Method of the Computer-aided Design Control and Adoptation into the Practice

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Abstract*: Primarily the CADC method is known as a new concept in modern manufacturing automatization. It is an acronym: Computer Aided Design Control. It means an integrated manufacturing control, where the CAD system controls and supervises machines and manufacturing devices. My aim is to examine the advantages, disadvantages of the system and its economic index. We can calculate the practicability of the method and determine the production and the profit. by means of a simple example. The poster shows the main part of the production with FMS – Flexible Manufacturing System. On the other hand, it describes a flexible CADC application. The final result is higher technical efficiency. In the examination of economical efficiency we calculate the costs and yield during serial production. The serial production of a complete chess kit is demonstrated here. I compare the FMS system with CADC manufacturing users. Very often, a new technical method might seem to be modern but its economical efficiency might change over time. Therefore, I fixed the frame conditions of the function, for example, the amortization costs are linear calculated,for a period of 3 years, the inflation rate and the basic interest rate are defined according to the National Bank's forecast in August, 2010. The technical, manufactoring and investment data , as well as the pay costs are calculated on the basis of the wages of average skilled workers. The sales prices are defined by comparing the internet prices of similar products. I determine supply and demand by SWOT analysis. Finally, I make a summary and put foward a proposal for further research and improvement of the CADC system in the near future.*

Keywords*: CADC; Computer Aided Design Control, FMS; Flexible Manufacturing System; SWOT analysis*

1. Introduction

1.1 Presentation of the topic

Nowadays the numerical control in principle is using in wide area of industry. NC[1] technology created the possibility of creating automatic manufacturing cells

and systems. Today NC machines operate with high performance computers. As a result of this CNC^2 machines with numerical control established. With CNC machines onbuilt machining tools and automatic exchange of the tools it developed so-called machining centers and then flexible manufacturing cells are created by workpieces automatic storing and exchanging. Flexible manufacturing systems (FMS^3) also developed by the flexible manufacturing cells are connecting with management network. Thus created high level manufacturing automation and it becomes more economical of every day. Of course it thanks to the flexibility of.

There are prominent role on my subject of CNC and the programmable logic control technology (PLC^4) and their programming. In addition to say about significant of CAD^5 and CAM^6 technologies too in my topic.

During my work I am investigating the possibility of CAD system become more efficiency.

To this end I have created some simple software module called Macros. These easy to use and allow interoperability between the technologies. My result not only a CAD software but also a method which can help engineers in merging work tasks.

My development is not simply involve programming because I got possibility of testing full system at a Company. Studies measuring the results gave me further proposals which can help to future use or any development will help.

1.2 Objectives

My aim is to prove that we could do self-control FMS by CAD planning program.

Tasks in this topic:
- To lay the theoretical foundations of using method
- To create softwares necessary to introduce
- To examine the entire process through a practical working
- To documented the results of practical measurements
- To analyze the economics of it
- To explore the strengths and weaknesses of the method
- Necessary to determine the future development directions

The main objective is to achieve as a result of experiments necessary project made parts were manufactured for Divisions of the Ltd. It is a tangible evidence of my method of operation.
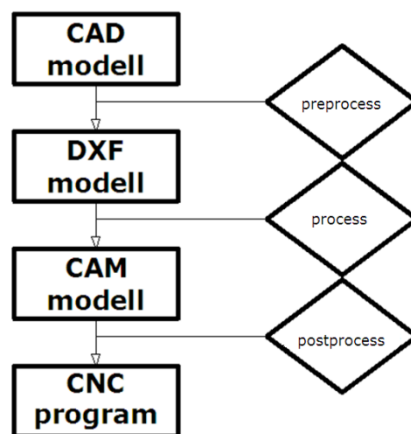
1.3 List of Abbreviations

NC1 : Numerical Control
CNC2 : Computerized Numerical Control

FMS3 : Flexible Manufacturing System
PLC4 : Programmable Logic Controller
CAD5 : Computer Aided Designing
CAM6 : Computer Aided Manufacturing
DNC9: Direct Numerical Control
DXF23: Data Exchange File

2. Introduction CADC technology

1.   figure Tasks of process

Most product born in CAD engineering system, gets form and other qualities. The manufacturing system gets data from a CAD system DXF file. The CAM system make tool paths from the CAD modell. The tool paths and the techology parameters (for example cutting speed, deep…) write into the convertibily manufacturing file. This file need to translate to CNC machine language. It is called gerber file. Too large gerber file can make from a difficult product. So the memory of the CNC machine can be full. In this problem solution if you use DNC process card, that makes a lot of DNC program packet from the original CNC gerber file.

The komplex CADC method:

1.   Product engineering in form 3 dimension body.

2.   Engineering product manufactoring technology.

3.   Drawing 3D tools.

4.   CAD virtual factory building.

5. Load the product 3D body into CAD virtual factory

6. Import or drawing tool paths into CAD virtual factory.

7. Moving paths export into DXF file.

8. DXF file translate convertibility manufactoring file by CADC moduls. DXF>CNC, DXF>PLC.

9. If need use postprocess moduls to translate manufactoring file on CNC machines language. CNC1>CNC2, PLC1>PLC2.

10. Generalling   DNC   packets   and   syncronized   timing. CNC2>CNC2.1+CNC2.2+CNC2.3, PLC1(STL)>PLC1.1+PLC1.2+PLC1.3

11. CAD simulation.

12. Sending packets to the manufactoring devices (CNC machines, robots and manipulators…)

13. Feedback: understand and visulaized coming informations from the factoring system.

13+1. Making Head-product and save it in the AI database.

The substance of the CADC method is that, the geometry of drawing objects write the moving paths and the other attributes mean the technology parametres.

I choose the AutoCAD system because this sofware is well-known, good market position, and simple programable.

I write the CADC process in the simple BASIC language because my aim that everybody understand it, and use in practice. The method does not depend on concrete softwares. You can use other CAD system and other program develop language to test CADC method.

The CADC moduls are made to the first DXF format, because every CAD system can use those. This DXF file format develop by AutoCAD R12 or LT version.

Object	Command	Layer	Color	Line-type	Coordinates	Other	Number of oppor-tunities
Circle	CIRCLE	1	1	1	3 Centerpoint (x,y,z)	1 (Sugar length)	7
Line	LINE	1	1	1	6 (Endpoints (x0,y0,z0-x1,y1,z1))	0	9
Polyline	POLYLINE	1	1	1	6 (Endpoints (x0,y0,z0-x1,y1,z1))	1 (Sugar length)	10
Arc	ARC	1	1	1	3 Centerpoint (x,y,z)	1 (Sugar length) (Start angle) (Finish angle)	9

1. table Compare attribute of drawing object

You can see the most information are containted in the polyline (10 independent variables).
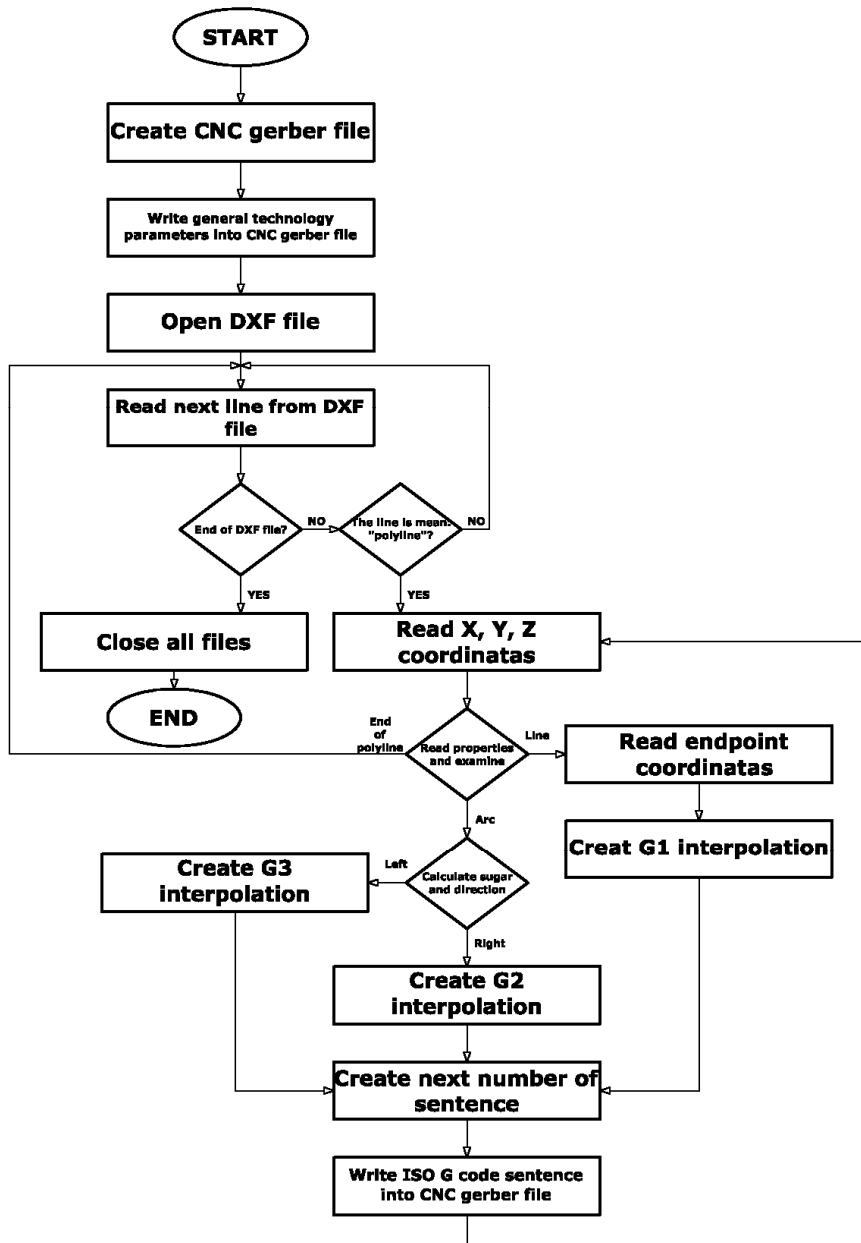
Every modul use it, that I made. Next, I tell you how can adopt itto the practice.

2.1 CNC-CADC Integration
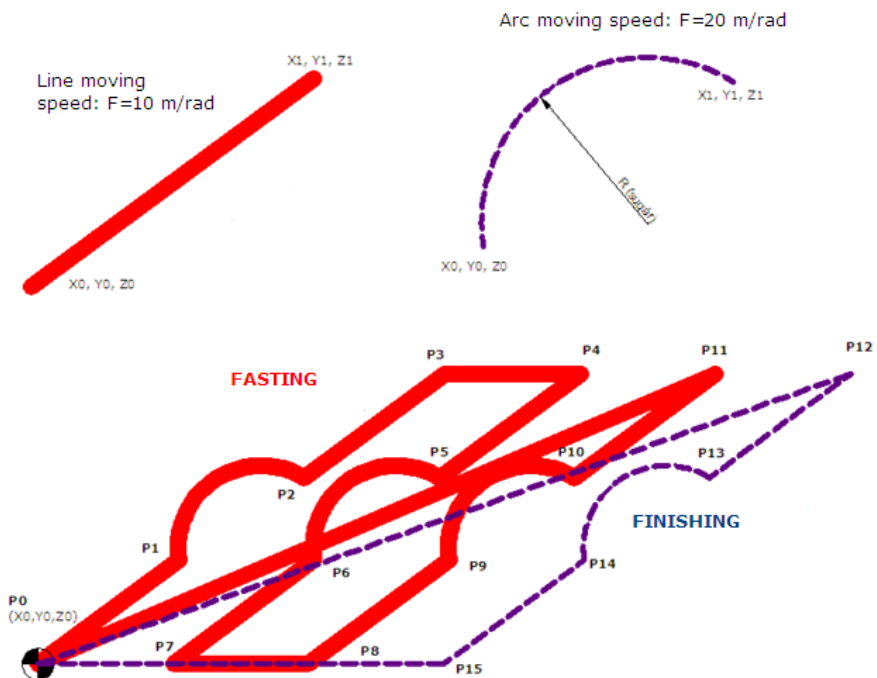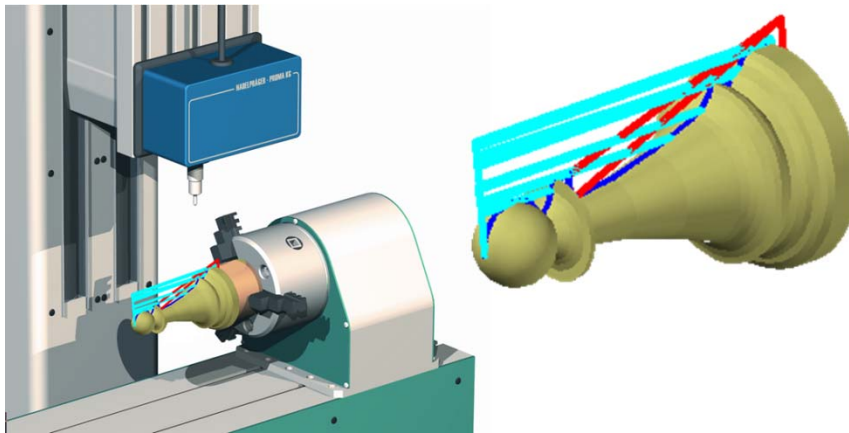
2. figure Part of moving add to technology operation

The moving paths of machines export from CAD system to the DXF file. After run the DXF2ISOG process. After process you get the CNC command file, that you can send your CNC machine, robot or transport devices.

3. figure Process of DXF-to-ISO.G

2.2 PLC-CADC Integration

You can use the CADC method also in the PLC technology. For example change the control drill, cutting machines, manipulators and other matterial transportation devices. Keep the principle of the method in view add the PLC inputs and outputs the start- and endpoint coordinatas of lines. The color of lines mean type of logical connections.

Logical condition: $Q2 = I3 \cdot I1 \cdot I0 + I1 \cdot I4 \cdot I0 \cdot (N \cdot F0) + I2 \cdot I3 \cdot F0$
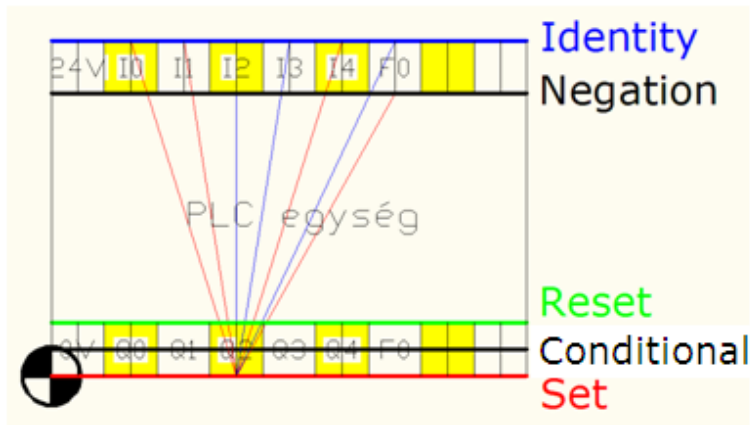
4. figure PLC programming by CADC method

The process search and write the logical conditions into the PLC text format command file from the DXF file. You can direct upload this PLC gerber file to the PLC.

2.3 DNC-CADC Integration

In the CADC system the timing of manufacturing and transportaions devices is realized by small command program packets. This program packets can send not only one machines. If need more production capacity same packet send parallel to more machines. In the every small program packets begin lines and the end lines have to join to the host machines language. Every packets need autonom, corrected CNC command file. Syncronization timing change:

- DNC packets sending time
- DNC packets file size

In my manufacturing tests I send 900 kB DNC packets with 9000 rad/minutes and 0,350 mm/rad technology parameters. Program cycles and subrutins didn't in the DNC packets. Only DXF exported tool paths. I could calculate the exact product time. Between the calculated time and the test product outcome the largest

difference was only +/- 8,5 minutes. This value is accept in the modern flexibility manufacturing system.
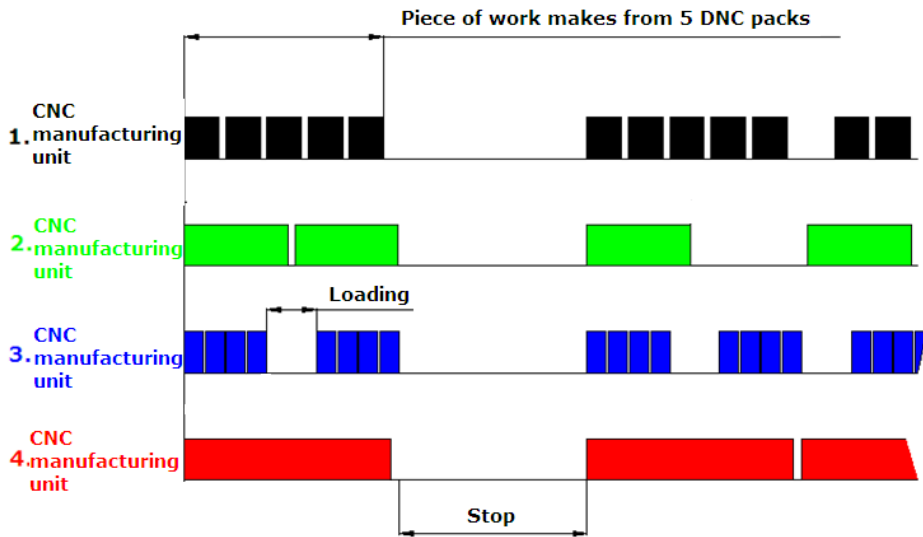
*5. figure Manufacturing units are timed by DNC program packs*
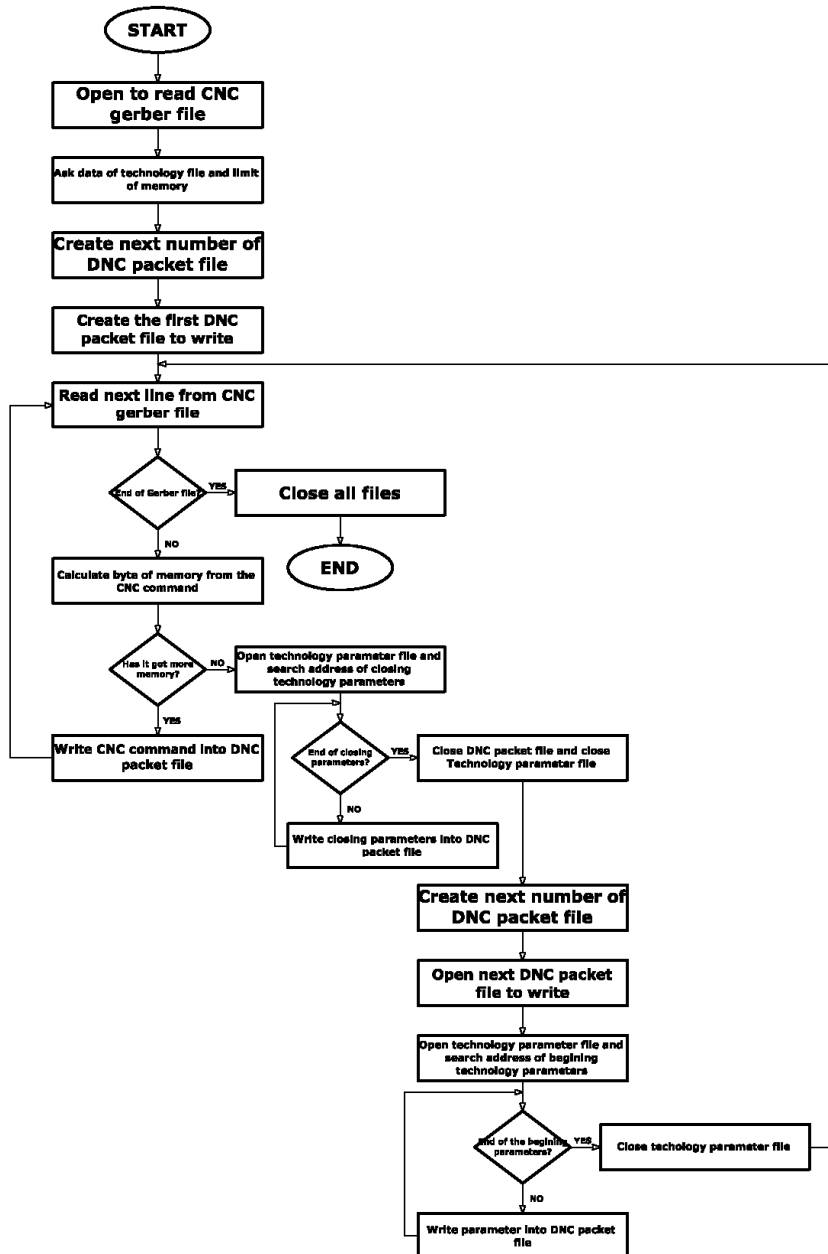
6. figure DNC process

2.4 Post-process modul application in the CADC method

The post-process mean that the geometry and technology data adopt on the concret machine.

My CADC system works in the ISO-G code. It means you can leave post-process if your machines understand the ISO-G code. There are two reasons why I made the CADC post-process modul:

- The hungarian industrial and hobby CNC owners use about 60% german machines often with NCP program language. They need it.

- I have to prove the G code is suitable to use and became every CNC program base language. The G program code can translate to every CNC program language.
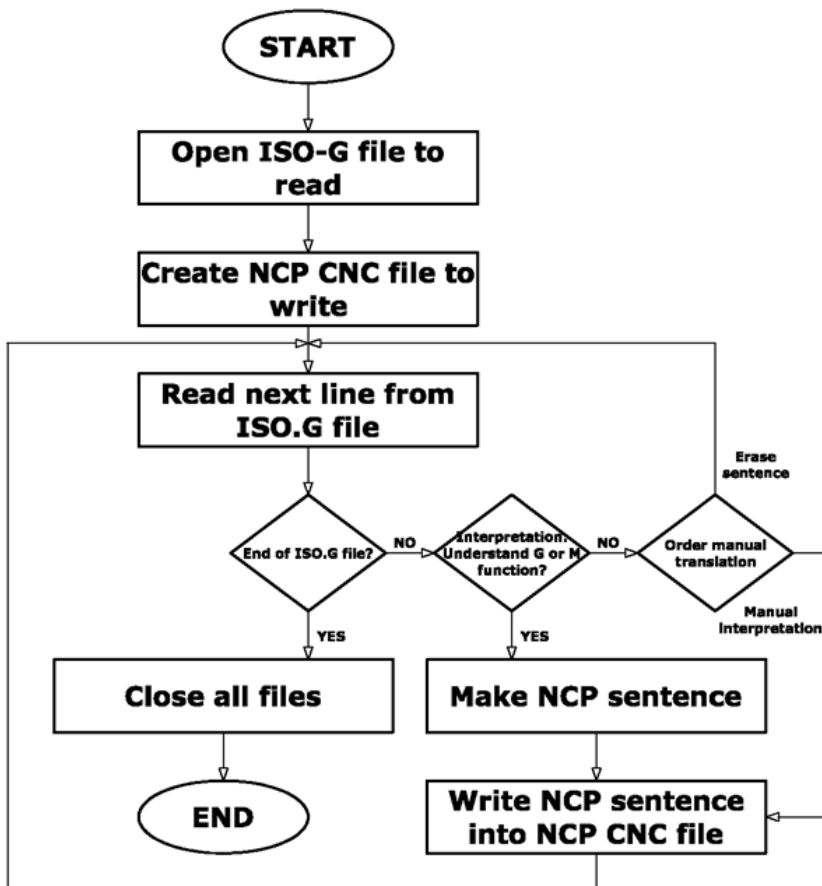
7. figure ISO-G code translation to CNC-NCP code

The test of the postprocess modul was executed on some polyline. The polyline was exported in the DXF datafile. Before I made the DXF-2-NCP modul same as DXF-2-ISO.G modul. I run both moduls (DXF2ISO.G + ISO.G2NCP). After I run the DXF2NCP post-process modul too. Both NCP file was same.

DXF-ISO.G + ISO.G-NCP = DXF-NCP

3. Development trends

Processes are established by CADC method in an external development enviroment. And also external DXF source file needed to use them. The advantage of this concept is that their use not subject to CAD and any exchange of data files can be processed by CADC.

If you selected CAD system, you aren't need to use data exchange file (DXF). Because we could integrate the system of written processes such as AutoCAD interior application.

There are several methods to choose the integration CAD system of processes.

- Using Visual BASIC programming language we create high level macros to the drawing.

- Using AutoCAD system's programming language called AutoLISP. AutoCAD commands can be defined as processes. Commands for easier access we can change text structure in file menu of AutoCAD. For example we may add their own menu.

CADC method of the first 12 are control characters. 13th in section we can find feedbacks which would create graphic animation supported real time condition monitoring.
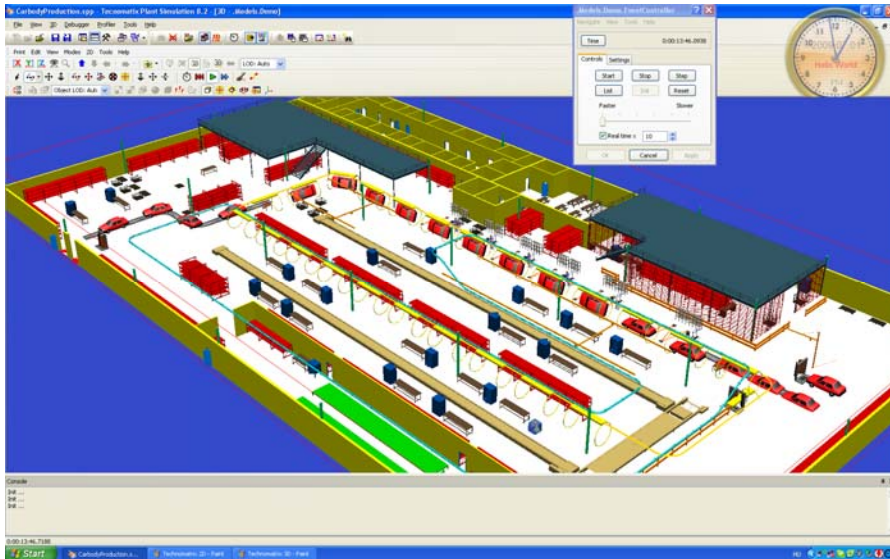
*8. figure 3D virtual factory*

We can set up an engineering-technology knowledge base with regulation system of CADC method (feedback information on potential). Products and their operational and production information are assigned to graphic information about the properties of objects jointly build a network of expert system.
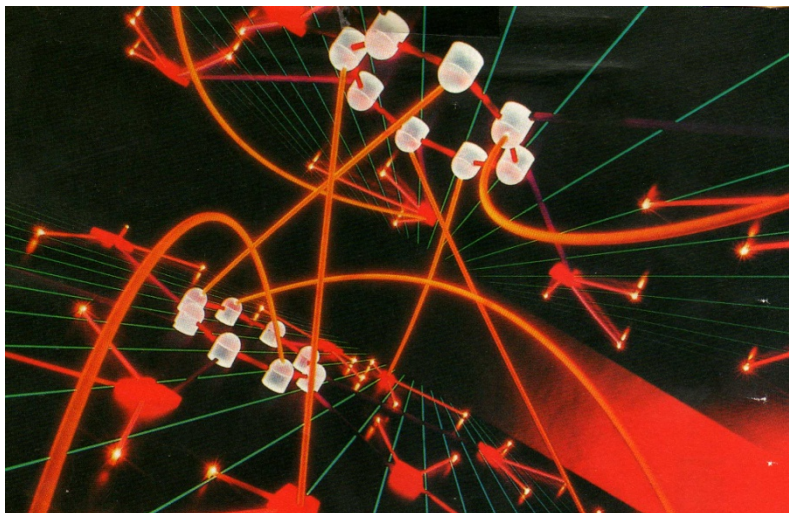
9. figure Data connection with graphical objects in the CADC database

This expert system is capable of generative method of controlling the production of general parts. (general parts are rather complicated complex products which contain several similar but simpler geometry of all ticket product and assigned to technical instuctions for the entire geometry and operations can be called from them.)

If an order was received for a product, we get pared downed general part by generative way parts ordered product of the manufacture. As the data base of pared downed general part contains the information needed for production technologies and operating instructions. After comparison and simplification of the same order we get the needed information for production operation automatically.
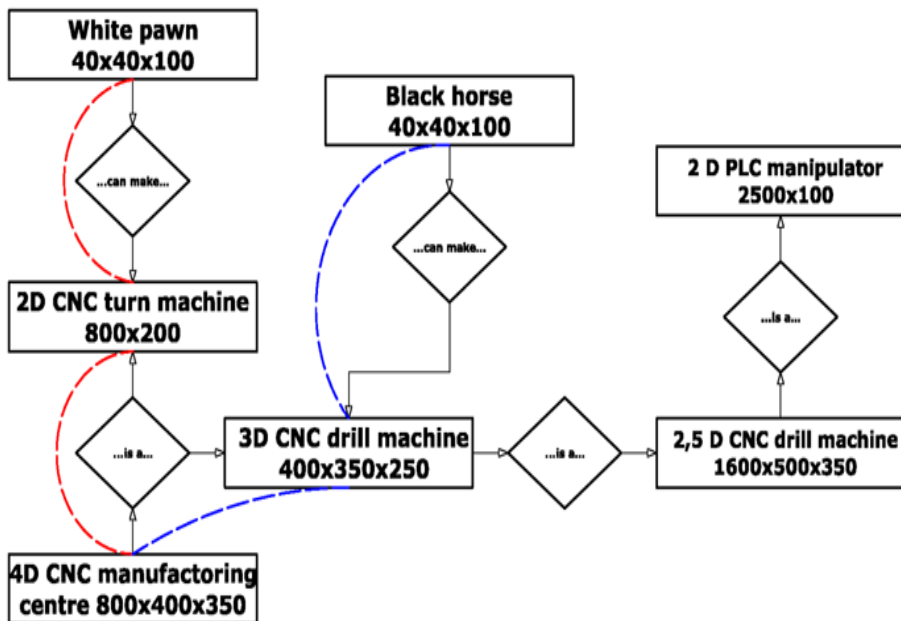
10. figure Artifical Inteligence database connection

As we can see the above chart reversing the direction of data between (dashed curves network) we get manufacturability conditions. We can apply the method similary for an CAD-based enterprise management system. Processes make transmission of data packets from similar flowcharts for clients who are allow or reject with their confirm is a function for CADC processes of continuing the tasks defined in the flowchart.

4. Economic analysis of CADC method

These are the technical efficiency of CADC:

- Less error

- Less cost

- Faster

- More opportunity AI (Artifical Inteligence)

- The communication is in the one channel

Very often, a new technical method might seem to be modern but its economical efficiency might change over time.

I compare the FMS system with CADC manufacturing users. And examine CADC production as investment oppurtunity.

In the examination of economical efficiency we calculate the costs and yield during serial production.

The serial production of a complete chess kit is demonstrated here.

The Chess Kit serial production is profitable just in the CADC because the technical efficiency better than the traditional FMS. So there are some products which unprofitable production in the traditional FMS.

Other hand, the CADC Chess Kit serial production is 8x better investment than you hold your money in the Bank.

I fixed the frame conditions:

- The amortization costs are linear calculated, for a period of **t = 3** years,

- The **i**nflation **r**ate (3,5 %) and the basic interest rate (5,25 %) are defined according to the National Bank's forecast in August, 2010.

- The **VAT** is 25 % (percent).

- The sales price E_t (4.792 HUF) is defined by comparing the internet prices of similar products.

- I determine supply (**S**trengths = 9, **O**pportunities = 6) and demand (**W**eaknesses = 1 and **T**hreats = 2) by SWOT analysis.

- **Vt** means percentage of successful production: 90 % (Inside modifying factor)

- **Ve** means percentage of successful sale: 75 % (Outside modifying factor)

- Technical and manufacturing data:

- o K_{cnc} means cost of the CNC factory machine

- o $K_{matterial}$ means cost of the production (matterials, energy, maintenance costs)

- o K_{wedge} means the wages of average skilled workers

- o T_{set} means one Chess Kit full production time

You can see in the Economic index table (window) the calculations:

r means the fact rate
Vt and Ve calculatio
Rmax means the production maximum income
Re means the oppurtinity of bank investment maximal income
I means economic index

Finally, I=8,1 is mean your money 8x (eight times) better in the CADC production than it is holden int he bank. And You can see in the Suggestion window my short tips about improvement of the CADC system in the near future.

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