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Research Paper

Overview Role of Simulation Package in Virtual Manufacturing and for CNC Machinery

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Abstract

Computer Numerical Control Machines (CNC) totally changed the scenario in manufacturing industries in terms of production volume, easy flexibility and with fewer deviations. As customers expect high grade of accuracy, precision, reliable and prompt supply it became essential in the manufacturing sector to reduce the time for developing and proving out new products. Normally programming and proving out the same plays a significant role in the product development cycle. Nowadays several software packages are there to stimulate the tool path, sequence of operations and validation of the program to ensure flawless performance. These packages do serve additional role of optimizing the program sequence and reduce the cycle time involved to manufacture the parts concerned.

Keywords: *CNC Machines, Manufacturing, Product Development, Simulation Softwares.*

1. Introduction

Ever increasing customer requirements and shorter development cycles demands an improved and highly result oriented system that would take care of error proofing in the part of program. The desired property for such a protocol is to be of zero tolerant and highly effective as well as efficient one. It became very vital to analyze the manufacturing process parameters before hand while going for huge investments. As a collaborative approach in product design and development cloud based tools offer significant role in the form of cloud based machining simulation systems for verification and optimization of CNC programs(1). Nowadays due to the promising technologies of Internet this automated part of manufacturing reaps maximum benefits in the form of saving cost and time. It also averts the accidents which would be happened if anything went wrong with the program and thereby securing considerable time and cost. These systems not only reduce the time to market but also greatly help in cost estimation. Highly promising digital manufacturing tools are paving the way for taking better stack of the manufacturing automation in industries(2)

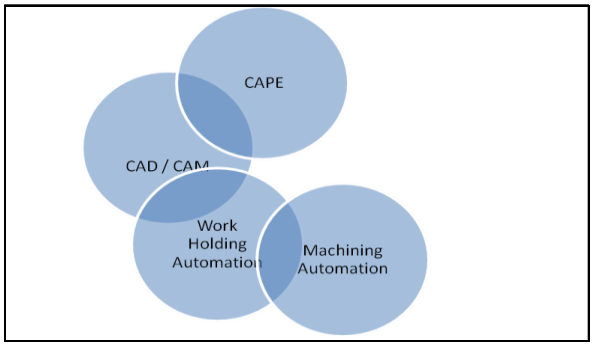

Fig. 1: Development Cycle

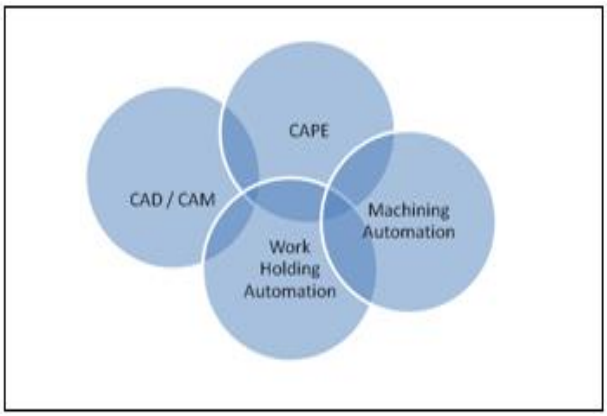

Fig. 2: Latest Relationship of Business Processes

2. Definition

Simulation can be defined with respect to manufacturing process are as follows.It can be regarded as business process for experimenting and evaluating application.
It could be viewed as a configuration model of a realistic thing and would provide the methodology to perform experiments on this model in order to decide the various course of action for the real one (3)
The main rational behind this process is to achieve better and optimized results. As it provides key insights into various aspects of product like overall performance, efficiency, reliability, detection of any problems in its life cycle etc. This would also improve two such primary goals in any manufacturing industry like reduction of cost and efficient output(4)

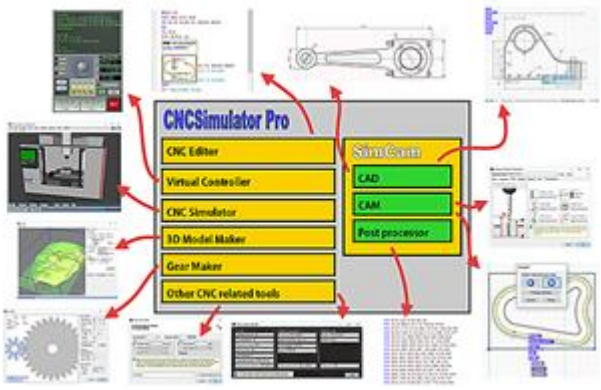

Fig. 3 : Architecture of CNC Simulator

A generalized architecture of a CNC Simulator is as shown above. It comprises normally a CNC Editor, Virtual Controller, CNC Simulator, 3D Mold Maker, Gear Maker and other CNC related tools for writing and stimulating the program(5). It also comprises CAD, CAM and Post Processor to simulate through a CAD model as input and in this case it is entirely automated generation program which includes all the parameters were assigned by the system itself and no manner it requires the program generation from user.(6)

2.1 Parts of Simulation

There are two phases namely design phase and validation phase.

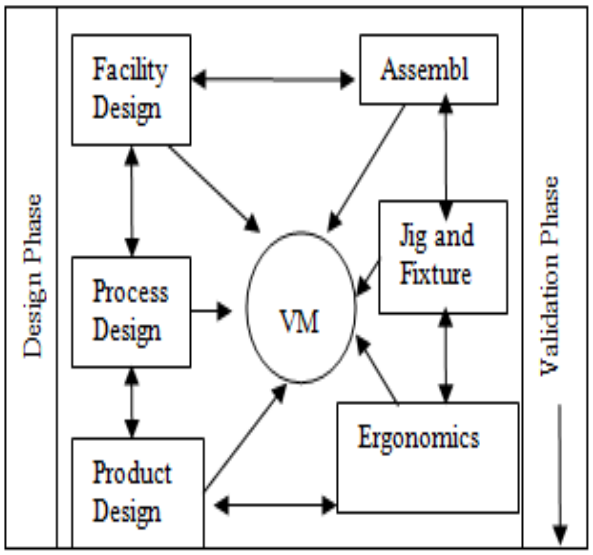

Fig. 4 : Simulation Phases

Design phase three sub divisions(7)

1) Collaborative Process and Product Development
2) Virtual build of product
3) Facility design for creation of facility virtually with all positioning elements.

Validation phase three sub divisions

1) Assembly validation and simulation
2) Jig and Fixtures validation
3) Human resource validation consists on ergonomy, safety analysis, material handling validation and serviceability of the parts etc.

2.1.1 Geometric simulation

A geometric simulator is called as continuous simulator as it proceeds in linear pattern and it usually involves three dimensional simulation of part geometry or the entire system. In most of the cases the geometric simulators perform the role in offline programming.(8)

2.1.2 Discrete Event Simulation

In large cases the simulation tools that are commercially used follows discrete event simulation. It involves the process of codifying the behavior of complex systems as an ordered sequence of well defined events.(9)

2.2 Applications of Simulation

Prime application areas where geometric simulations finds is Virtual Reality, Virtual Manufacturing, Offline Programming, Collision detection. According to discrete event simulation thrust areas of application are Inventory systems, Work in Progress and queuing systems. (10)

3. Software Tools for Simulation

There are several types of softwares are available in the market to suit different conditions and in different manner like simulators, digital manufacturing tools and virtual manufacturing tools. The commercial name and its vendors are tabulated in Table 1

Table1: List of CNC Simulators and their source.

Name	Source
i cam	Icam Technologies
Mastercam	CNC Software, Inc
vericut	CG Tech
nc sim	Cadence Design Systems
tebis	*Tebis* Technische Informations systeme AG
heekscad	openware
swansoft	Nanjing Swan *Software* Technology Company
Creo	PTC
predator	Predator Software Inc
easy cnc	Openware
cadem	CADEM Technologies Pvt Ltd
Technomatix	Siemens
delmia	Intrinsys

Even though there are several CNC simulators are there in the market for simulation, optimization, and verification and in digital manufacturing platform only few have been discussed.

4. Cloud Systems for Simulation

Due to tremendous growth in Communication networks and the disruptive evolution of Internet of Things (IOT) it led versatile growth inclusive of manufacturing sector also(11). Some of the packages are functioning through cloud basis which makes use of dedicated servers rather than overloading the work stations.

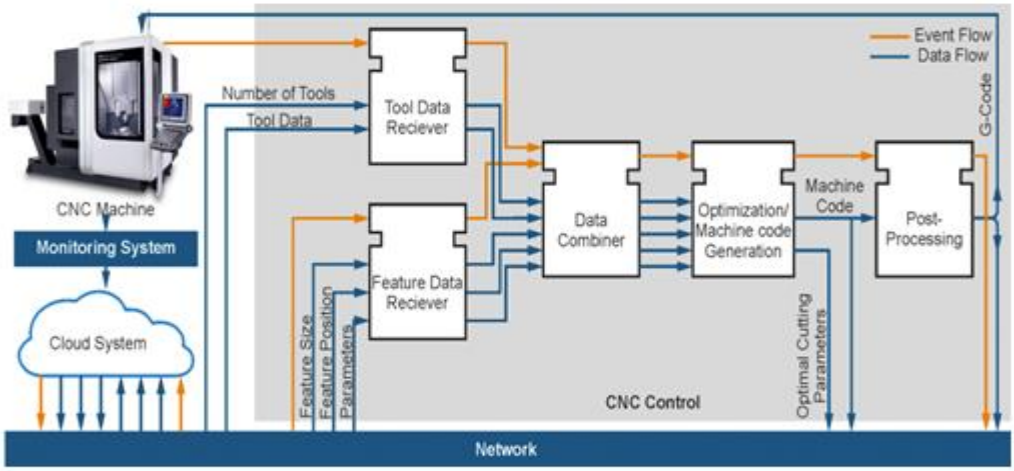

Fig.5: Cloud Architecture of CNC Simulator

As it follows a client - server model for the simulation tasks it saves much of the time of the processor in terms of computation and storage. To make things better nowadays as it is the role of smart phones plays a vital role in any form of technological development it does the same in this very same manufacturing sector too(12). Many packages intentionally allow a mobile version to perform the key tasks in the CAD / CAM sector of manufacturing engineering. The architecture of the cloud based simulators is as shown in figure 5. It gives an aerial view of the connection network and the role of the elements concerned in the network. Here it is evident that the automated machine itself is connected to the cloud computing system through a post processor and a dedicated network.(13)

Table 2: List of CNC Simulators and their source in cloud platform

Name	Source
machineworks	SHEFFIELD
meshcam	GRZ Software
mecsoft	Mecsoft corporation
machining cloud	mastercam
Fanuc CNC Simulator	Fanuc
hsmworks	Autodesk

5. Discussion

Role in Manufacturing: Most of the packages still use discrete event simulators for simulation. Integration between discrete event and geometric simulators are used in virtual manufacturing. On an average it reduces the time in manufacturing nearly 35% in manual programming, optimization of program and proving out the same in real machines(14)

User Interface: To create a user friendly environment most of the Packages still follows the menu and icon based Graphic User Interfaces (GUI).(15)

Hardware Requirements: Most of the packages still rely on PC like peripherals and some in workstation levels. Nowadays it is the era of cloud systems which has superior quality and speed in handling these packages with much ease than that of pc level systems.(16)

Software Requirement: Still today most of the packages are rely on windows based operating system.(17)

Supporting File Formats: Many packages support standard file formats like STEP, IGES for file transferring applications.(18)

Programming Languages: Still C and C++ plays a key role in developing simulation softwares. In some systems Visual Basic and Java too used for developing the softwares.(19)

Reporting Structures; It usually in the form of programs in alpha numeric codes, graphical representation of tool paths and ultimately as a video clipping for verification and presentation.(20)

Real World Interface; It requires dedicated communication channels to transfer datas to the machines concerned once generating, optimizing and proving out the program in offline mode.(21)

Customization; Some packages offer customization of the package to suit the needs of the customer to make it a standalone applications. As some packages has the capability to incorporate the parameters and controllers exclusively to suit the particular brand machine.(22)

6. Research and Future Scope

- A major difficulty faced by the work personnel in real shop floor is the methodology of operations performed in a simulation package is not similar as that of real machines. This synchronization enables the system as a virtual one with the same kind of controls and consoles is an important one in this area.
- The potential of Artificial Intelligence (AI) may be better utilized to make the things in future and if the packages follow the same set of Standard Operating Procedures (SOP).
- This system would have the capability to cope up with version changes and revisions as it may be controlled through PDM packages. Integration of the simulation system along the CAD / CAM system would ensure a defect free revisions as the entire stream of automation would be readily updated on all layers.
- There should be a mechanism in the packages to show the various kinds of activities that were attributed on it to verify the sequence of changes that were taken place on the program due to any version change.

7. Conclusion

There is a lagging in competency of using these systems among the shop floor level to bring out the best possible results. A dedicated communication channel has to be evolved to orient simulation and its results with real world systems, like calibration(23). This paper presents a comprehensive review of simulation tools and their role in manufacturing and means of their communication with real world machines. Some packages offer added features like surface finish assessment in order to ensure the suitability of machining parameters that are supplied for machining conditions(24). The major advantage of the system

is the prevention of accidents and time saving offline optimizations rather than on Machine Data Input (MDI).The major drawback with the packages is that they are not capable of generating canned cycles directly for the programs as a standard protocol. Some packages support the canned cycles as like real machines but they too might not be able to generate a program on its own with the inclusion of canned cycles.(25)

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