Integrated Technology to Enable Intelligent Design

Dr. Tao Yang Han

Chairman and President, IronCAD, LLC, USA

Manufacturing companies are always facing the challenge of better, faster, and cheaper. To achieve such goals involves multiple areas through the product lifecycle. Sharing information, leverage data and functionality cross board is the key enabler to achieve better, faster, and cheaper.

Smart Manufacturing is an integrated and collaborative ecosystem to achieve such goals. Within a Smart Manufacturing ecosystem, the central piece of the information to be shared is the product representation data created by a design system. Designers and other users all need to access the product representation data and use functionality in a design system. Design systems play a critical role in a Smart Manufacturing ecosystem. A good design system not only needs to empower designers but also enables non-designers to easily perform design functionality.

Examining design systems in the marketplace one can identify multiple areas that need improvement. Many design systems require users to repeat tedious steps. User errors are easily to happen during those time-consuming steps. To automate such tedious steps would be a great improvement. The knowledge of using a design system and the domain knowledge to perform certain design are both necessary to perform design tasks effectively and efficiently. A good part of such knowledge can be kept in a design system and invoked, when needed, to assist the users to perform better design faster. The ability to store and invoke such knowledge in a design system makes it smarter and more productive. A powerful design system shall make itself easy to use even for non-experienced users. Built-in assistance in using a design system would be another key feature in a good design system. Of course, the performance speed of design functionality significantly affects the efficiency of a design system. As a summary automation, smartness, built-in assistance and performance are the major factors to build an Intelligent Design system.

Using a 3D CAD system as an example some functionality making an Intelligent Design system and the underline enabling technologies are discussed.

Part design is a major functionality in a 3D CAD system. Using intelligent feature catalogs (the building components) users can D&D those features into a design environment to put them together

and create a part. Users can refer to existing geometry and the design system will automatically position and create the feature geometry. This automation in 3D space makes part creation at least 30% faster than traditional way of feature creation starting from 2D sketches. To modify a part geometry after creation user's interactive gesture is a good indicator of what design result the user is expecting. An Intelligent Design system with smartness will recognize the user's intention and produce the desired result without the user going through many manual steps to achieve it. Smart Update technology can figure out how to change the geometry and update feature history to accomplish the desired design result. When a design operation fails using a particular geometric kernel an Intelligent Design system can automatically invoke a different geometric kernel to successfully complete the requested operation. An underline Kernel Collaboration technology enables such desired capability.

Another major functionality in a 3D CAD system is assembly design. Traditional CAD systems provide interactive tools to let users manually position parts together, and use constraints to maintain certain relationships between parts. Practically, in many cases how a part is related to adjacent parts is known already. Such knowledge can be kept in a CAD system. Then when a part is incorporated in an assembly its position, geometry, and relationships with adjacent parts all can be automatically decided. This highly desired capability can be carried out by Smart Content and Smart Behavior technology which speed up assembly design more than ten times faster than traditional CAD systems. Smart Content technology stores useful information with objects and enables runtime connection to other systems to obtain time sensitive information. Smart Behavior technology use such additional information to automatically execute multiple steps of assembly design. Leverage similar technology such automation capability can extend to engineering drawing creation. With those smartness and automation not only speed up the design and avoid human errors it also considers business factors, such as procurement and manufacturing processes, during the design to optimize the design results.

A challenge all 3D CAD systems are facing is when a system's functionality grows it is also getting more sophisticated. Users have difficulty finding the necessary functionality and figuring out how to use it. In this regard an Intelligent Design system will provide assistance to help users. Comprehensive search capability to find related technical documents is helpful. Furthermore, invoking AI technology using Large Language Models (LLM), such as Open AI's GPT, and integrating it through middleware will provide freeform question and answer assistance to users. This significantly reduces the barriers for new users.

As mentioned previously, performance is another critical factor of a design system. An Intelligent Design system will optimize its software algorithm to speed up performance. It also uses the hardware power to their extreme. For example, in 3D CAD design system one performance bottleneck is to create hidden-line engineering drawings from a large assembly with thousands of parts. Technology using parallel computing and a combination of CPU and GPU power would significantly improve the performance in large assembly view creation.

The above-mentioned technologies and their contributions to an Intelligent Design system will be presented and discussed.

==========

Experience:

Dr. Tao Yang Han is the Chairman and President of IronCAD, LLC. He co-founded IronCAD in 2001 to provide the best innovative and collaborative design solution software for the manufacturing industry. Since its incorporation IronCAD has grown business in the world-wide market through its 50+ distributors cross America, Europe, and Asia. Building on top of the success of IronCAD technology in 3D CAD design, Dr. Han has extended IronCAD's solutions into modular assembly design, design-to-order configuration, and simulation for manufacturing automation.

Prior to founding IronCAD, Dr. Han was the CTO of Alventive. He invented a number of patented key technologies in the 3D CAD industry. Dr. Han was a visiting professor at National Taiwan University from 1987 – 1989. He received a PhD degree in Structural Engineering from Cornell University in 1984. Besides his career development, Dr. Han had played key volunteer roles in charity organizations.