expectations, poor product performance, and other product launch issues.

Information Technology for High-Tech Product Development

The evolving capabilities of social media applications can help to provide the same real-time communication possible with collocated product development teams. The resulting collaboration improvement enables high-tech companies to increase product complexity and thereby improve the customer experience. It also shortens time to market—a critical success factor. Companies improve their ability to design right the first time, avoiding missed market opportunities and assuring sufficient profit margin.

Although there is progress, many current product development information-system solutions and design tools are not social-enabled, and constrain the quick and effective capturing, building, and integrating of design knowledge required for effective design tradeoff decisions. Many product development tools (e.g., CAD, CAE, and Excel) produce standalone design files. Since these tools capture knowledge in individual files, they actually disconnect and disperse knowledge rather than enable innovators to integrate it. Many Product Data Management (PDM) solutions still manage data more than they manage true information. Further, the file check-in and check-out function of PDM is often ignored or avoided, disrupting effective information exchange and limiting the PDM information's base value.

The maturation of a truly transparent, low-effort, borderless design environment for high-tech manufacturers is underway, but is not yet complete. Efforts in this direction, however, can already benefit virtually collocated teams and the rapid product attribute tradeoffs needed for high-tech product development. CIMdata believes that the ideal future solution will be a borderless workspace environment that enables people to collaborate and share tradeoffs, product attributes, and any other data, as though they are working simultaneously on the same spreadsheet. All the inefficiencies, errors, and rework that occur today due to passing around files will be significantly eliminated. Attributes of this design environment are presented below.

Systems Engineering Processes for High-Tech Manufacturers

Companies developing high-tech products should look for end-to-end PLM process solutions based on systems engineering. The solutions should be evolving towards integration and interoperability of design applications, collaboration tools, and information bases, including the following systems engineering processes:

Requirements Traceability & Test: High-tech manufacturers must seek solutions that can capture and document customer requirements and track and demonstrate how the requirements were met. Many high high-tech companies, such as medical device manufacturers, must demonstrate a direct link from a requirement to the function that meets the requirement, and a link to the test verifying that the requirement has been met. In addition to reducing product risk, organizational efficiency improves when the whole organization can self-coordinate using the same requirements and test data.

Systems Architecture Validated: High-tech companies should look for solutions that provide a top-down product architecture design capability. With complex products, decisions must be made regarding how to meet customer requirements, which can be satisfied by software, electronics, or mechanical solutions. The solution should enable manufacturers to

define product architecture to address requirements, set targets for systems, simulate systems behavior, and lay out the product from a systems perspective, rather than just from a component perspective. The result is a system design with clear decisions about how requirements will be met and how the systems will function. This results in an optimized product and in less product development waste.

Component Supplier Management: High-tech companies should look for a solution that enables a component catalog with detailed attribute data. Quickly finding components that will resolve tradeoff decisions can often mean the difference between a profitable product and one that loses money. The solution should provide a means to select components based on requirements and to evaluate components for tradeoffs between cost and performance. Most PLM solution providers have functions to add attribute data to components and to organize suppliers, but none has effective tools for developing component attribute data.

Concurrent Hardware & Software Design: High-tech companies should look for tools that enable collaboration on the electronic and mechanical product modules; integrate printed circuit board (PCB) and mechanical design; define, compare, and update interfaces; and trace design changes. A best practice would be to develop hardware and software concurrently. With many high-tech products, software development is the last step in the development process and results in delayed product release. When engineers work on a design simultaneously, and can see how the various interfaces interact with each other, they make better decisions—resulting in less rework and better adherence to the product development schedule.

Product Testing & Simulation: High-tech companies should look for the ability to perform product architecture analysis and to attach simulations to use cases. Product testing and simulation should be performed continually during the product development process, not at the end when too much time is wasted in reworking designs. For high-tech products, simulations should be performed in the context of a system.

Issue, Defect & Change Management: High-tech companies need the ability to capture and track product changes and defects and assign them to the product structure. No product or development process is perfect. This is especially true for complex high-tech products. Therefore, creating, tracking, and managing issues and design changes are essential.

Planning for Efficient Manufacturing Processes: Once a design is developed, it has to be manufactured, so high-tech companies should look for the ability to plan manufacturing processes during the design phase of the project. An integrated solution is required for concurrently planning manufacturing during design. The manufacturing engineers should be able to develop an assembly plan, validate the assembly process using automated tools, define the manufacturing plan, and even define work instructions, using design data.

Product Documentation: Last but not least is creating product documentation. High-tech companies should look for solutions that enable assembly drawings to be created from a product structure, create service manuals from ECAD and MCAD data, and develop marketing videos from 3D models—all of which are features that will improve documentation. Seamlessly creating documentation during design rather than at the end of the product development process is another way to reduce product development times and improve time to market. Of course, knowing what material can be used and when, is critical to avoiding excessive rework due to design changes.

Conclusion

Increasingly more products are delivering functions using electronics and software. As a result, many traditional manufacturing companies are actually transforming into high-tech product development companies. As this transformation occurs, these companies are finding that developing high-tech products requires management of complex product tradeoffs. A borderless information environment could be the future solution for high-tech product development.

Some PLM solution providers, such as Dassault Systèmes with their Smarter, Faster, Lighter solution experience for high-tech manufacturing companies, are already taking steps towards a more seamless product development environment. Dassault Systèmes is defining processes based on proven systems engineering principles, and they are working towards a unified platform that facilitates sharing information among multiple disciplines. Thus, all of the people working on the project are virtually collocated, and collaborate to increase the knowledge required to produce something that will delight the customer. In our view, this is the correct approach to satisfy high-tech needs.

About CIMdata

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