CAD Framework Initiative – A User Perspective

Todd J. Scallan

IBM Corporation, Neighborhood Road, Kingston NY 12401
CAD Framework Initiative, 4030 W. Braker Lane, Austin TX 78759

Abstract

This paper presents an overview of the CAD Framework Initiative (CFI) from a user's perspective. CFI is an industry consortium whose charter is to define interface standards that facilitate integration of design automation tools and design data for the benefit of end users and vendors worldwide. Integration problems faced by CAD users are introduced, followed by a discussion on the concept of a CAD framework. CFI's role in the evolution toward framework standardization is described. Specifically highlighted are key demonstrations of CFI's progress that have been conducted at the Design Automation Conference. The paper concludes with a discussion on end user benefits and expectations with respect to CFI.

1. Introduction

Computer-Aided Design (CAD) is a general term that applies to the use of computer hardware and software to assist with engineering tasks. CAD is employed in a wide variety of disciplines, including electronics, mechanical drafting, software design, and many others.

Manufacturers of technical products rely heavily on CAD tools as an integral part of their design processes. To maintain a competitive edge in areas such as integrated circuit design, many companies have invested considerably in the development of proprietary CAD tools and systems. In addition, commercial vendor products are increasingly utilized for specific tasks, such as the design of printed circuit cards.

As competition becomes more intense and technology cycles shorten, the adaptation of existing design systems to address the requirements of next generation products offers a constant challenge. There exists a myriad of complicating factors, including combinations of purchased and in-house developed software, distributed heterogeneous computing environments, and design methodologies that span multiple disciplines across the manufacturing enterprise.

2. The problem

A tremendous problem for CAD customers is the difficulty encountered when integrating design tools into their production environments. Tools from different vendors, and many times from the same vendor, do not work well together. This is typically due to incompatible data formats, conflicting execution environments, and dissimilar user interfaces. Replacement of a tool requires rewriting data conversion routines and the control mechanisms that manage the tool within a customer's design system. Users must be retrained to interact with the new tool, resulting in lost productivity.

The tool integration problem can be attributed to the nature of the CAD industry, which can be characterized as follows:

- No single source provides a turnkey solution that meets all the needs of an enterprise.
- Many vendors only provide solutions for specific applications, such as simulation.
- Customers require integrated solutions that consist of multi-sourced tools, including in-house developed.
- Existing standards, such as EDIF and VHDL, address only pieces of the integration problem.
- Ongoing consolidation within the CAD industry is forcing vendors to combine tools from other sources with their own products.
- Vendors and customers recognize the need for CAD tool cooperation and ease of replacement.

To answer the tool integration problem, some vendors have introduced proprietary CAD frameworks. However, these products do not provide adequate solutions. In fact, frameworks from two vendors may address completely different sets of problems. For example, some vendor frameworks provide a unified data model and other common services for newly developed or modified tools, while others provide mechanisms for tool invocation and the management of design files without tool modification. In the absence of common guidelines to which CAD vendors can adhere,
customers continue to struggle with tool integration in heterogeneous environments. To overcome this dilemma, developers and users agree that standards for CAD frameworks are needed. However, before discussing standardization, the notion of a CAD framework should be explored in further detail.

3. What is a CAD framework?

A CAD framework is a software environment that enables the coexistence and cooperation of a variety of design tools. It provides a base on which tools can be developed and integration functions that shield end users from system complexities.

A typical engineering design environment consists of many tools supplied by different vendors, all using various graphics interfaces, design files or data bases, and translators for exchanging data with foreign tools. In addition, many customers develop their own tools to supplement vendor offerings. An engineer is typically a member of a team and often performs several tasks concurrently. Data sharing is required in varying degrees and must be controlled to provide consistency and integrity. The states of designs, libraries, software levels, and other aspects of the design cycle must be managed.

3.1 Framework users

A framework supports activities for three basic classes of users:

1. The developer implements CAD tools. Historically, most tools have contained internal frameworks; that is, services for graphics, data manipulation, and access to system resources. The trend today is to externalize those portions of the CAD tool that are not associated with the core algorithm, and to provide them in the form of framework services. This allows developers to focus solely on algorithms and facilitates better integration of tools.

2. The administrator customizes the framework. The framework must provide facilities to assist with the administration of the design environment. Tasks include the registration of users and tools, definition of design tasks, and construction of rules that enforce design methodologies.

3. The CAD user executes tools within the framework. The framework must insulate the user from the complexities that make up a design environment. Among the many details to be hidden are system and network configurations, establishment of tool environments, data conversions, and methodology rules checking. Activities are centered around tasks, such as "design a chip."

3.2 Framework components

A CAD framework is a modular, extensible structure consisting of several major software components that are tied together by an overall architecture. The primary functional goal of a CAD framework is to facilitate tool interoperability and interchangeability. Interoperability implies cooperation among tools from multiple sources. Interchangeability refers to ease of tool replacement within a design system, which relates directly to the portability of tools across frameworks and platforms. Framework components include the following:

- A system environment provides an operating system independent interface to lower level supporting services and network transparency.
- A repository provides a storage mechanism for configuration and control data, as well as actual design data. It is actually the logical aggregation of storage mechanisms that span application domains and which may be distributed across a network.
- Design data management refers to the control of information about design data. Versions of designs, interrelationships among components in product configurations, and data states must be tracked to ensure design data integrity and consistency.
- A common design representation provides a data model on which multiple tools can operate, hence achieving a significant degree of data integration.
- Inter-tool communication mechanisms and protocols allow tools to exchange messages, thereby facilitating cooperative processing. Messaging includes point-to-point, multi-cast, and broadcast modes.
- Methodology management provides a mechanism for the definition of rules that comprise a design process and for the enforcement of those rules. For example, a customer may wish to define a policy that stipulates, "Physical design cannot occur until successful completion of a simulation."
- A common user interface provides a unified appearance and behavior across design tools.
- A session manager serves as an agent that monitors and coordinates all framework activities on behalf of the end user.

4. The CAD industry's response

An industry-wide movement to define framework standards has taken the form of the CAD Framework Initiative (CFI). CFI is a non-profit corporation consisting of
approximately 50 member companies. Its charter is to define interface standards that facilitate integration of design automation tools and design data for the benefit of end users and vendors worldwide. CFI is not developing a framework; rather, its end product is a set of standards that includes requirements definitions, an architecture reference, information models, and programming interfaces. CFI is initially focused on electronic design automation. However, by maintaining domain independence for the majority of framework services, CFI will be able to expand its scope to other disciplines, such as mechanical and software design automation.

CFI began meeting on a regular basis after the 1988 Design Automation Conference, and was formally incorporated in February 1989. Since that time, interest has grown and the organization's momentum has continued to rise. Members of CFI include CAD developers, integrators, and users. Representation is international, including companies from North America, Europe, and Japan.

It is CFI's intent to be synergistic with other standards and related activities. It adopts and adapts existing standards, where applicable, and has actively solicited input from numerous other organizations. Where invention is required, CFI attempts not to conflict with existing standards.

4.1 Demonstrations of progress

One of the first major accomplishments for CFI was a project that culminated in a demonstration at the 1990 Design Automation Conference. The DAC-90 Project proved the feasibility of vendor cooperation, which is critical to the success of CFI. In addition, the project illustrated how real problems could be solved through industry acceptance of framework standards. Specifically, the demonstration focused on the classic netlist translation problem.

The DAC-90 Project was based on a programming interface to a design representation of netlist data. The interface and design representation were developed by CFI as a feasibility study and as a preview of standards that would eventually emerge. The programming interface was used to integrate arbitrary pairs of tools that produce or consume netlist data. For example, a schematic editor and a logic simulator would be a producer and a consumer, respectively. It is important to note that this project did not take a data exchange approach like that employed for EDIF. Rather, it illustrated data integration where a consumer tool could directly access design information stored by a producer tool.

Participation in the demonstration exceeded the expectations of many. Twenty vendors contributed 32 tools and five workstations. To continue the momentum achieved through this success, a new expanded project was initiated for demonstration at the 1991 Design Automation Conference.

The '91 Integration Project included four possible roles for company participants: data producer, data consumer, data server, and framework cockpit. In addition to an expanded design representation interface, two additional draft standards were featured: a specification for the encapsulation of CAD tools into frameworks, and an inter-tool communication programming interface that supports notification and request messaging among tools and frameworks. Once again, the project was a tremendous success, with 26 companies contributing CAD and supporting technologies.

4.2 CFI 1.0

The results of the CFI DAC-90 and '91 Integration Projects proved invaluable in testing the feasibility of vendor cooperation and validating key concepts and approaches to framework standards. However, the time has arrived to deliver the standards that will fulfill the first step in CFI's goal of tool and data integration. CFI 1.0 is a set of candidate standards that address requirements for basic "plug and play" of CAD tools. These initial standards include base guidelines for design environment software (system and networking services, error handling, and execution log format), design representation supporting basic netlist manipulation, inter-tool communication providing messaging among tools, and basic techniques for describing tool encapsulation information.

5. What is next?

While CFI has made significant progress in a relatively short time, it must now shift from a primarily technology oriented organization to one that is product oriented and customer driven. CFI's product is its standards specifications. Its customers are the CAD suppliers that implement the standards, and the end users that reap productivity gains from CFI-compliant software. The final measure of CFI's success is not a set of legislated standards, but rather the acceptance of commercial products in the marketplace that implement those standards.

A "pilot program" has been established to facilitate the insertion of CFI 1.0 standards into real products. Its primary goals are to refine the 1.0 specifications, achieve industry acceptance through commercial implementations, and help set the direction for subsequent CFI releases. Several pilot projects have been initiated. Each project involves the implementation of one or more CFI 1.0 standards within commercial products and the deployment of those products in an end user production environment.

Follow-on CFI deliverables are being defined in terms of timely solutions to user problems. The standards that comprise these deliverables fit within the context of an overall architecture and a technical road-map. The CFI technical organization has undergone a restructuring to accelerate the definition of specifications. In addition, the process whereby CFI produces relevant standards is being 
streamlined to enable rapid progress without sacrificing the attainment of broad industry consensus.

To help support the ongoing activities of CFI, such as the pilot program and 1.0 product release, a sponsor membership class has been established. Several key companies in the CAD industry, representing both major customers and suppliers, have demonstrated their strong commitment to the success of CFI by becoming sponsor members. The extraordinary level of participation and commitment on the part of all CFI member companies is expected to continue.

6. Conclusions

The CAD integration problem must be addressed through vendor cooperation. The CAD Framework Initiative was formed to serve as a vehicle for driving framework standardization. CFI has so far demonstrated a tremendous amount of success. The achievement of rapid progress in a consensus-based environment is evidence of CFI's acceptance by the industry.

CFI was born out of frustration in the end user community. Users have benefited from the establishment of CFI in that CAD suppliers are working together to remove barriers to integration. There are in fact already commercial implementations of CFI draft standards. The CFI 1.0 pilot program will result in final balloting of the 1.0 standards, insertion of the standards into commercial products, and utilization of CFI-compliant software by significant CAD customers.

The CFI 1.0 release offers benefits to both CAD developers and users. For developers, standard interfaces and approaches to framework services provide structural consistency and promote code re-use, thus lowering development and maintenance costs. Once the standards are implemented within commercial products, users will benefit from decreased integration costs and increased productivity. For example, the design representation standard provides a common mechanism for CAD tools to share data and eliminates the need for netlist translation. The user has the flexibility to select the best tool for the task at hand based on the tool's function, and not on whether the tool can be incorporated into the user's existing system. Further, an often repeated step is potentially eliminated from the design process, such as the netlist translation that typically occurs within the design entry-simulation loop.

Beyond CFI 1.0, users can expect solutions to more difficult problems. The next major release, CFI 2.0, has been defined to address the following end user needs:

- Support for mixed level design will allow the representation of design data at various levels of abstraction. A user will be able to select the appropriate level and view for a particular operation.
- A general model for design object management will serve as the basis for library and design information management.
- The ability to allow multiple users and tools to share design data will represent initial support for concurrent design. Session and context management will provide each user with a consistent means of managing and preserving the state of the execution environment.

A road-map will provide a clear vision of CFI's future deliverables that will be staged in a timely sequence of releases. The road-map will help CAD customers plan the migration of CFI compliant products into their present design systems. The definition of releases will be more closely tied to end user requirements. Finally, as CFI expands into new areas such as component representation and technology CAD, it is anticipated that CFI's scope will include CAD domains beyond electronic design.