CNC2CNC AUTOMATIC TRANSLATION IN CIM BASED ORGANIZATIONS FOR STEEL PROFILE PROCESSING

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ABSTRACT: When factory owners buy new equipment, especially in the case of CNC Machines, the programing language for the new machine is not similar with those for the elder equipment. This induces a time period necessary for training for the new programming language and for translating the programs form the archives in order to prepare the status of "ready to use" for the new equipment. It is the moment when archive translation under CNC2CNC specifications reveals many competitive advantages.

KEYWORDS: Automatic CNC2CNC translation; plasma jet cutting; archive replication; shortening the "ready to use" status for CNC machines

1. INTRODUCTION

CIM based organizations have often market advantages in terms of quick manufacturing.

These advantages are related with the integrated design-manufacturing chain offered by CAD-CAM applications [5].

Obtaining automatically the CNC programs is the main productivity gain, shortening the cost and time consumption of manual CNC programming.

The CAD-CAM application has in principle a postprocessor that adjust the programming features and can release different CND programs for different CNC machines.

Some enterprises have a business developed through many years and the products are repeated in fabrication with a cadence that cannot be predicted since is based on commands or replacement of large assemblies of parts.

This is the case of factories for towers for power lines where the replacement of a tower or of a subassembly of ten occurs years after the first fabrication.

The original design could be elder than the CAD-CAM system and all CNC programs were released using manual programming.

Even if a postprocessor is available, the whole construction must me reengineered through CAD in order to obtain the programs for the new CNC machine.

This can bring a lot of cost and time consumption and can lower the general profitability of the enterprise.

2. CIM INFRASTRUCTURE FOR STEEL PROFILE PROCESSING

The manufacturing of steel products is oriented on CNC machines able to cut, trim, bore and mark steel profiles or steel plates. Even if the assembly is weld oriented, the component parts must be obtained following the same machining scheme.

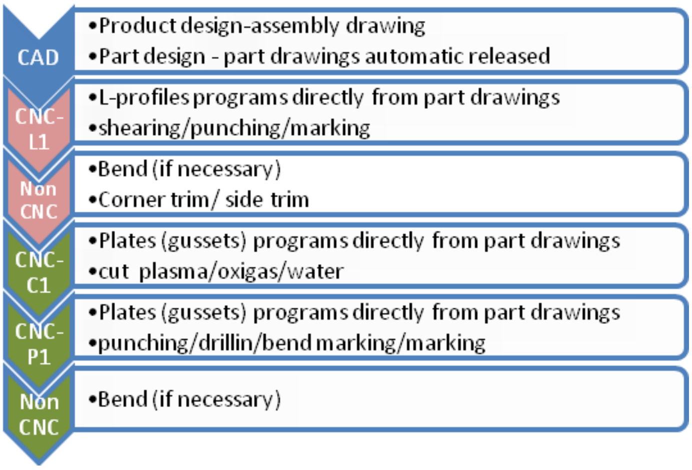


Figure 1. Manufacturing steps for steel constructions

Figure 1 shows the manufacturing flow for steel L profiles and gussets as parts of a power line tower steel construction. There are three types of CNC machines involved:

L type - L steel profiles (usually with equal sides of L)

C type - for cutting contour of plates with energy jet (plasma, oxygen-gas, water)

P type - for manufacturing plates

The factory can have a history of manufacturing steel constructions that could be even older than the introducing of the CIM manufacturing system.

This means that are available archives of programs for NC machines elder than archives released with the CAD-CAM application.

The format of the programs in archives is adapted for the first NC machines involved in steel parts manufacturing, part of them being further in use, part of them obsolete due the renewal or replacing of the manufacturing machine park.

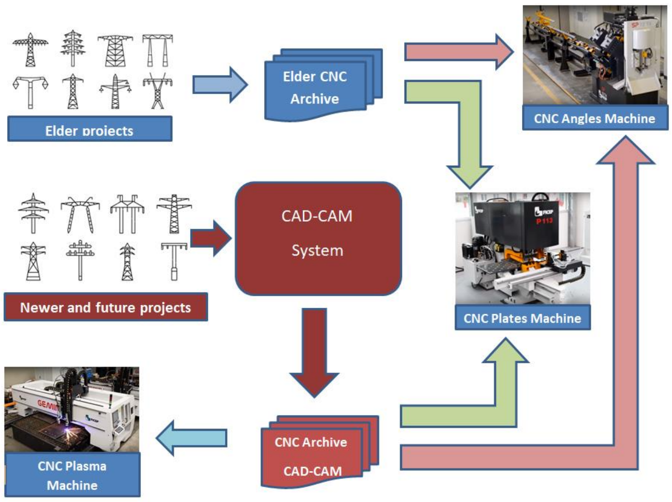


Figure 2. Flow of CNC programs from elder and newer archives

3. CHANGING OR ADDING CNC MACHINES

The CNC machines ecosystem can suffer changes that consist in renouncement on elder CNC machines, renewal of elder machines or introducing new CNC equipment.

There are more scenarios that will interfere with the established CIM system.

Scenario 1: Old machines are further in use in parallel with the newer ones.

This scenario conducts to a multiplying of the manufacture capacity from the day when the archives written for elder CNC machines are available also in the new CNC language.

Even if the CNC machines are the same, newer products are often with different specifications for programming, sometimes extremely different.

When the project was developed through CAD, the solution is in most CAD-CAM systems to write a new postprocessor that covers the specifications for newer machines. Not all systems offer this solution and often the skills of the designer are not sufficient to cover this task.

When the archive is elder and CAD database for them is not available, the solution is reengineering and then generation of new CNC archives for each CNC Machine.

Reengineering brings a lot of time and cost consumption because old drawn planes must be drawn again into the CAD application that can generate the CAM archive.

Scenario 2: Old machines are not in use anymore but old archives are written in this CNC codes.

Solution is reengineering and generation of newer archives written with appropriate CNC codes.

In some cases the reengineering is not available since drawn parts even in paper release are no available or become illegible.

Both scenarios show the same difficulties and losses.

In order to shorten the release of new archives is to consider cutting the reengineering phase and introducing a procedure of automatic translation of CNC archives.

4. CAD2CAD AUTOMATIC TRANSLATION

The archives are organized as folders having as content files written in correspondent CNC codes for angles parts or for plates. The files are often unsorted and the codes for the two types of parts are different.

The CNC2CNC convertor must follow some steps in order to perform the automatic translation.

- Conserve the path for the source directory;
- Read the whole directory content and forms a database with names of all files;
- Conserve the path to the new directory archive that must build;
- Select the CNC specification set for new archive;
- Perform the translation both in one2one file and in mass translation;
- Notifying the user up on the number of angles and plates files converted;
- Establishing the marking strategy (directly from CNC source or as default from factory specifications).

The structure of the new directory is divided, having an angles directory and a plates directory, the translator can write each part type in the designated destination, as advantage for further manipulation of files.

The translation process can be improved with features as automatic evaluation of CNC source code and marking the bad programs in a list in order to correct and reinsert them into archive.

Table 1. Description of CNC code for angles (old FICEP / Fenice-Mitrol)

Header	
N:SP_101 G71 D:SP_101 C:SP_101 P:L45X5 M:S235JR LP1911 SA45 TA5 SB45 TB5	Part Code Angle profile Material Angle length Wing Thickness
Mark description	
TS88 X250	Mark Mark position on X
Punched holes	
TS11 DA13 X911.5 TR25 X1576 TR25 X1611 TR25 X1811 TR25 X1861 TR25 TS11 DB13 X821.5 TR25 X881.5 TR25 X1836 TR25 X1886 TR25	Punched hole FaceDiameter X position Y position Order on X as default by translator
Footer	
M30	End of program

Table 2. Description of CNC code for plates (old FICEP / Fenice-Mitrol)

Header	
N:SPL_101 G71 D:SPL_101 C:SPL_101 P:P88.5X6 M:S235JR LP204 SA88.5 TA6 CA25 CB75	Part Code Plate profile Material Angle length Wing Thickness
Mark description	
TS88 X100 TR100	Mark Mark position on X and Y
Punched holes	
TS11 DC13 X25.5 TR20 X38 TR68.5 X165.5 TR68.5 X178 TR20	Punched hole FaceDiameter X position Y position
Footer	
M30	End of program

For each file from the elder archive will be performed following cycle:

Step 1: Reading the file (text without formatting)

Step 2: Clipping the header information

In this step the information can be on one or more lines in a specific format that describes the part code, material type (angle or plate), material dimensions (length of the angle or length and width of the plate), material standard description (quality).

Step 3: Clipping the manufacturing information for punches and marking

For each hole that is to be punched is indicated the actual face (A or B for L angles) X position from part origin and Y distance from the main edge (corner of L profile)

This cluster could be very large as number of lines but are homogenous described.

Step 3: Clipping the Mark of the part

Step 4: Generation of the new header

Step 5: Generation of the new cluster of holes description

Step 6: Generation of the new marking information

Step 7: Generation of the new program footer.

Step 8: Writing the new program in the appropriate folder

The name of new file will be the code of the part followed by the appropriate extension.

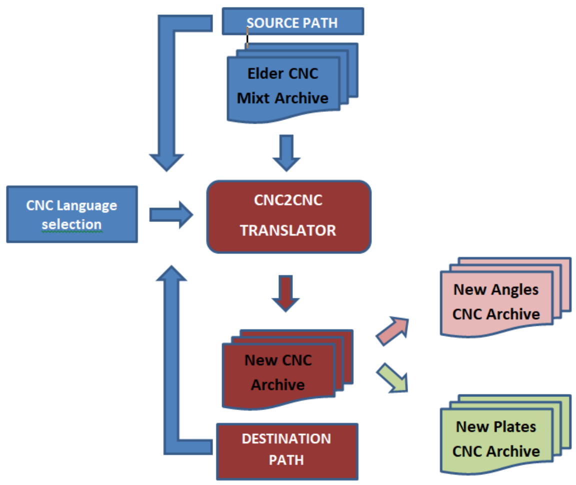


Figure 3. Automatic CNC2CNC translation of elder in newer archives

This format used for elder CNC machines that could be or not any more effectively used, can be retained as meta-language for describing the whole manufacturing process.

The CAD-CAM system that was to time developed has the particularity that generates CAN programs in these meta-languages.

A new postprocessor can be written, but as shown above, sometimes the reengineering of a project is quite impossible to be performed due lack of time and lack of information.

Am more efficient approach is to translate the old archive using CNC2CNC translators.

For each new CNC machine can be developed a new translation tool that follows the same rules.

Since an archive of thousands of parts is translated in up to five minutes, the efficiency of the translator is proven.

A new installed CNC machine can be used in the same day or in the following day, multiplying the manufacturing capacity.

Table 3. Description of CNC code for angles (new FICEP Fenice-Mitrol [2], [4])

Header	
[[PRF]] [PRF] CP:L P:60X60X5 SA60 TA5 SB60 TB5 [[MAT]] [MAT] M:H2 WS7.860 [[PCS]] [HEAD] C:CIPRU D:D1 N:D1_A2R_0LL20 POS:1 M:H2 CP:L P:60X60X5 LP2055 QI1 SCA101	Angle L profile Material Angle length
Mark description	
[MARK] X290.5 Y25 N:D1_A2R_0LL20 MOD0	
Punched holes	
[HOL] TS11 DB15.5 X30 Y35 [HOL] TS11 DB15.5 X1063 Y35 [HOL] TS11 DB15.5 X1163 Y35 [HOL] TS11 DB15.5 X2025 Y35	

Table 4. Description of CNC code for angles (VERNET-BEHRINGER)

Header	
Affaire :EAU_33 Plan :L0 Repere :ADCB_029A Profil :L60*60*5 Longueur :2684.5 Qaf :1 Qtf :0 Etat :H2 Origine :	
Angle description	
Debut Profil Forme :L Largeur :60 Hauteur :60 Epame :5 Epaile :5 Fin Profil	
Punched holes	
Debut Percage 1,2366.5,25,0,M 1,25,33.5,17.5,T 1,85,33.5,17.5,T 1,1280,36.5,17.5,T 1,1973,36.5,17.5,T 1,2606.5,36.5,17.5,T 1,2659.5,36.5,17.5,T 2,55,30,17.5,T 2,115,30,17.5,T Fin Percage	
Other	
Debut Decoupe Fin Decoupe Debut Dec Libre Fin Dec Libre Debut Coupe 0.00 0.00 0.00 0.00 2 Fin Coupe Debut Macro Fin Macro Debut Contour Fin Contour	
Mark Description	
Debut Info Commentaire : Marquage :ADCB_029A Norme : Next : Fin Info	
Footer and other …	
Debut Grugeage Fin Grugeage Debut Doubles Biaises Fin Doubles Biaises Debut Barre Fin Barre	

5. NEW CLIENTS AT HORIZON

The CAD-CAM system in the CIM based steel construction organization offers several advantages in terms of using the manufacturing capacities and enlarging the palette of clients.

Several organizations are able to perform great designs using different CAD applications, some of them at great scale (Tekla, AdvancedSteel, Bocad).

These software applications can use the DSTV standard to describe the part in terms of material, code, geometry and manufacturing features.

Table 5. Description of DSTV code for angles

Header	
ST	
ÎÏ 05-18	
001	
Sp.101	
Sp.101	
S235JR	
2	
L45X5	
L	
1910.94	
45.00	
45.00	
5.00	
5.00	
7.00	
Punched holes	
BO	Side
u 1575.94u 25.00 13.00 0.00	X
u 1610.94u 25.00 13.00 0.00	Y
u 1810.94u 25.00 13.00 0.00	Diameter
u 1860.94u 25.00 13.00 0.00	
u 911.75u 25.01 13.00 0.00	Non-order
h 1835.94u 25.00 13.00 0.00	From post-
h 1885.94u 25.00 13.00 0.00	processing
h 881.75u 24.99 13.00 0.00	
h 821.75u 24.99 13.00 0.00	
Mark section	
SI	
v 250u 2.00 0.00 10rSp.101	
EN	End program

This standard becomes more and more used by CNC machine as standalone coding system, replacing the G-code and their variants.

Not all sections of DSTV are used on all CNC machines programs due the special features that are often missing.

The examples from Tables 5 and 6 are for CNC Machines where holes are punched (BO sections) and marking is stamped (SI section). Other CNC machines can have drilling and plasma jet cutting.

Postprocessors for DSTV permit to describe the entire part through a single file and are suitable for angles of any profiles and plates.

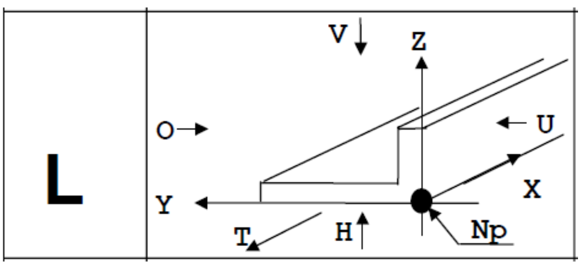
The clients are interested in finding factories able to process parts releases with third part CAD projects.

Most of them search opportunities to manufacture the designed constructions on lowest cost or faster.

Reengineering the design into existing factory CAD-CAM application is not a solution because is costly, time consuming and not certified by the authors of prime design for end users.

Table 6. Description of DSTV code for plates

Header	
ST	
ÎÏ 05-18	
001	
Spl.101	
Spl.101	
S235JR	
2	
?6	
B	
203.87	
88.45	
0.00	
0.00	
6.00	
0.00	
Punched holes	
BO	
v 25.74u 20.00 13.00 0.00	
v 38.09u 68.45 13.00 0.00	Side
v 178.13u 20.00 13.00 0.00	X
v 165.78u 68.45 13.00 0.00	Y
	Diameter
Other information	
AK	
v 0.00u 0.00 0.00	
v 203.87u 0.00 0.00	
v 181.32u 88.45 0.00	
v 22.55u 88.45 0.00	
v 0.00u 0.00 0.00	
EN	End program



V = front view; U = bottom view; O = top view; H = rear view; T= transportation vector

Figure 4. DSTV description of L profile [1,3]

Only solution is to become from the design team the archive of ready to use CNC programs written in a format that is supported by the postprocessor of the CAD program.

The archive will be translated with a CNC2CNC translator in the format of a meta-language archive and the retranslated using the common translation tools available for each CNC machine.

The double translation forms a chain of modifications and adaptation of the information generated from original design source, without reengineering and without any alteration of information.

Complete description for DSTV blocks used in CNC programming can be found in [1,3].

Contour description in DSTV description for plates is used to generate CNC code for plasma/oxi-gas/water jet machines. These are obtained directly from the translation, using the contour description under AK section of DSTV file.

More contours can be evaluated and nested to a comprehensive plate that conducts to a more efficient use of the material.

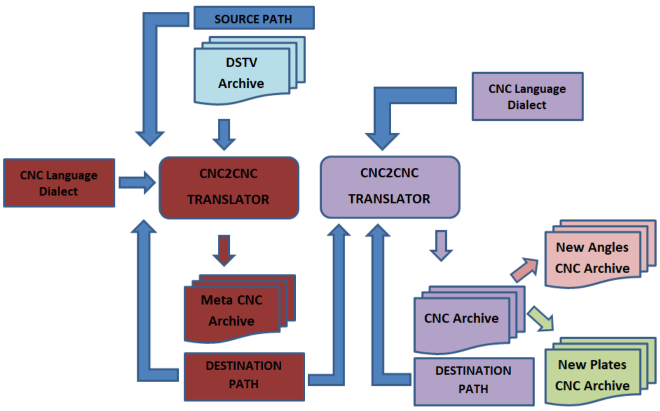


Figure 5. DSTV translation chain using meta-language for new CNC languages

As shown in figure 5 it can be considered a chain of transformation from a DSTV source using as first step a translation to the considered meta CNC language (historical existent in the factory, used as main postprocessor in the CAD-CAM application) and as second step a translation from meta CNC language to other existent CNC dialect/language.

6. CONCLUSIONS

There are some important conclusions related with the translation CNC2CNC of programs archives:

- Make reengineering unnecessary;
- Time/cost consumption sinks at lowest level;
- Accuracy is 100% (without any other human interaction);
- Chains of translations can easy performed;
- Introduction of a new machine as ready to use is possible at shortest time;
- Manufacturing capacity can easy increased since two or more machines can be used simultaneous for the same steel construction;
- Increase the "just in time" capacity to serve the clients.
- Offers the possibility to exploit the information from archives transferring into the enterprise database as source for other CAPP (Computer Aided Process Planning) applications;

7. ACKNOWLELGEMENTS

The examples are selected from the part archive manufactured at S.C. ELECTROMONTAJ S.A. – FSMZ (Galvanized Metal Towers Factory) where the CAD-CAM System was implemented since 2003 through 2007 and the multi translate CNC2CNC system was continuously developed and improved from 2012 through 2019.

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