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[1.]Dávid TÓTH, [2.]Andrea MUDRIKOVÁ, [3.]Peter KOŠŤÁL

THE ROLE OF STEP-NC IN DRAWINGLESS ENVIRONMENT

[1-3.] Slovak University of Technology, Faculty of Material Science and Technology,
Institute of Production Technologies, J.Bottu 25, 91724 Trnava, SLOVAKIA

Abstract: Modern manufacturing enterprises are built from facilities spread around the globe, which contain equipment from hundreds of different manufacturers. Immense volumes of product information must be transferred between the various facilities and machines. Today's digital communications standards have solved the problem of reliably transferring information across global networks. For mechanical parts, the description of product data has been standardized by ISO10303 (STEP). This leads to the possibility of using standard data throughout the entire process chain in the manufacturing enterprise. Barriers to realizing this principle are the data formats used at the machine level. Most computer numerical control (CNC) machines are programmed in the ISO 6983 G-code language. Programs are typically generated by computer-aided manufacturing (CAM) systems that use computer-aided design (CAD) information. However, G-code limits program portability for three reasons. First, the language focuses on programming the tool center path with respect to machine axes, rather than the machining process with respect to the part. Second, the standard defines the syntax of program statements, but in most cases leaves the semantics ambiguous. Third, vendors usually supplement the language with extensions that are not covered in the limited scope of G-code. The replacement for G-code is so-called STEP-NC, the name STEP-NC meaning the STEP standard extended for NC. STEP-NC is a new model of data transfer between CAD/CAM systems and CNC machines. It remedies the shortcomings of G-code by specifying machining processes rather than machine tool motion, using the concept of working steps. Working steps correspond to high-level machining features and associated process parameters. CNCs are responsible for translating working steps to axis motion and tool operation.
Keywords: STEP, CNC, G-code, production system, CAD, CAM

INTRODUCTION

Virtual Enterprise (VE) is a temporary alliance of enterprises that come together to share skills and resources in order to attend a business opportunity and whose cooperation is supported by computer network. STEP is a standard used in data transfer between these enterprises. SADT is a graphical representation and in a VE is used to elaborate diagrams to improve VE management and STEP performances.

PDM can be defined as: electronic handling and control of product information throughout the whole product life cycle across system and organization boundaries by means of vaulting, workflow, and product structures. The goal of this paper is to elaborate the SADT diagrams for the product information and transfer used in VE.

Virtual Reality (VR) technology uses digital computers and other special hardware and software to generate a simulation of an alternate world that is believable as real by the user. Engineers have been using computers for years to create models of physical parts, devices and systems and simulate their operations, but the present CAD/CAM (Computer Aided Design / Computer Aided Manufacturing) systems lack the realism and interactive capability provided by an immersive VR environment.

The implementation of a supporting infrastructure for Virtual Enterprise (VE) can be based on a number of component technologies and paradigms:

» Interoperability and integration of standards – STEP, EDI, TCP/IP, etc.
» Integration of Workflow Management Systems;
» Integration of advanced Information Management Systems – PDM.
» Integration of Safety and authentication mechanisms – digital signature, etc.
» Integration of MAS development environments;
» Integration of legacy systems – PPC/MRP, CAD, CAM, CAE, etc.

» Infrastructures – Internet/Intranet/Extranet, CORBA, Java, etc.

Virtual Enterprise challenges the way manufacturing systems are planned and managed. Shared virtual environments can allow engineers from different locations to work together and in the same time. These environments give engineers and designers a better understanding of the product, improve quality, reduce time to market and ensure that designs are right from the first time, reducing the need for expensive reworking later in the process. Collaboration can be extended outside a company by sharing virtual product information with suppliers and partners, creating a closer relationship in product development.

The biggest change in recent times for the CAD/CAM industry lies with the term "integration" Integration plays a very important role in the future of CAD/CAM products. There have been big workstation-based integrated CAD/CAM systems around for many years. They provide CAD and CAM integration by providing all pieces from the same company. But now there is a new group of products touting integration as a key issue. They pursue integration through other means than single brand products.

ENGINEERING DATA MANAGING

Engineering data is difficult to manage because:

» there is a lot of it (with more being created each day);
» it is on many media (e.g. paper and magnetic disks);
» it is used by many people in different functions (often at different sites);
» it is used by many computer programs (often on different computers);
» it often has several (different) definitions;
» it exists in many different versions;
» it has multiple relationships and meanings;
» it may need to be maintained for many years (e.g. fifty years).

PDM systems treat engineering information as an important resource that is used by many functions in a company. They allow companies to get control of engineering information, and to manage activities in several departments. In the long term, PDM systems will allow companies to get control of all their engineering information, and manage the overall engineering process. These characteristics set them apart from systems such as CAD that aim to improve the productivity of individual tasks in one functional area. Viewed as data processing systems, EDM/PDM systems go beyond individual application programs such as CAD and NC. Viewed as organizational tools, they go beyond individual approaches such as DFA (Design for Assembly) and project management systems.

PDM systems provide a backbone for the controlled flow of engineering information throughout the product life cycle. Other systems using engineering data, such as CAD, NC, process planning, MRP and field service will be integrated to this backbone. For CAD/CAM integration and data transfer between different Integrated Design Systems from one enterprise to another we used STEP Standard in our study. It is the aim of the STEP architecture to standardize the exchange of product model data across three levels: description methods, integrated resources and application protocols (AP).

The development and standardization of an AP, is really the development of a standard for the exchange of product data in a given domain. To do this, several intermediate models are set up: the "application activity model" (AAM), the "application reference model" (ARM) and finally the "application interpreted model" (AIM). SADT is a graphical representation which can transpose in programming language used in AAM (Application Activity Model) defined in norm ISO 10303 (STEP). This standard is utilized in data transfer between different Integrated Design Systems.

The SADT methods has been exploited in order to structure the research oriented towards the realization of the directory scheme, for a better definition of the existing situation and for detaching the functional specifications of the projected system, which has to meet an analysis of the needs. We choose the actigramm as tools of shaping in our analysis. We understand to call "actigram" those diagrams of the model, which are graphically represented as boxes designated by verbs, sometimes accompanied by complementary data are represented by arrows and designated by names. This representation allows a description of the series or parallel activities, as well as of feedback.

The model is hierarchically constructed. At its most general interpretation, the system is perceived as a simple box. I can therefore expand and decompose this box, thus creating a first diagram, which can provide wider information in the field. The boxes of this diagram can be deconstructed in their turn, and can create new diagrams, and so on and so forth, until we reach the proper level of detail. The first diagram is presented in Figure 1.

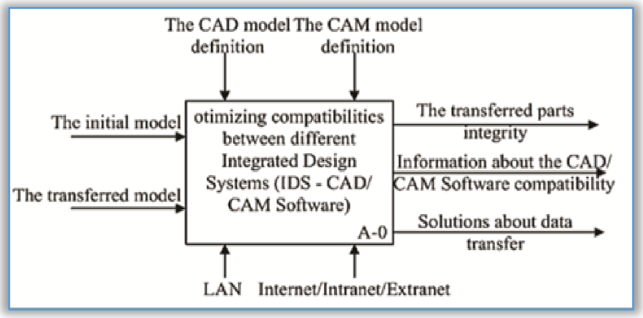

Figure 1. Diagram A-0: The data transfer modeling by using STEP format

The purpose of this SADT diagram is to optimize data transfer between different IDS software. At this case study we work from last year and we don't finish yet but we made some progress from last published paper.

We develop this SADT until the "Generating the 2D or 3D parts/assemblies in CAD Module" activity. There are two ways to elaborate the parts/assemblies in IDS: The first one is to design the parts/assemblies directly in actual IDS and the second one is to import the parts/assemblies model realized in previous IDS.

When the parts/assemblies 2D and 3D are generate from another IDS we must take account about transferring standards (STEP, IGES, and DWG/DXF) and make the adaptation of the part/assembly in the actual CAD. Whichever are the ways to elaborate the 2D and 3D assembly the final drawings and 3D parts are validating in the present IDS by project director? At the end of this stage the virtual prototype is realized and validated. Technical and functional data, part/assembly geometry are inputs.

REASONS OF PDM SYSTEMS DESIGNING

The SADT/STEP/PDM plays a major role in VE. PDM systems are designed to:

- reduce engineering costs by at least 10%;
- reduce the product development cycle by at least 20%;
- reduce engineering change handling time by at least 30%;
- reduce the number of engineering changes by at least 40%;
- store, control, managed documents and other information about products;
- enable engineering teams to share information on products and processes quickly and with consistent accuracy
- permit the integration of techniques such as CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) into coherent business systems across an entire enterprise.

PDM addresses issues such as control, quality, reuse, security and availability of engineering data. PDM offers important new functions for the engineering environment. It will help solve many of the problems that beset today's engineering environment, and for those who master it, will offer new strategic opportunities. The advantages of PDM used in Virtual Enterprises are:

- reduce the time to introduce new products;
- reduce the cost of developing new products;
- reduce the cost of new products;
- improve the quality of products and services;
- improving design and manufacturing accuracy;
- have a strong effect on competitively, market share and revenues.

All these benefits are achievable only if in the PDM systems are used the STEP Standard for data transfer between enterprise and implicitly is very important to improve this data exchange by using SADT technique.

DATA TRANSFER BETWEEN DIFFERENT INTEGRATED SYSTEMS IN VE

The biggest problem in virtual industries is the need to work with the same IDS, in order to keep the historic of each piece of an assembly. This is nowadays one of the criteria of choosing the partners. If the IDS used by the designer is different by the one used by the programmer, the last one will use an imported model with no historic. If there is a revision of the model made by the designer, all the programs for the machining will be lost, just because the model used has no historic and it is like a read only model. In most of the companies there are lots of stories about this transfer issue, all of them with time, money lose.

The compatibility of CAD / CAM / CAE is similar to that used to justify any technology-based improvement in manufacturing. It grows out of a need to continually improve productivity, quality and competitiveness. There are also other reasons why a company might make a conversion from manual processes to CAD/CAM: increased productivity, common database with manufacturing, better quality, better communication between posts, common database with manufacturing, reduced prototype construction costs, faster response to clients/partners.

All these issues would disappear if the parts/assembly transfers between different IDS with historic would be possible. This is the reason why a transfer solution is searched for so many people.

Starting from the similarity of design commands in any IDS, Shaft, Revolved Protusion, Revolve, Revolved Body and Pocket, Cut Extrude, Cutout, is a needed to be created the UML 2.0 architectures for shafts designed in CATIA, SOLID EDGE, UNIGRAPHICS and SOLID WORKS in order to transpose the UML in C++ Programming language and to obtain the agent source which can be transformed in import/export software by a programmer.

After that the users of different IDS will be able to work on the part with full historic. The main idea of this architecture is to be the start point of the future professional software that will improve CAD/CAM/CAE communication between any software. This software is going to be able to read the steps made by the designer in the IDS that he is using and to actually redesign the part in the destination IDS, making the same moves like the designer, but using the other IDS commands. This way the part will be editable after each transfer.

CONCLUSIONS

Numerical Control (NC) machines were first introduced in the early 1950s and sparked the research and development of Computer Aided Manufacturing (CAM). In industry, CAD techniques are extensively used to design products, and CAM techniques are used to manufacture the products. Special languages were developed to translate the shape information from the drawing into computer-controlled machine tools. Current NC programming is based on ISO 6983, called G-code, where the cutter motion is mainly specified in terms of position and the feed rate of axes.

Even though G-code is a well-accepted standard world-wide it is in fact a bottleneck for today's CNC production chain. Programming with G-code results huge programs which are difficult to handle; last-minute changes or correction of machining problems on the shop floor are hardly possible and control of program execution at the machine is severely limited. Even worse, due to many different dialects and vendor-specific additions to the programming language, part programs are not interchangeable between different controls. As a result, porting programs between machines is difficult.

STEP is considered only a way to transfer data between different CAD-systems, but STEP has also developed towards manufacturing information management, the STEP-NC concept. STEP-NC provides not only a full description of the part, but the manufacturing process as well annotating CAD design data with manufacturing information about the stock, its cutting characteristics, and tool requirements. STEP-NC defines data representing working steps, a library of specific machining operations performed at the CNC, so that any controller will be able to calculate the tool path based on definitions contained in formatted routines integrated within the controller itself.

STEP-NC is a new model of data transfer between CAD/CAM systems and CNC machines, which replaces G-code. It remedies the shortcomings of G-code by specifying machining processes rather than machine tool motion. Working steps correspond to high-level machining features and associated process parameters. CNCs are responsible for translating working steps to axis motion and tool operation. Basically, the standard is the smooth and seamless exchange of part information between CAD, CAM, and NC programming.

At the moment STEP-NC standardization is in ISO/DIS phase (Draft International Standard) and international development work continues in many countries. Many end users have started their pilot-projects concerning utilization of STEP-NC and also CAD/CAM software vendors have made implementations for research projects.

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