

# A new hybrid dynamic modelling approach for process planning

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Received 23 August 2004; accepted 17 September 2004

## Abstract

Today's highly competitive market places a great emphasis on improving efficiency and reducing costs. Simulation modelling is being widely used as a successful tool to design and analyze manufacturing systems. Enhancing the product design is an important issue. In addition, generating efficient simulation models with shorter lead times has become equally important to winning customer satisfaction. To meet these criteria, a new hybrid modelling approach for generating a simulation model and virtual environment from a process plan is presented.

The proposed approach integrates simulation and virtual reality in order to render a dynamic shop floor model automatically using the basic process configurations. This is accomplished using an input database. The model interface is user-friendly so that the new users of simulation and administration can use the model easily once the input database requirement is fulfilled. Moreover, the model allows the user to trace the performance criteria of any process on the shop floor level at any instant as well as to experiment any production scenario. The virtual environment is used to verify through visualization the simulation model and also to provide a better understanding of the activities of the shop floor.

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*Keywords:* Simulation; Virtual reality; Process plan; Shop floor; Head mounted display

## 1. Introduction

Simulation modelling is being widely used in areas, such as manufacturing, health, network communications, training, education, and military. Such popularity of simulation has resulted in a large number of simulation software tools available on the market [1], some of them are general-purpose simulators and some are designed specifically to model and analyze manufacturing systems. Manufacturing simulation has been one of the primary application areas of simulation technology. It has been widely used to improve and validate the designs of a wide range of manufacturing systems [2]. Virtual reality (VR) may play very significant role to support the simulation tools to understand the results and the dynamic behaviour of the model [3]. Virtual reality offers the opportunity to visualize, explore, manipulate, and interact with objects within a computer generated environment, and is a useful tool to enhance process planning involved in design, development,

evaluation, and validation [4]. Layout planning is not a new problem in the manufacturing environment. Virtual factories help in evaluating plant layout before actually building them and it assists in avoiding the costs involved in doing a physical re-layout. It also allows the user to get a better perspective than what could be achieved in 2D solutions [5]. Lee et al. [6] have presented the techniques, which are used in applying virtual reality in manufacturing applications.

The problem with the simulation packages available on the market today, it requires good knowledge about programming and modelling techniques. Also, it is very time and money consuming to develop a simulation model for a manufacturing system [1].

This paper is devoted to the development of software with Graphic User Interface (GUI) using Visual Basic programming language that provides non-expert users with a flexible tool to develop simulation model dynamically of real shop floor activities. Virtual environment of the shop floor is generated automatically based on the input data, which is given by the user. The Graphic User Interface has three main options, which include input, process, and output. The input

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options are used to construct the process model of the manufacturing system that generates the process plan of the shop floor. The process options are used to generate the simulation model of the shop floor as well as the virtual model. The process options are also used to run the simulation model. Finally, the output option is used to display the statistics of the shop floor.

## 2. Description of the manufacturing system

The Graphic User Interface is developed for an existing manufacturing system that does treatment operations. The manufacturing system consists of a number of machines named Ovens, which does coat sheets with a special material for heat resistance. The sheets can be coated as much as required. Different processes can be associated with each Oven, these processes include: Oven setup, coating sheets, cleaning the Oven, maintenance the Oven, changeover the sheets to be recoated. The software that has been developed will allow the users who do not have any knowledge about simulation to build simulation and virtual model of the described manufacturing system. The GUI of the software can be used to as a tool to simulate the different activities of the shop floor to measure the performance of the system.

The following section describes the main components of the developed software that integrates the simulator, the process model, and the virtual reality model.

## 3. Graphic User Interface

Graphic User-friendly Interface is developed using Visual Basic 6.0 to allow non-expert users to develop simulation model of the shop floor dynamically using simulation software called Witness, and it can be used also to create and implement virtual model of the shop floor automatically using virtual reality software called Superscape VRT. Fig. 1 shows

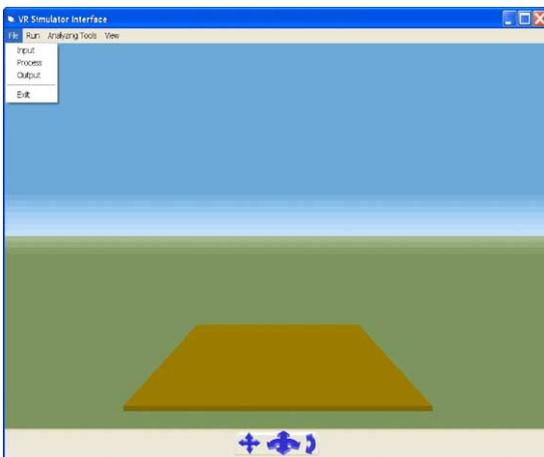


Fig. 1. Main menu of the Graphic User Interface.

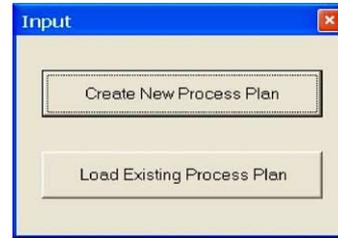


Fig. 2. Input Menu Options.

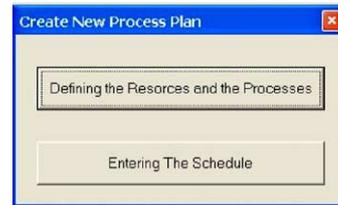


Fig. 3. Create New Process Plan.

a snapshot of the main menu of the Graphic User Interface. The GUI has three main options to build and simulate the manufacturing system. These options include: *Input Menu Options* [to input data], *Process Menu Options* [to process the data], and *Output Menu Options* [to output the results].

### 3.1. Input Menu Options

The Input Menu Options can be used to construct the process model of the shop floor. The Input Menu Options provide the user with two options to enter the process plan of the shop floor. These options are: *CreateNewProcessPlan* and *Load-ExistingProcessPlan*. Both of these options can be accessed by clicking on the Input option from the user interface as shown in Fig. 2.

#### 3.1.1. CreateNewProcessPlan

Once the user selects the *CreateNewProcessPlan* option from the Input menu, a window appears with two options as shown in Fig. 3. The first option is used to define all the resources and the processes that need to be analyzed using the resources details form.

Fig. 4 shows the resources details form that needs to be used to define the machines and the parts by giving them

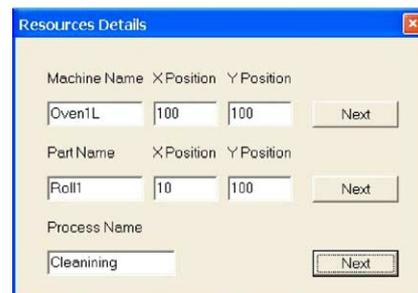


Fig. 4. Resources details.

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