Computer Aided Decision Systems - Industrial Practices using Big Analytics

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Lecture 35
Product Data Exchange (Part 1 of 2)

Welcome back to the week where we are discussing the Decision Support System for Computer Aided Design and Computer Aided Manufacturing.

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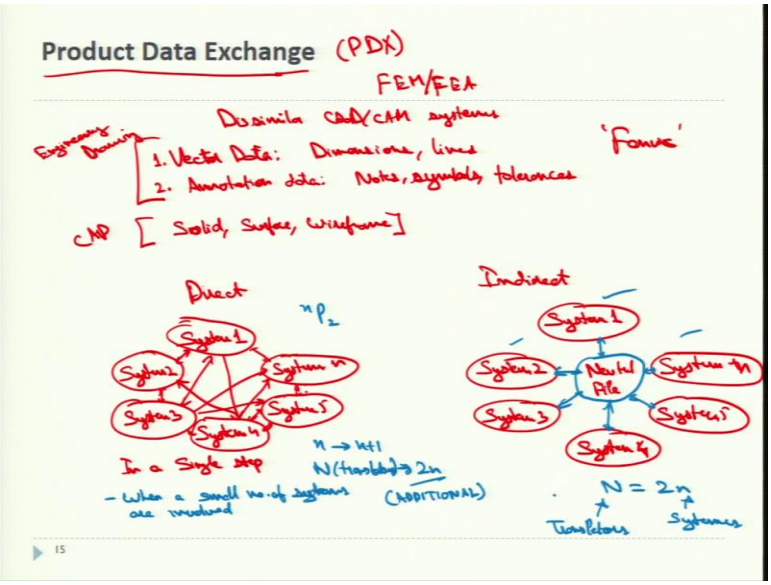

In this lecture, I will try to discuss the Product Data Exchange which is also known as 'PDX', Product Data Exchange, which is a method of drawing the data exchange to use to translate between the different CAD programs and CAX programs. CAX means it could be Computer Aided Engineering, it could be Computer Aided Manufacturing, it could be Additive Manufacturing, Computer Additive Manufacturing or so, whatever you call it.

So, Product Data Exchange is an important topic to be learned, because the basic incompatibilities among the various elements representations which are there in a CAD-CAM system are through the exchanging of the modeling data, even very raw or very trivial geometric entities such as circular rocks are represented by incompatible forms in many systems.

So, some systems such as I talked about nerves, I talked about B supplies that data how do we store the data, how is this data to be read by our final machine that is to do the production over it because it runs a part programming and it develops a program or a code for running the program over it. Even if the program is not to be run, it is for Computer Aided Engineering only where FEM, that is Finite Element Method is to be taken or Finite Element Analysis is to be taken.

The design data is required in the required format. So, transferring the data between dissimilar CAD-CAM systems requires the need of a neutral system that is what we call the Product Data Exchange formats. So, there could be different kinds of data we have in general description of a product that could be given in a,

1) Vector Data: Vector Data I mean, the solid lines, dotted lines, center line, the cutting plane lines which is engineering drawing. The Vector Data which represents the proper dimensions lines.
2) Annotation Data: Annotation Data is the dimension values, or notes, or symbols, symbols for different surface finish requirements, or the tolerance that we put there. So, we can put here the notes, symbols, tolerances, if those are put in the drawing.

These are the data that we get from engineering drawing. In addition, the data that we get is from the CAD models in the form of the solid surface and wireframe that we discussed in the last lecture. So, this is associated with some Annotation Data as well. So, CAD-CAM data exchange gives us the fundamental incompatibility that I said among different entity presentations. Then complexity of the CAD-CAM systems is there which is to be put into a neutral or a balanced system that could have a common language to understand. Then, we have varying requirements of different users, different machines when these are manufactured, the users give their own data, their own kinds of setups, sometimes. And, it is to be manufactured in such a way. For instance, generally within the post processing, we just put that in a block diagram.

There are Computer Aided Manufacturing post-processors which try to read the data that is developed in a CAD or which has been analyzed through a Computer Aided Engineering platform. So, that post-processor, it could be a Fanuc, it could be a German system, it could be a system from different parts of the world. The ‘Fanuc’ is a very general system, to put this name, Fanuc is a very commonly used post-processor or CAM software, which reads a specific kind of the data

files, there are certain restrictions on access to property databases. So, that is why it is required. So, the rapid pace of technological change calls the use of the Product Data Exchange to be understood in the best manner.

Now, there are different kinds of translators that are there for data exchange, so, having talked about the need of what Product Data Exchange is, there are two major kinds of the Product Data Exchange methods, I would call it as:

1) Direct- Direct means, if I have a system 1, system 2, system 3, system 4, system 5 and let me say system n. There are certain systems, so, they have a direct interaction between them. For instance, to SolidWorks when you change a program, when you save the program in SolidWorks that is saved in a SLD PRT or PRT format. Solid CAM is a software that is a post-processor developed by SolidWorks itself, that has a direct interaction. So, it could be direct interaction between the systems, between any systems could interact with any other systems. This is the direct interaction. So, in this direct solution, we produced a direct translator of the data. So, it entails translating the modeling data directly from one of the CAD-CAM system formats to another usually in a single step. This solution converts the data or the database format from one native format to another native format and it requires knowledge of both the native formats in a way. These are generally written by the computer service companies that specialize in CAD-CAM database conversions, there are different companies. I will talk about the top companies who provide the direct interaction between them, between the data software's.
2) Indirect: Indirect translation we have systems here as well. We have a neutral file in the center. Now, the neutral file is able to connect to different systems, it can interact with any of the systems. So, any of the systems whether it is a CAD or CAM system can have an interaction with other systems using this neutral file. So, in the indirect translations, this neutral database structure is independent of any existing or the future CAD-CAM systems. This structure acts as an intermediate tree or a focal point of communication among the dissimilar database structures. These are all the dissimilar database structures of different CAD-CAM systems. The solution converts a native format to a neutral format and the systems can interpret and understand this neutral format. These neutral formats are the only that we need to discuss in this lecture. So, what are the majorly neutral formats. The

interaction between the different systems when the system is designed, if suppose, you need to design a new CNC machine, either you will purchase an existing post-processor in a Fanuc or in a head and hen they are different systems are there or you will try to generate your own post-processor.

Then, you will have to define which languages or which formats would support this. It is just like your PDF file is saved from different formats, PPT could be saved in PDF, your JPEG could be saved as PDF, word file could be saved as PDF, PDF becomes just a Print Data Format that is used for printing in general. So, in the similar way, we have a neutral file that can interact with different post-processors, yes, there are different details in different content formats as DXF, I discussed in the last lecture. It is a 2-dimensional format, only IGES and STEP are a 3-dimensional format, so, neutral file is important. So, generally each of these translators have different merits and demerits.

- So, translators provide a satisfactory solution when a small number of systems are involved. But, as this number increases the number of translated programs which are required between any systems increases, you can see because here n system and each system is interacting with others system. So, it is supposed, if we have maybe two systems to be taught it is a np2 program that has to be developed, so, each time when we add 1 value when n turns to n+1. So, the number of programs double. It is multiplied by 2 in a way. So, when n goes to n plus 1, so, then the number of translators if I put it as capital N that is a translator, increases by twice of the n because many programs are required or different translators are required. So, for a small system where we have a small pair that is to be compared, it is okay.
- ❖ But, for a larger system, we generally prefer the neutral file, in the neutral file the total number of systems or the translators that will be required is equal to 2n for n, number of systems. This is n, number of systems, these are the translators. Please make a note in the case of the direct system this 2n is additional. This is additional if the n is increased just by 1 number. And, in the case of an indirect system, the total number required is 2n only. So, very small number systems, those are there, if you are fixed that okay, I am ready to do a mass production where my machines would be running, this specific kind of the program and only this format I will be receiving, yes, we can work with a direct system you can

have a program, we can maybe purchase a SolidWorks and solid CAM, both of the software's and that can be keep on working.

If we know that our system has to have some best kind of work or maybe a kind of a job kind of a production, if the flow is not a complete product flow, if it is a process flow in your layout, then the indirect system is taken where neutral file is taken because neutral file will keep on changing or keep on accepting the format whatever is taken from the different CAD files that you receive for the different batches that you are trying to produce or manufacture.

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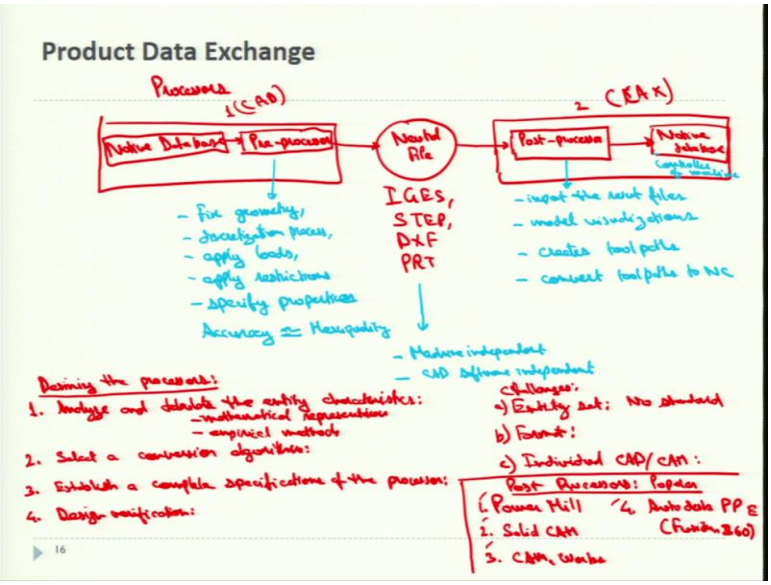

So, when I talk about the neutral file, where does this neutral file fall in the overall database's connections? So, when I say I will just name it as the different processes which are there, what we have is? We have a native database and another native database which means these are 2 different systems, maybe system 1 and system 2, we have a neutral file here that tries to take the data from 1 database to another to connect to the neutral file itself because neutral file has to understand what native database is there, the file has to be pre-processed before interacting to the neutral file, we have pre-processors here. And, once the preprocessor transfers the file to the neutral element here, it goes to the second database where the second native database is also to interact or to communicate with my neutral file.

Now here, what we call is something known as post-processor, consider maybe this is a CAD program or this is a Computer Aided X program which could be in Computer Aided Engineering or Computer Aided Manufacturing anything. Now, this neutral file could be any of the format's that I will just discuss. It could be IGES, it could be STEP, it could be DXF, it could be PRT, any of these files could be there.

Now, here are the pre-processors. What are these? Pre-processors are utilized to fix geometry to continue with the discretization process, apply loads and restrictions. Pre-processors, this is to fix geometry, discretization. For instance, if my file, my CAD is only a solid model that I have developed and my post-processor is Computer Aided Engineering where I need to conduct my Finite Element Method. In this my whole system is to be divided into a mesh. Mesh means it could be a triangular, it could be a trapezoidal mesh that would face the different kinds of analysis over it, it could be thermal analysis, it could be the stress analysis.

So, depending upon that, how do we discretize what is the size of the mesh, this pre-processor tries to work on that as well, then it also applies loads, apply restrictions, then maybe some properties are to be specified, specific properties of the models, constituent materials. So, in the end the file is ready to be transferred to the neutral point or that is a neutral base.

So, because pre-processing takes up the majority of the labor time for simulation study in a way. So, automation tools and ability to customize processes are extremely significant for lowering the overall analyst effort.

So, due to the differences in modeling between Computer Aided Engineering software as well as differences in the handling of data between different CAD systems and maybe the simulation systems as well, managing the data to be imported from different CAD systems is a significant element in the pre-processing step. The accuracy of the analysis is determined by the mesh quality, here I would say accuracy = mesh quality. Mesh quality as I mentioned, is the discretization. Also, the amount of time that is needed for modeling processes is determined by the levels of automation as well as the case specific modeling tools which are used here.

On the other hand, we have the post-processor, post-processors are responsible for importing the result files. These files post-processor analyze using different solvers providing different

environments and tools which are necessary to generate complete reports via maybe model visualization is also taken somewhere. In the case of the CNC post-processor is a piece of the software that generates the tool path. So, once the tool paths have been created in any of the CAD systems, it generates the tool paths. The software also converts the tool paths into NC programs. NC is a Numerical Control Program which is read by the controller of the machine. So, here are the native we have the controller of the machine. The majority of the Computer Aided Manufacturing Systems are designed to be machine independent. Machine independent means these are standalone systems which can interact with different kinds of the CAD software. It can interact with different kinds of CAD systems and on other hand the CAM systems as well. So, these are independent sitting at the center. These 4 processes are just kind of the independent systems, also sometimes with the machine itself. Some specific post-processor is attached that is not independent of the machine, but mostly these are machine independent.

Now, being machine independent enables them to be programmed according to the components independently for the specific machine that will be used to manufacture those components. The toolpath data that is generated by the CAD system is saved in files that are independent of machines. So, these are the files which are known as the neutral files. So, these files I will put here, these are machine independent. Then, these are CAD software independent. While designing the processors, it is important that we follow the specific set of rules, designing the processors.

1) We analyze and tabulate the entity characteristics, when I say entity this means the kind of the entity set that you are using that could be IGES or STEP file. The standard may contain an entity that has no equivalence with any of the CAD systems even.
   - So, this step involves the study of the entity mathematical representation, that is what are the equations that these follow, is it a curve that could be mathematically represented or not? So, are we using a standard curve or are we using any CAD-CAM system that is supporting a kind of the curves or the mathematical representation which are those?
   - In many cases an entity can be represented by a number of nearly but some methods could be there if not mathematical, it could be some empirical methods as well.
2) We define or clear ourselves with what is the conversion algorithm. Select a conversion algorithm. So, this clearly provides the information required to design the proper conversion algorithm. What is the algorithm that we are trying to do? Are we going to

conduct an analysis over it only? Or are we going to manufacture finally, using a CNC or the Additive Manufacturing setup.

3) Then we set it to complete specifications of the processor. When I say complete specifications that means, what has been done in step 1 and 2, the core is built, the data is tabulated and analyzed, we selected an algorithm, then the complete specification of the detailing of the things which are done in step 1 and 2. So, this includes the standard revision of the processor that supports it, the subset of the standard entities it can support and the User Interface of the processor that is to be developed.
4) Then we go for the design verification. Design verification procedure that means we carefully verify where the processor is actually able to operate or interface between different organizations or different vendors. The processor should be verified by developing test data running it through different processors and comparing the actual results. This is how different processors could be designed, there are certain steps to those.

Challenges:

Yes, there are certain problems in those as well problems could be it could be because of the entity set that is there.

- Entity set might not be a very general IGES or STEP, it might not have no equivalents with any of the specific CAD-CAM systems or the system may contain an entity with no standard that is there suppose, no standard is there. In this case, the processor could either ignore translating this entity or translate this entity into a similar one while destroying the original meaning in a way.
- Now, another challenge could be because of the format, when you say format, while standard allows exchanging complex structure and relationships, its format must be processable by a wide range of different computer systems. Therefore, we can only use simple data formats and management methods which are known to these systems.
- Then, it could be individual CAD-CAM systems. When you say individual CAD-CAM systems that means these limits are now relating to the model size, the model space, the data procedure that is required, different systems have different requirements if you are trying to design this system. So, this Decision Support System has to be designed

accordingly as per the requirement that you are making. Now, many people are developing small CNC machines by themselves. They are developing their own post-processors. They are all small companies in India. There are companies in Bangalore, in Hyderabad, in Ludhiana, who are developing these small 3D printers as well. When small 3D printers are developed, they try to see what would interact with the file. So, all these challenges when these are taken, the standard files are taken, but companies which go big, which wish to keep their system within themselves only. They go for individual CAD-CAM that does not interact with very common softwares.

So, this is post processing, how does it work? The top used post-processors in Computer Aided Manufacturing. If I try to talk about them,

1) Power mill- Power-mill is a post-processor or post-processor editor which is a high speed and it is used for generally five axis machining, it is supported by Autodesk wholly, then one of the leading providers of the software is Autodesk, post-processors in power mill are available for a range of CNC machines and even some robots also use them.
2) Solid CAM- Solid CAMs are compatible with SolidWorks and inventor. It is developed by the dissolved systems company that developed SolidWorks only. So, like many CAM packages, the solid CAM is also not very easy to edit. So, it is written in a fine format that is a GPP file format which mostly consists of the different statements, where we need not have any text editor.
3) Cam works- Cam works is a post-processor editor which is a feature-based CAM software and it is designed for adaptable automation. So. It is also provided by SolidWorks only. Cam works is one of the packages or one of the very few packages that offers the post-processor editor for high flexibility. That is the graphical input interface allows you to quickly customize the post-processors and generate error free code out of it other than the power mill, Autodesk has its free version of the CAD software that is known as Fusion 360.
4) For Fusion 360 Autodesk has developed, Autodesk post-processor editor, so this is majorly used for Fusion 360. Fusion 360 is a cloud-based software with the people not having much knowledge about the CAD in a way that amateurs who are there. They can also use this and we also the computer that you have, you can with 8 GB RAM itself. You can only start

using this without even a graphics card; this could work to some extent. So, Fusion 360 provides you with good information about how the CAD software's work. Many drawings could be developed here, but for the detailed analysis sometimes for the very big assembly.

Suppose, for instance, if you need to develop a complete car model, different components assembly or so. You would definitely need a more sophisticated software such as, an Inventor such as SolidWorks or so. Fusion 360 can be useful for the small systems in general, for developing your overall shape, the outer body. These are the major software there are many others that could be put in the list, because there are now 10s of the software which are available in the market.

And, we can talk about many of them but these are the 4 majors that I have mentioned here, for the CAM. I will talk about the post-processors or the post-processor readers for Additive Manufacturing as well in the next week. In the next lecture I will talk about the different entity sets or the format that is IGES, DXF, STEP and we will try to finish this week there. Thank you.