

Feature

The State of Industrial Design 2001 - Teams and Tools Cross Paths

by Jeffrey Rowe, IDSA



Portable PC concept for Compaq created using Unigraphics Shape Studio by Formation Design Group.

Many companies continue to realize that industrial design (ID) matters because it is increasingly becoming a product differentiator, especially for new technologies or crowded markets. The profession itself, along with the tools of the trade, continue to evolve.

As I have stated in the past, computer-aided design (CAD) packages, are not the same as computer-aided industrial design (CAID) packages, and vice versa - each product type addresses a specific need and serves a definite purpose. Historically, CAID has occupied the conceptual front-end of the product development process (primarily surfaces), while CAD has been best suited for the design refinement portion of the process (primarily solids).

CAID packages are developed specifically with industrial designers in mind - in a graphic environment they strive to stimulate creativity by providing a wide variety of design options. In essence, these tools are used to quickly create and alter the shape, form, and surface qualities of 3D models. CAID tools also excel at presenting design concepts with photorealistic rendering and lighting effects.

All of this is nothing new, however, and should come as no surprise to anyone.

What is new, though, is the fact that in more design groups, cross-disciplinary teams are using widely diverse tools for developing products more quickly and with higher quality. We are starting to see CAID, CAD, CAM, CAE, and PCB tools being used virtually simultaneously by design teams located around the globe. Interoperability is a huge factor here in providing a common design language that lets dispersed groups share information and perform their work more efficiently and with higher quality.

This brings us back to the task at hand; to focus on the industrial design portion of the product development process. With demands, expectations, requirements, and visibility rising so much in industrial design these days, we decided to conduct a short survey with many of the industry's top software vendors that cater to industrial designers to try and get a pulse on trends in industrial design from their unique perspectives. The vendors we spoke with included:

- Alias/Wavefront
- McNeel & Associates
- PTC
- Raindrop Geomagic
- SolidWorks
- SDRC
- think3

- UGS

Note: See accompanying *ID Tools Product Guide* for details concerning product offerings from these and other CAD/CAID software companies.

The CAID Wishlist

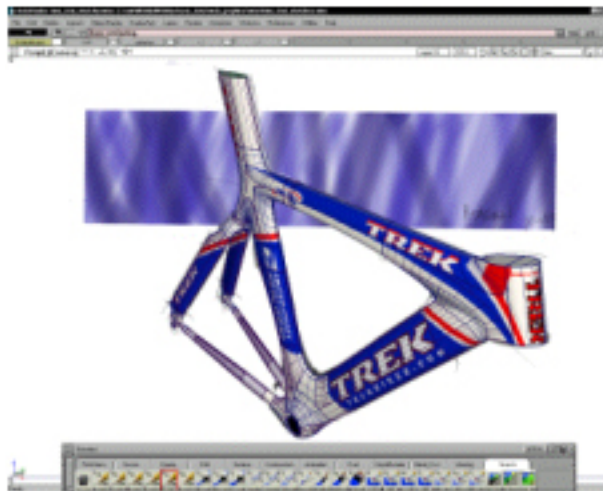
From past experience, we feel that industrial designers would like to see the following attributes in a design package:

- Integrated 2D sketching and 3D modeling.
- Ease of experimentation with shape, form, and texture.
- Ability to create and refine any imaginable organic, freeform bodies.
- Presentation and visualization capabilities for design reviews.
- Data exchange with MCAD systems that maintain absolute data integrity and design intent.
- Ability to better communicate with design and manufacturing engineers.

To determine whether this wishlist was still representative of user wants, we posed the following question to the various participants to better understand what their customers were asking for in industrial design software tools.

What do today's industrial designers want in a design package?

Alias/Wavefront - "The ability to take ideas in the form of 2D sketches and quickly transform them into 3D to visualize and communicate concepts."



This image, created using Alias/Wavefront Studio Tools, shows the 3D design of the composite time trial bicycle frame used by Lance Armstrong to help him win the 2000 Tour de France. (Image courtesy of Trek Bicycle, Waterloo, Wisconsin.)

McNeel - "Designers want products that are easy enough to use that they can stay focused on being a designer and not a software technician. One that is flexible enough to develop any shape, yet accurate enough to be used in manufacturing."

PTC - "When talking about industrial designers, we distinguish between two groups. One group is made up of 'true artists', and the individuals in this group are somewhat detached from technology. Their preferred design media are traditional tools, such as pen, paper, foam, and clay. If they use a 3D tool, they usually prefer a high-end application. The other group consists of industrial designers who understand and use technology, and are using it as they are taking the concepts of the artists into

production. We often describe these individuals as designers that "know what the artist wants and understand what the engineer needs.



Lunar Design used PTC's Pro/ENGINEER to design its Hewlett Packard monitors. Senior Product Designer Ricardo Penate said the most useful features were surfacing, skeleton model assemblies, scaling of skeletons, and transparent shading for translucent parts. Pro/ENGINEER also allowed Lunar to interface with manufacturing vendors overseas early in the development process and to address potential problems prior to tooling.

Each of these groups has a different "wishlist". Looking at the most common problems found in today's industries, there are a few things that stand out and, therefore, create disconnections in the overall product development process. The "artists" are creating most of their work in 2D. While they think in 3D, everything is projected into a 2D world. Artists are often dependent on others to create the 3D model, or they build it in clay or foam.

Artists and industrial designers that are using 3D software are passing on models to engineering. This is the step when the design gets "thrown over the wall" - and designers are giving up their control over design intent.

Ultimately, what it comes down to, are two crucial elements:

- Give the artist the ultimate conceptual design tool, allowing for free exploration in 3D without being constrained to surfaces and math.
- Give the other group of industrial designers an environment that truly integrates with engineering and manufacturing."

Raindrop - "Industrial designers want tools that allow them to spend more time on creativity rather than editing control points. Once a design is created, it should be automatically compatible with other CAD software, so design intent is not lost by having to recreate the model."

SolidWorks - "Ease of use balanced with the ability to model very stylized shapes."

SDRC - "The freedom to quickly realize a design concept in 3D. The ability to work from physical mockups, blank screen or reference data, as well as the ability to import 2D sketches in a usable manner. Tools that allow creativity to be expressed within tight time constraints and deadlines. The ability to manage data effectively, and the ability to work seamlessly with downstream applications. Account for packaging and other feasibility requirements while creating a design, and the ability to assess the functional and aesthetic form of a 3D model before manufacture."

think3 - "Styling continues to be a key factor for the success of products in today's competitive market environment. Generally, industrial designers want a CAID system that optimizes the styling process, giving them the freedom to design in a freeform manner. Once a design concept has been determined, they want to be able to add the constraints and refinements necessary to effectively and accurately engineer and produce the end product.

The ideal CAID system would:

- Permit early design capture, experimentation and visualization.
- Accommodate a user's design style and methodology.
- Encourage and enhance the creative process by means of dynamic command inputs and real-time feedback.
- Handle any kind of complex, free-form shape, without concern for the mathematics underlying the functions.
- Communicate and preserve design intent throughout the product development process.
- The ability to accurately exchange data with MCAD systems and to effectively (and automatically) communicate design intent with design and manufacturing engineers.
- Decrease the need for physical models, which is where the computer-aided data flow is often broken today."

UGS - "Basically, designers want a fun, inspiring "virtual place" that encourages rapid shape exploration with an interface that is simple enough to be used by non-engineers and allow ID managers to use the product occasionally. Designers are very sensitive to first impressions and react intuitively to the smallest graphical detail, therefore, like products that feel accessible to new users.

The challenge is that designers often need to go straight into working with assemblies and complex surfaces. They need to try many options and make complex decisions very quickly, as well as get things "roughly-right" on multiple options before investing extra time to go back in and tighten things up on a selected option. This calls for a very intuitive user interface, with a friendlier presentation: more "real-tool" metaphors, clearer step-by-step dialogue boxes, and more task-based control groupings

Many designers probably won't create a checklist of required features. Instead, they would ask for an application capable of quickly exploring design alternatives in an unconstrained way, then building off in select directions. It is critical that the underlying application has a solid foundation and is capable of creating bulletproof data. There is nothing more discouraging than exploring a CAID package's limitations while trying to evolve a new creative solution."

Significant Recent Developments

We next asked what the various vendors regarded as the most significant developments in the industrial design and tool arenas.

What do you consider to be the most significant developments in the area of industrial design today?

Alias/Wavefront - "Designers are creating a lot more digital models and not as many physical ones. Industrial designers are not handing off as much of their work as they did previously. In an increasing number of instances, industrial designers are responsible for a product from art to part. They are also increasingly involved with product branding and packaging, not just design anymore."

McNeel - "New CNC manufacturing techniques allow for more flexibility in terms of production and a change in the design process. This is giving industrial designers unprecedented control over designs."

PTC - "More and more companies are switching or at least want to switch from their traditional process to a digital process. The goal of some of our design centers is to eliminate foam completely. The ultimate goal is "digital drives the process". That doesn't mean that prototypes are being eliminated, but instead of the physical model being the master model, the digital representation becomes the master model."



An athletic shoe that was scanned and digitally reproduced using Raindrop Geomagic Studio.

Raindrop - "The most significant development is use of 3D photography as part of concept creation. 3D photography is the process of automatically turning physical parts and objects into digital models for use in design, engineering, manufacturing and marketing. The goal is to make digital 3D as easy as traditional photography. If you can easily bring in 3D models that can then be manipulated intuitively, the emphasis shifts to creativity rather than computer skills."

SolidWorks - "Many of our customers involved in industrial design have a host of talented and creative people, but many of these individuals have been trained to rely on more traditional methodologies of conceptual design (the use of charcoal renderings, for instance.) From a CAD point of view these could be considered 2D. Typically after these renderings were created, a CAD operator or designer would turn them into 3D CAD models. The power and increasing ease of use of digital tools allows all those involved with the design process to create the 3D models directly without sacrificing creativity, resulting in drastic time-savings."

SDRC - "Traditionally industrial design has been a "bolt on" authoring process to the mainstream product development environment. In today's climate of collaborative product commerce and lifecycle management, the old practices of a standalone process just don't work. Companies are increasingly in need of an integrated solution to all of their product lifecycle management needs - including industrial design."

The traditional needs of industrial design such as shape definition, visualization and communication are retained but product design cycles are becoming increasingly short and the demands on industrial designers are increasing with respect to their ability to respond to and make rapid and often late (in the process) design changes. The compression of the design cycle is compounded by the often equally demanding package and feasibility requirements present in most of the products that industrial designers define.

The need to be right first time is also ever present, as well. These demands all call for organizations to address the whole product lifecycle from the very beginning and to fully integrate the ID work with engineering and manufacturing. The processes of the future are those that allow the creative nature of the industrial design world to be preserved (and even enhanced) but in the context of the product as a whole. Of course, the continuing trend for much industrial design work to be outsourced places additional emphasis on the collaborative elements of the ID process, not only is the whole product lifecycle critical, it is itself distributed across an increasing number of sites - both within and without the parent organization. As such, the product lifecycle needs to be managed together with the collaboration of the parties creating it wherever they are in the world."

think3 - "Hardware speed and graphics quality have significantly improved the look-and-feel of designing on the computer for industrial designers and the speed with which they can work with a model. User interface advancements have continued to improve the designer's experience working with the computer, affording a more natural and intuitive environment."

UGS - "Technology has been growing quickly which brings many changes in the use of computers as design tools. Not that long ago everything was done by hand, such as sketches, rendering, and drafting. More recently, 2D CAD programs became popular. But in the beginning many designers were not willing to leave their big drawing board for a 15-inch screen, because you cannot do the same job full size, and also it was not easy to draw curves freely compared with your hands. However, like the fate of typewriters, the drawing boards have been fading out and leaving more room in the studio."

Industrial designers are more involved in the entire process, from identifying, and developing concepts through mechanical interface design and tooling/production issues. Not that they do all these tasks, but do need to

understand all aspects of the product, from the niche in the market it needs to fill, to the problems the line-assembler may encounter. Using all these pieces of the puzzle and molding them together with the users' concerns becomes quite a synchronized process, which can be thrown off course very easily. Being a key player throughout the entire development process, the industrial designer is far more than "the one who designs the aesthetic shell of the product". To accomplish the integrated tasks requirements on time and on cost, the industrial designer must communicate in the most effective manner possible with the other players. With engineering, tooling, and manufacturing being a major part of the process, industrial design must speak their language to knock down communication barriers and deliver projects efficiently - CAD is the engineers language, and ID needs to be fluent with it.

Business best practice has finally formally recognized the strategic importance of industrial design as a brand-expression medium and of industrial designers as strategic managers of brand character."

Challenges And Problems

The next question centered around what the various participating vendors perceived as the biggest challenges and problems facing today's industrial designers.

What are the greatest challenges faced by industrial designers today?

Alias/Wavefront - "Collaborative product design can be a problem because it's not easy to get concepts from several different designers and make them work effectively together without the danger of creating a "design stew." Designers today have more of a responsibility to "sell" a design, even in-house, than they ever have before. Time to market is getting faster, but demands for fresh and distinctive product differentiation are ever greater. Finally, designers are expected to produce "high design," but without high manufacturing costs."

McNeel - "The new control that new manufacturing processes and materials allow the designer are slowly being accepted by others in the process. Changing this process to make the design process more flexible has been slow. Resistance to this has limited with what industrial design has been able to do. Using tools that are good for engineering and only marginally acceptable for design and styling."

PTC - "Industrial designers getting their ideas into the final product. Today, a lot of times a design gets lost as it goes through engineering and manufacturing. Complex tools - why is the tool of choice for designers primarily a 2D application? Because there are too few tools out there that allow "blue-sky" conceptualizing, playing with form, shape, and ideas. All 2D information is communicated to the people who understand the complexity of 3D tools. And this leads to the next point, data transfer. It doesn't matter how creative a designer is, how cool the design is, but when the design leaves the design department, the control leaves with it. This is less of a problem for design firms than for in-house corporate design groups. And since designers love their own so-called niche applications - the output only serves as reference data for engineering."

Raindrop - "Differentiation and time to market. Design intent is often lost in the manufacturing process."

SolidWorks - "Many are faced with making the transition from a 2D-oriented design approach to a true 3D design mode. Until recently, however, the design tools were too complex to be used except by a few well-trained experts. Can the CAD system accurately represent stylized, freeform organic shapes? Just as important, can these tools can be used by mere mortals? Is the system easy to use? Or do you need nine months of dedicated hands-on use and training just to create a stylized shape? These are all crucial questions and problems."

SDRC - "The biggest challenges and problems that we see include:

- Reduction in lead times
- Higher customer quality expectations
- Higher customer expectation for innovation and originality of designs
- The need to express a design in a manner immediately usable by the downstream processes
- The need to collaborate globally with customers across the enterprise

- The need to account for feasibility requirements throughout the design process
- The ability to react quickly to change requests without sacrificing any of the above requirements
- The ability of the tools they use to integrate fully into the product authoring process as a whole
- The ability to express themselves fully with the tools available
- The requirements for managing data within a freeform model - for example, surface topology or the relationship between a network of curves and the surfaces built from them
- The availability of craftsmanship evaluation tools during the creation and modification of a design
- The ability to manage data from any source from within a single application for example, points, polygons, surfaces, curves, etc."

think3 - "Dependence on physical models. Today's designers spend a significant amount of time working with physical models to refine, improve, and optimize a design to achieve style and ergonomic goals. Freeform design is difficult and often inaccurate, because with many CAID systems today, designers do not have the flexibility to quickly and easily handle complex, freeform shape design without concern for the mathematics underlying the functions. At the same time, they face the challenge of communicating effectively with design and manufacturing to ensure data integrity and design intent is carried through the design process."

UGS - "Technology and marketing trends are pushing more and more responsibility into the front-end of the product development process. Industry is asking for innovation leadership from industrial designers. To live up to the challenge, the profession needs to expand its knowledge base and do a better job managing overall development risk. But above all, designers must retain the ability to remain creative despite the increasing pressure to perform."

As industrial design software tools become more advanced, we have seen an increased focus on the tool. As with anything, when more emphasis is put on one skill, another skill suffers. Regardless of the tool, designers focus on the creative process and create truly innovative solutions. When the digital revolution first hit the graphics and printing industry we saw an explosion of great work and creativity. Unfortunately, we also witnessed an unprecedented amount of technology-enabled mediocre design. The graphics industry has moved beyond that and clients are arguably enjoying the highest level of service ever. We expect to see this cycle to play out in the industrial design field as well.

It sounds perfect but in reality how CAID seamlessly integrate with engineering is one of the biggest problems we are facing now. It is caused by designers and engineers using different software, as their job nature and habits are different. Designers do not like working in CAD environment because it requires them to follow a lot of rules, typing numbers, datum, poor user interfaces, and so on that they do not feel comfortable. On the other hand, CAID program provide a comfortable user interfaces and working environment, powerful freeform modeling tools, and offer extensive visualization tools.



Design Interface (Kowloon, Hong Kong) uses Unigraphics from concept design to final production. Representing a neighborhood electric vehicle designed to ease traffic congestion and pollution, this "mico" concept car was modeled in Unigraphics.

Another problem among the integration between designers and engineers is the 3D model itself. Sometimes engineers complain that the models created by designers are bad. It happens mostly in the undercut, draft angle, parting line and too complex for the mold. Engineers have to fix it, or even worse, to recreate it before they can start their job. Such changes cause changes in shape lead designers to complain back to the engineers about losing their design intent. There is no such functionality to fill the gap between CAID conceptual model and engineering CAD model. It's not fair that designers have to take the responsibility since they are the first ones who create a model. But the situation does not allow designers to refuse because the whole process will go more smoothly than engineers taking the job. Therefore, we have to pay more attention to benefit of downstream users rather than just enjoying pushing and pulling models. Moreover, industrial designers have to strengthen their modeling technique as well as good knowledge background of manufacturing.

Too many designers are still seen, wrongly, as no more than glorified product illustrators, undereducated and facing extinction in a world that is going 3D. To some degree, a major problem that has plagued industrial design throughout its history has been exacerbated by our set of increasingly advanced tools. Industrial design is most effective if used strategically. While often valuable, the tactical use of design invariably occurs too late in the development process. The deterministic nature of many CAID tools has placed increased emphasis on the final stages of the design process. This detracts from the profession's core value, creative product solutions.

Looking Ahead To The Future

Finally, we asked all of the participating vendors about their thoughts on the future of industrial design and the tools that they provide.

What's ahead for the discipline of industrial design and what will ID tools look like in the future?

Alias/Wavefront - "Increasingly more gestural interfaces, especially for power users will become the norm. Global design communication and collaboration. Designers competing more with each other, even in-house, to have the opportunity to see their designs become reality. Improved visual communication that will largely be software driven, but hardware enabled."

McNeel - "Designers will no longer be forced to use tools that were meant for engineering and only marginally acceptable for design and styling. Design will increasingly be tied to manufacturing techniques, marketing demands, and acceptance on new methods of design."

PTC - "Going digital, industrial design will finally become regarded as a vital part of the process. Again, this already works to a degree in smaller design firms, yet it still is the major obstacle in larger corporations. Design is a major component in almost every product area, and it is judged by how good it looks and works, and not by the fact on how much data transfer went into the product. In times where demand is increasing, time to market is more critical than ever before, companies will have to tweak their processes. Many of our clients are rebuilding the design in the engineering environment. This is not profitable.

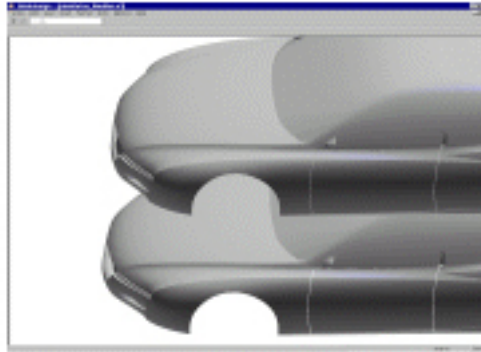
ID is the driving factor today in new product development when it comes to differentiation. Demand for "cool" products is increasing, people are starting to realize that good design doesn't cost any more than mediocre design. This fuels the demand for more cool products in a shorter amount of time. In order to meet demand, companies will need to streamline their processes, and the software is a big part of it.

Computer hardware is also important. Portability is key, so you can design anywhere, but still be connected. Education will understand the need, and drive the future requirements for software and hardware."

Raindrop - "Using 3D photography. Take graphic design as an example. It experienced a huge boom when digital photography became accessible to everyone. Tools are much easier to use today than 10 years ago. Industrial design needs to come out of its ivory tower and be more integrated with the way people work and their need for customization. I would like to see industrial design be as popular as graphics design in the next five to ten years. This means we can go beyond designing greeting cards or personalized Web sites to a personal factory where we can design things that we actually use. That would be really exciting."

SolidWorks - "Continued merging of traditional industrial design and mechanical design. Software's power to get the job done will increase. Along with that, ease of use to allow every user involved in design to use the tool. The mathematics of the advanced shapes will be hidden from users. Terms like C2 continuity or UV curves needlessly expose users to mathematical terms, when what they really want is a smooth organic shape that looks good. More freeform, interactive tools will emerge. Ultimately, all needs should be satisfied by one design tool. We call this mainstream design."

SDRC - "Future enhancements are likely to be driven by the same market needs as the rest of the software industry. They will be heavily influenced by the availability of ever faster hardware for both raw CPU and graphics display. Education with respect to software knowledge will benefit heavily from the Internet and Web-based learning techniques - the emerging trends in distance and e-learning will open up new opportunities for user training that can cater to more widespread teaching programs together with specialist advanced training programs on a request basis."



Using Global Shape Modeling found in Think 3's thinkdesign/thinkshape program, the modification of this model took only minutes to execute and regenerate.

think3 - "Integration of computer-aided styling into the CAID process - technology advancements will continue to be made so that computer-aided styling becomes an integral part of the CAID process. Global shape modeling will be a cornerstone of this trend, advancing to the point that users can build smart models capable of self-adaptation. In addition, the technology will be customized to meet the unique requirements of specific applications and market segments."

Ease-of-learning and ease-of use will (actually, must) continue to improve, so that more designers will be encouraged to move from traditional artist tools to CAID tools. Among many factors that will play a role in this are:

- Mobility to make it as easy for the artist to interact with the computer as it is for him to reach for a sketch pad.
- Intuitive user interface that encourages design exploration and provides immediate feedback in a natural way. Additional work will be done in the area of novel data input techniques, such as speech.
- Visualization software improvements will give designers a greater degree of comfort with using the computer as a primary means for conceptual design, rather than pen and ink or artist's brush. They'll not only be able to see how the physical model will look, but they'll be able to visualize how it might be used and interacted with in a "real-world" environment. Altogether, this kind of information will provide important information during the design process for making improvements without necessarily requiring a physical model.

UGS - "In more and more companies, industrial design will be seen as one of very few strategic core competencies, the strategic guardians of brand-equity. Industrial designers will thrive in an integrated 3D environment, adding more value than ever to the overall innovation process and gaining in status as a result."

Industrial design will continue to break out of the "create an aesthetic shell" pigeonhole, and become more involved in every aspect of product development, as the industrial designer has "the image" of what a product can be, the ability to be the voice of the user throughout the project/product development process, and the responsibility to address and incorporate many other issues along the way. Culminating in the delivery of a

product the client never dreamed of, but realized they wanted all the time.

To improve the CAID tools to fulfill the need of designers is not just an enhancement in modeling tools and adding features. Getting the right shape is important, but it is just a part of the whole design process. It should be more concentrated in the aspects that are not cared about, like studying different concepts, making experiment for trying different approach, making quick model for evaluation, etc. Those are vital essential elements to a successful design.

Industrial designers are and will remain interested in the tools that provide the most fluid means of exploring, creating and communicating creative solutions. On a broader level, industrial design deliverables are becoming increasingly standards based. It is important that future enhancements acknowledge this and provide the tools to better communicate between a variety of platforms. Individual designers will always have their preferred CAID environment. File formats, and file portability should be secondary to the quality of a designer's work. As with most technology products, platforms that embrace open standards and work to build strong user communities will continue to grow.

The immediate issue is professional development: will designers have enough confidence in their creative brand-building knowledge to move beyond their old-fashioned 2D illustration skills, and master new, more strategic roles, using new 3D tools. The longer term the issue is who is educating the designers of tomorrow for a professional world that is totally different from the one their teachers know?

Comments? Feedback? [Click here](#) to tell us what you think about this topic or if you have additional information you'd like to share on this subject.

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