Computer Simulation Software for The Rotational Moulding Process

R.J. Crawford*, E.J. Wright** and M.P. Kearns**

* The University of Auckland, New Zealand and **The Queen's University of Belfast, Northern Ireland

Introduction

A computer simulation package has been developed that permits the shape of a moulded part to be loaded into the program and it will predict the wall thickness distribution in the rotomoulded part. The system is set up just like the rotational moulding machine by inputting the type of rotation (eg biaxial or Rock & Roll), the position of the mould on the plate of the machine, the rotational speeds, the oven temperature, the heating time, the type of cooling, the cooling time, etc. If some areas of the mould are shielded or receive extra heat, then this can also be input. The program will then predict the mould and internal air temperature profiles as well as the thickness of the part at every point on its surface.

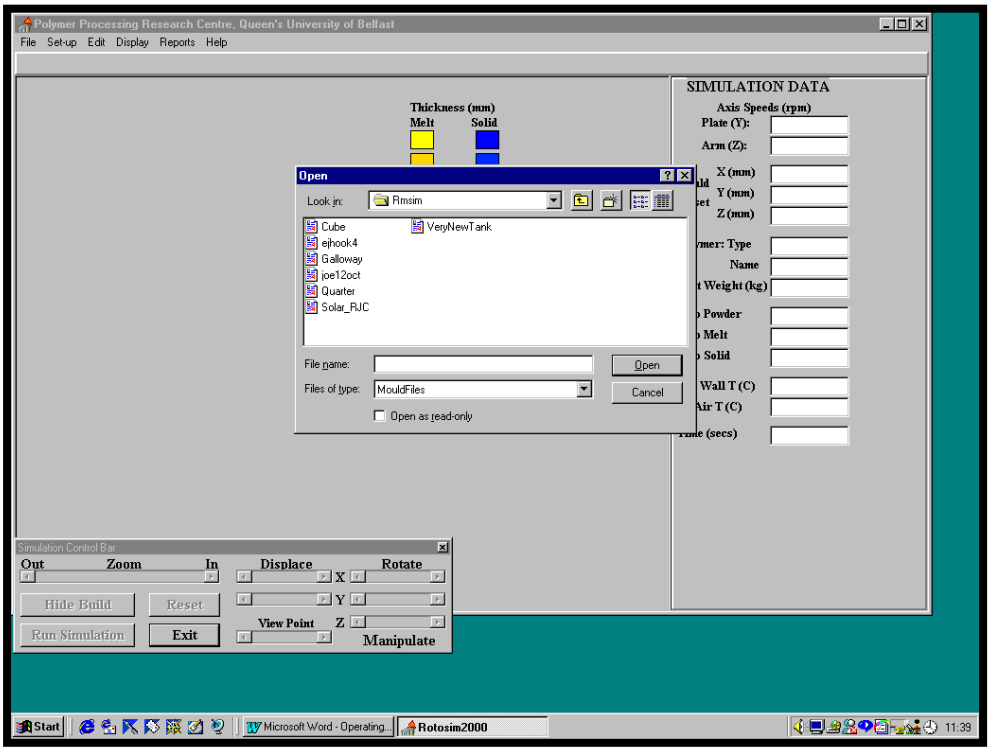
The software runs in Windows on a PC. The speed of operation depends on the power of the computer used and the complexity of the moulded part but typically the simulation runs faster than the actual moulding time. Thus if the real cycle would take 12 minutes, the simulation of this cycle takes about 8 minutes.

Such a simulation package offers many advantages to moulders. Not only is it useful as a training package where all sorts of "What if….?" scenarios can be explored but it provides practical data on mould design and optimum machine set-up. Before metal has been cut or cast, it is possible to take an image of the shape of the part and use the simulation to decide what are the best speed ratios, what is the best position on the plate, what oven time is required, what areas of the shape are difficult to fill, etc. This information can then be used to finalise the design of the part and set up the moulding machine in the most efficient manner.

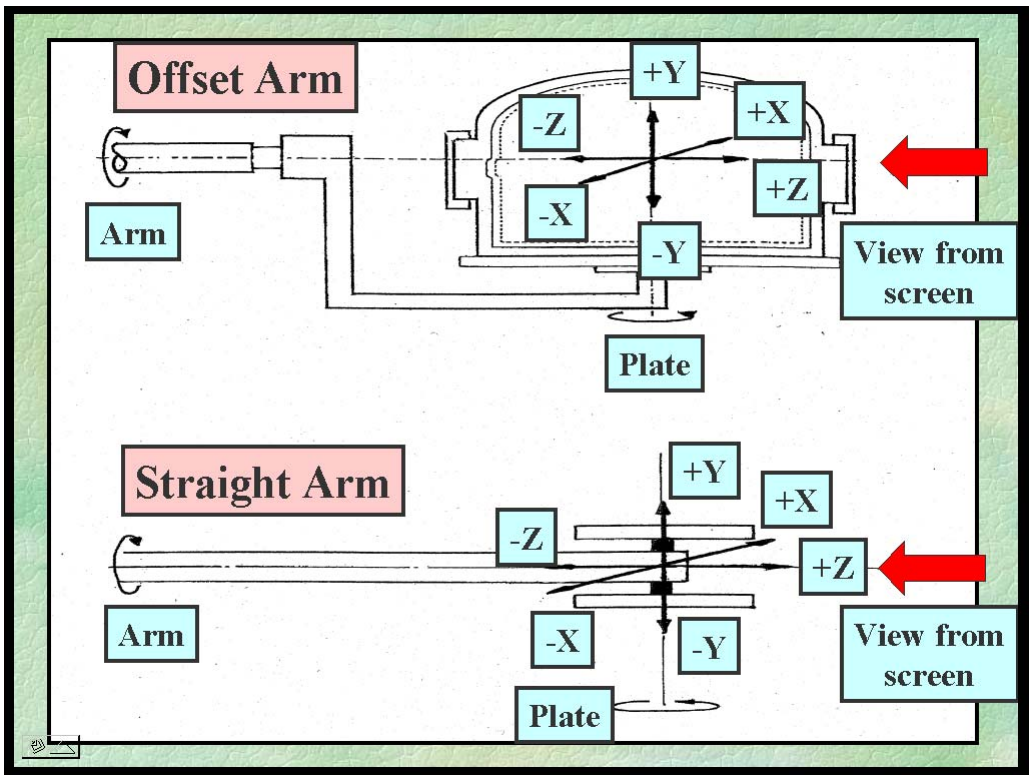
Use of the Simulation

Initially a part file has to be loaded into the program. If a CAD file exists then this has to be meshed using a standard Finite Element Package such as FAM, COSMOS or LUSAS. Many CAD software packages such as SOLIDWORKS, ProEngineer and AutoCAD have add-on facilities to do this automatically. The rotational moulding computer simulation simply needs the meshed file of the part shape and it is then self-sufficient in regard to the analysis that it carries out. Shrinkage factors can be allowed for at this stage. There are also demo files already in the program that can be used for training purposes.

If a "**Mold**" file has already been created then it can be opened. This is done by pressing the **File** button at the top left corner of the main RotoSim page and highlighting the **Mold** line. A page will appear with a list of available mold files as shown below:



After the mould has been selected, it will appear on the screen. At this point the **Manipulate** controls can be used to rotate the mould to get check its shape. The X, Y and Z axes rotation bars are at the bottom right of the **Control Panel**. The orientation of the mould on the machine and screen are as shown below:

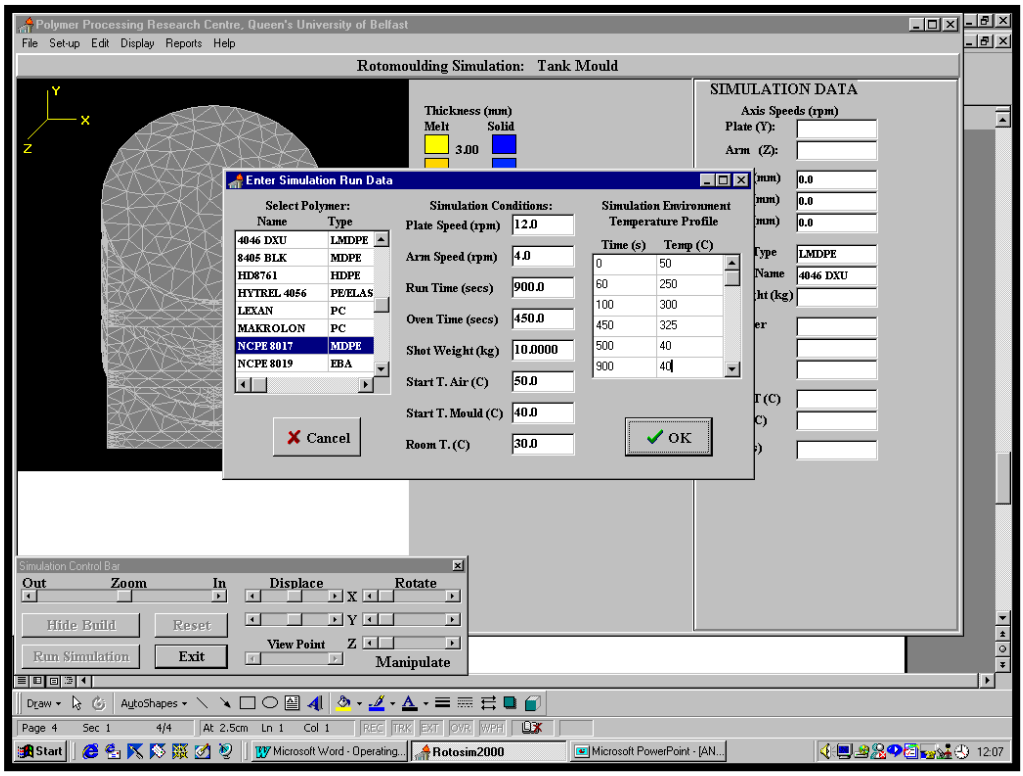


The orientation of the mould relative to the X, Y and Z axes can be altered as required using the **Position the Mold** heading under the **Set-Up** button.

The next stage is to select a rotation mode for the mould – biaxial rotation or "Rock & Roll". This is done by pressing the **Set Up** button and then **Select Drive**. If "Rock & Roll" is selected then a screen appears to allow the rock angle, dwell time, and the position of the mold to be set. If "Biaxial" is selected then the screen simply returns to the main RotoSim page.

If required, the mould can be offset from its current position (centroid at coincident point of the two axes) by using the **Position the Mold** in the **Set-Up Menu**.

At this stage the moulding conditions must be selected (or a **Run** file can be selected from the **File** button if a previous set of data is to be recalled). For a new mould with no previous Run files stored, the new data is input by selecting the **Set Up** button and highlighting the **Enter Test Data** line. A page appears similar to that shown below and the various speeds, charge weight, etc should be input. A material should also be highlighted to select it. All the material data and mold/oven/cooler heat transfer data can be edited by the user.

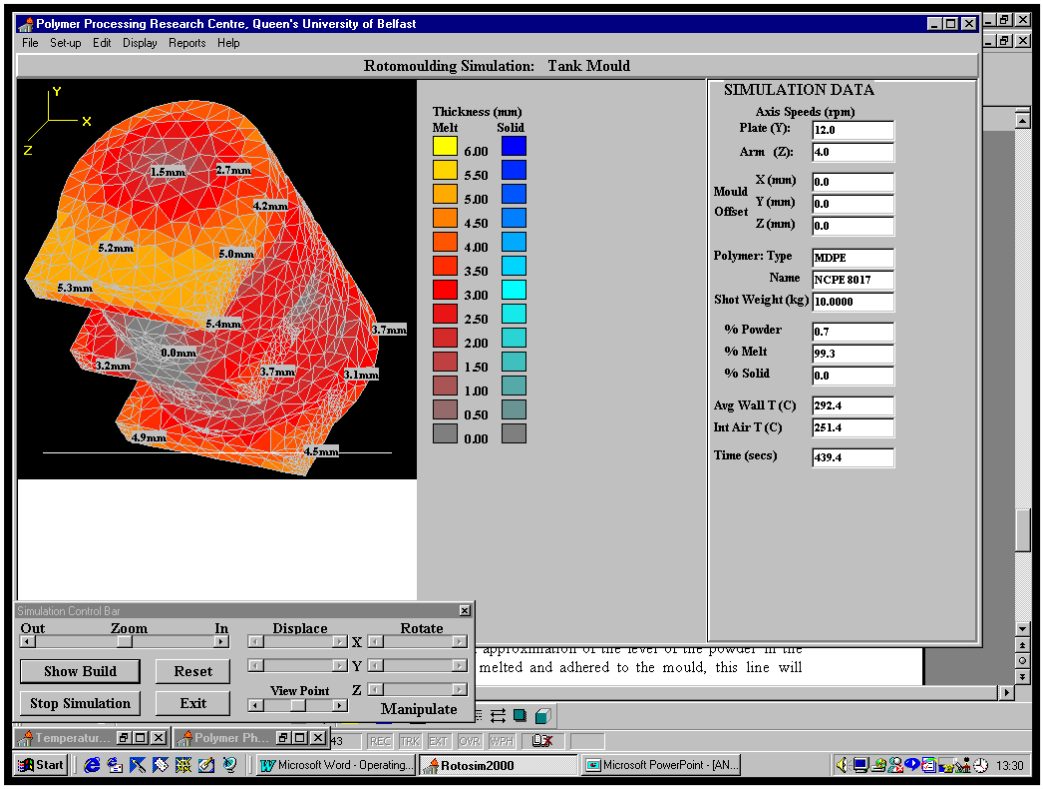


The oven temperature variations are entered in the Table at the right side of the Pop-Up window. In the case shown, at zero time the oven is at 50^{o}C. After 60 seconds the oven temperature is 250^{o}C, and then after 100 seconds it increases to 300^{o}C. After 450 seconds it has increased to 325^{o}C. Then as the mould enters the cooling phase, the temperature drops to 40^{o}C after 500 seconds, etc. Any heating and cooling profile can be set up to study its effect, which is a major advantage of the simulation.

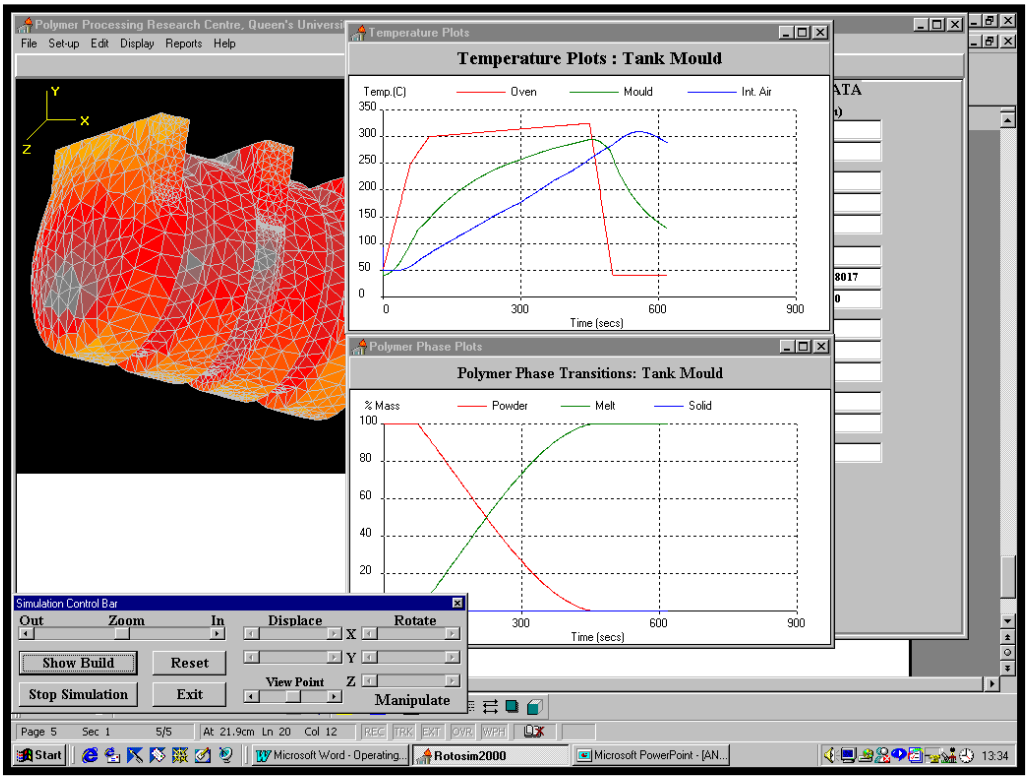
A pop-up window then appears to enable the input of the cooling conditions. If forced air cooling occurs for the first 10% of the cooling cycle, followed by water spray for the remainder of the cycle then this information is input by firstly pressing the forced air (red) button. The horizontal bar will turn red. Move the mouse along the bar until 10% appears and press the mouse button. Then highlight the water spray (yellow) button. The remainder of the horizontal bar will turn yellow. Any cooling combination can be input in this way.

If speed reversals occur then these can be input by pressing the **Set-Up** button and selecting "**Set Speed Reversals**". A Pop-Up window appears which allows the arm and plate speeds to be reversed together or separately. To set up a sequence of speed reversals, simply use the mouse to click on the horizontal bars and the colours will change between red and green as required.

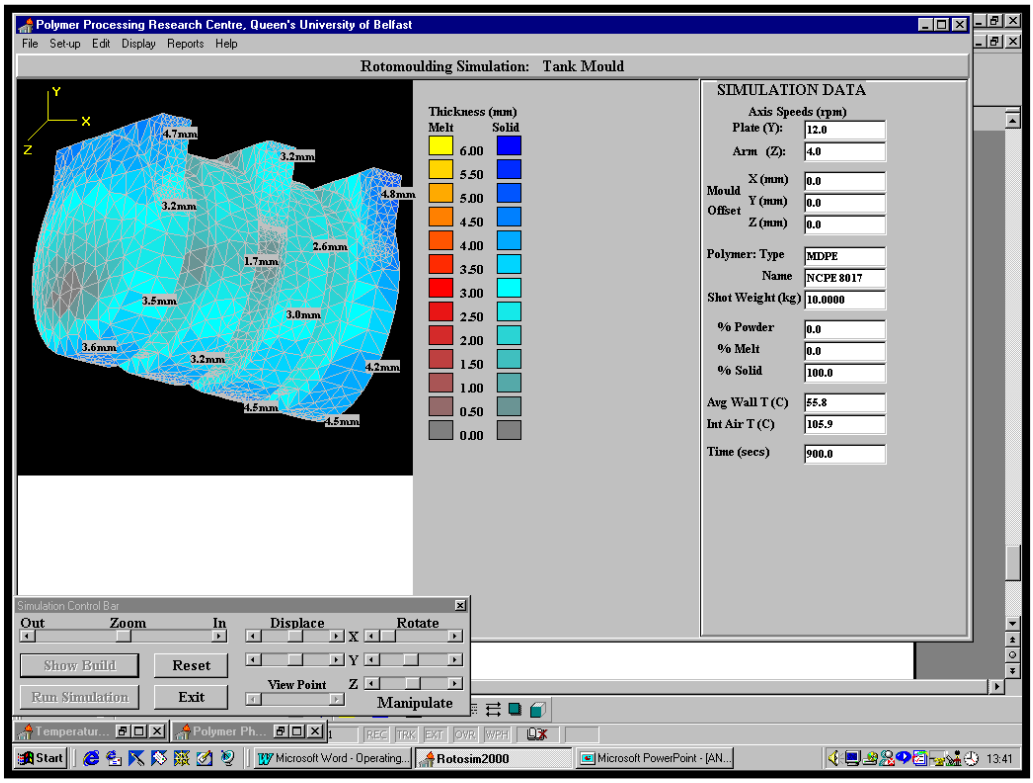
To start a trial, press **Run Simulation** on the **Control Bar**. The mould will start to rotate on the screen and the user can watch the build up of material thickness as it happens. The horizontal white line gives an approximation of the level of the powder in the mould. When all the powder has melted and adhered to the mould, this line will disappear. When the mould is not rotating, the thickness at any point on the mould wall can be seen by clicking the mouse on the point of interest (see below).



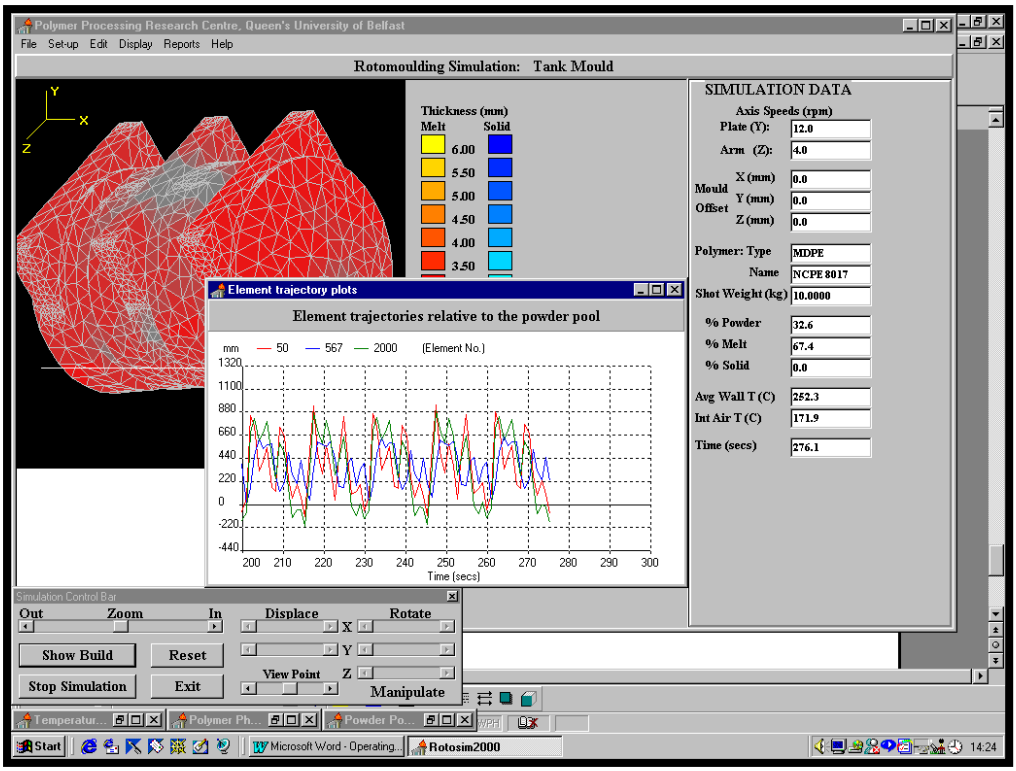
At any moment in time it is possible to call in the temperature rise graphs and information about the relative amounts of powder/melt/solid material. These will appear as Pop-up windows and can be positioned at any location on the screen, as shown below:



At the end of the trial the thickness at any point on the mould can be observed. This is illustrated below. A full summary of the trial and the results can be printed by selecting "**Simulation Report**" using the **Reports** button.



Another feature of the program includes the ability to track, relative to the powder pool, the movement of up to six points on the surface of the mould. This can be useful to explain why certain areas of the moulding do not have the desired thickness. To set this facility up, it is necessary to identify the element number for the point of interest. Before a trial run is started, the mould should be rotated to an appropriate orientation and the mouse is clicked on the point of interest. The element number should be noted. This can be repeated for up to six points. The same procedure can be repeated to get Histograms of the regularity with which selected points come into the powder pool.



These notes are only intended to give a brief overview of the capabilities of the simulation program. Further information about **RotoSim** can be obtained from:

Plastics Development Centre
3 Carnbane Industrial Estate,
Newry,
Co. Down
BT35 6QJ
Northern Ireland

PH. 00-44-28-302-67938
Fax 00-44-28-302-63203

E-Mail: plastics.d.centre@btinternet.com