Dynamic Scheduling

Introduction (Seminar 8)

The Dynamic Scheduling system in ManuDyn is represented by the Scheduling menu group. Jobs are placed on the Schedule when they are Issued to Production by using the "Job Issue" menu item; their status can be updated manually via the "Job Update" menu item or dynamically via the "Factory" menu item. The schedule may be defined and/or altered via the "Scheduling" menu item and various reports obtained via the other items in this menu group.

The scheduling technique employed is principally a infinite backward schedule to determine a "Due By" date (which is the last date an operation can be performed and the job still meet the Customers Due Date), and a Work Centre Capacity Profile (a critical machine loading). We will discuss however both Forward and Backward scheduling as well as finite and infinite capacity profiling.

Before we start however, there are some terms which we need to define. Some of these terms can be stated simply and some will need to be explained by way of example.

Scheduling Systems

The *Estimated Process Time* is the Setup and Process time define against the Manufactured Item (or Part).

The term *Inter-Process Delay* represents the delay time between operation. That is the time from the finish of one operation and the start of the next. It is defined in "System Settings/General Options – Scheduling"

A *Forward Schedule* produces an Estimated Completion Date for the Job, by working forward from the current date (today), taking the Estimated Process Time (and Inter-Process Delay) into account, together with Due Date priority and the Manufacturing Calendar status into consideration. For example, if today is say the 12th and a job has 4 processes with operation times as shown below and all Inter Process Delays 1 day (IPD), it will be delivered as follows:
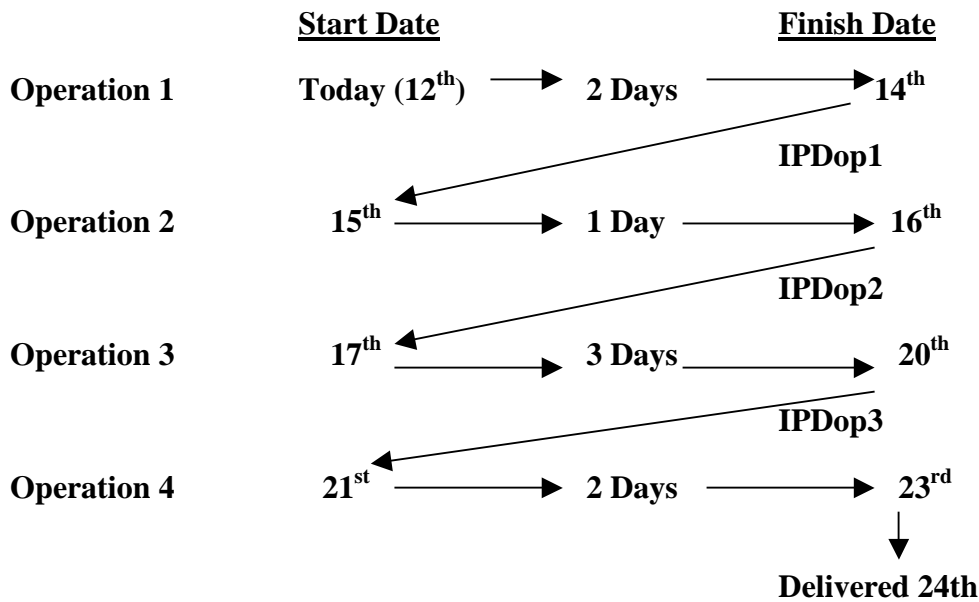
Forward Schedule

	Start Date		Finish Date
Operation 1	Today (12th) → 2 Days →		14th
		IPDop1	
Operation 2	15th → 1 Day →		16th
		IPDop2	
Operation 3	17th → 3 Days →		20th
		IPDop3	
Operation 4	21st → 2 Days →		23rd

Delivered 24th

Figure 1- Example of Forward Schedule

The output from a Forward Schedule is the Estimated Completion Date.

This date may be before or after the Due Date for the Job. If the projected completion date is say 3 days after the job is due, then this job will need to start by the 9th of the month in order to get it out on time.

A ***Backward Schedule*** starts with the Job Due Date and works backward through each operation, taking the estimated process time (with Inter-Process Delay) and the Manufacturing Calendar status into account, to determine a Start Date and a Finish Date (Due-By Date), for each operation and also produces a Machine Capacity profile.

Backward Schedule

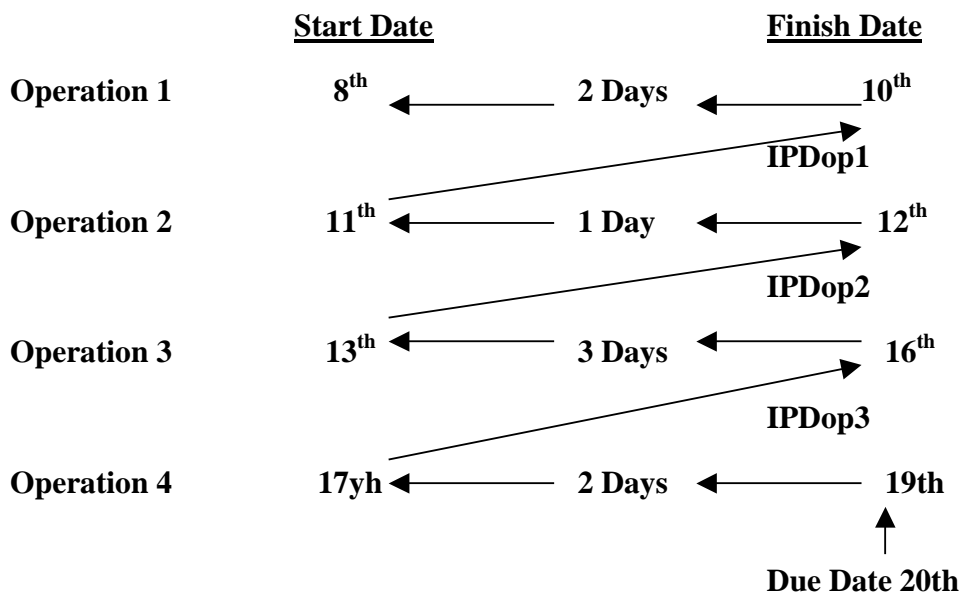|	Start Date		Finish Date
Operation 1	8th ← 2 Days ←		10th
		IPDop1	
Operation 2	11th ← 1 Day ←		12th
		IPDop2	
Operation 3	13th ← 3 Days ←		16th
		IPDop3	
Operation 4	17yh ← 2 Days ←		19th

Due Date 20th

Figure 2 - Example of Backward Schedule

The output from a Backward Schedule is a Capacity Requirements Profile and a Due-By Dat for each operation.

The Due-By Date is the last date by which an operation must be finished for the Job to be delivered on time.

Both schedules provide a means of determining the date by which a job must be started in order for it to be finished on time. The Backward schedule however does it in a more viable form (particularly from the Customers point of view), as it "Schedules" the job to go out on time (when the Customer wants it). ManuDyn only uses the Backward schedule for this reason.

The Work Centre Schedules

The scheduling system in ManuDyn is controlled from the Scheduling Menu Group. Jobs are actually placed on the Schedule however when they are initially entered as Sales Orders through the "*Sales Orders/Order Management*" menu selection and they are placed on the Schedule for every operation in their routing.

The Start Date for each operation is determined by a Backward Schedule from the due date of the taking Inter-Process Delay into consideration and the status of the Manufacturing Calendar. The

Schedule for the job can be viewed from the Gantt Char Icon () shown on the Sales Order blue toolbar. The example shown below is for a simple Cut/Punch/Fold Job with a Due of the 25th of the month.
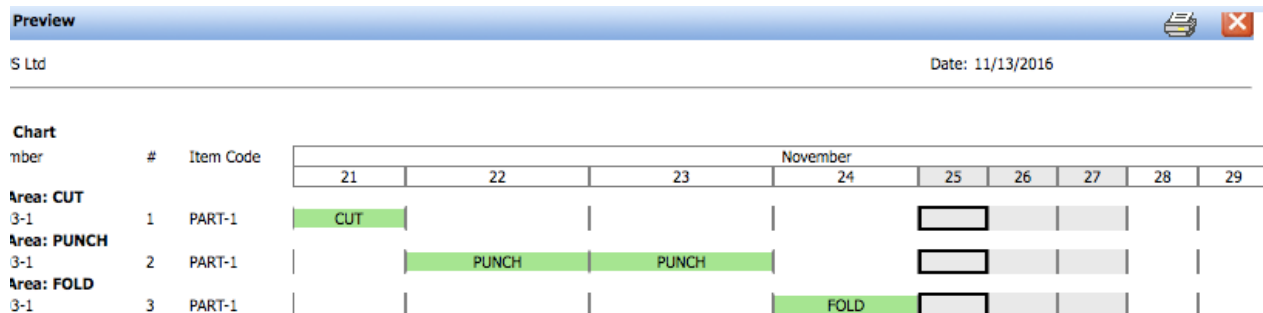

Figure 3 – Gantt Chart for Job

The Job therefore needs to finish (last operation Fold), on the 24th. It takes less than a day to do the fold operation but because I also have Inter-Process Delay of 1200 minutes in my system setup only 1 operation can occur per day so the pen-ultimate operation (Punch) needs to finish by the 23rd etc.

This Schedule represents the last date the job can be processed through each of these stages and still go out on time. It's a "Critical Date" schedule.

If we select the "*Scheduling/Scheduling*" menu item, we can view all of the jobs on the schedule at each stage of production. For example, the "Punch" Work Center Schedule might look similar to that shown below

Figure 4 – Work Centre Schedule for Punch

Once again there is a Gantt Chart Icon however this time it shows the situation for all of the Jobs on this Work Centre Schedule
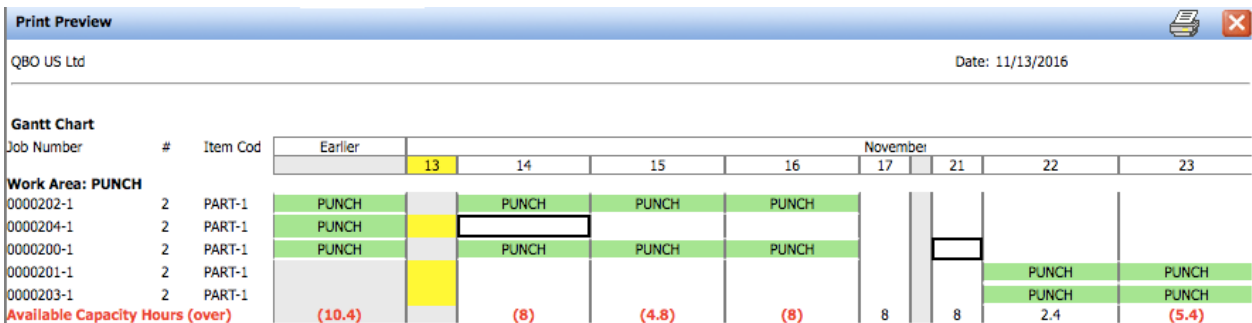

Figure 5 – Gantt Chart for Punch Schedule

This Gantt Chart display also indicates where the loading on the Schedule exceeds the production time available. Clearly where this is the case the jobs need to be "moved arround", that is a new Start Date needs to be defined. If you "mouse click" on a Gantt Chart element corresponding to the Job you wish to re-schedule a Process information dialog will be diplayed (see below), to allow you the set a new Start Date.
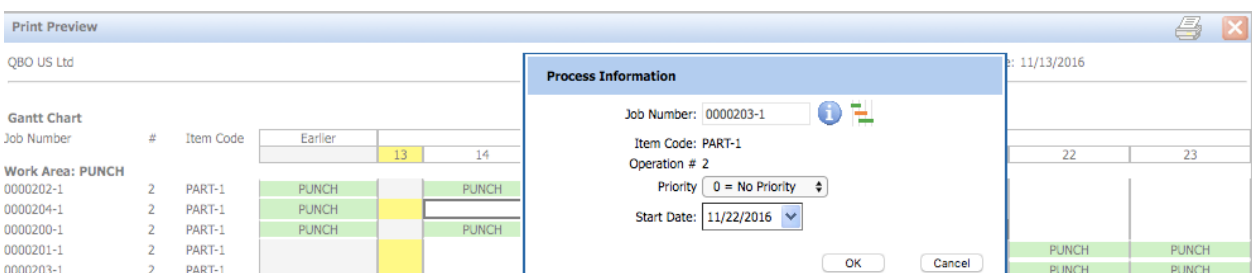

Figure 6 – Process Information Dialog

If the Start Date is set earlier than the current date then all prior operations needs to start earlier and are "pushed back". If you set a Start Date latter than the current date then all subsequent operations need to start latter and are "pushed out" accordingly.

Referring to the example at the beginning of this section (see Figure 3), if we start the Punch operation of the 21st instead of the 22nd then the Gantt Chart for the Job will be as follows:
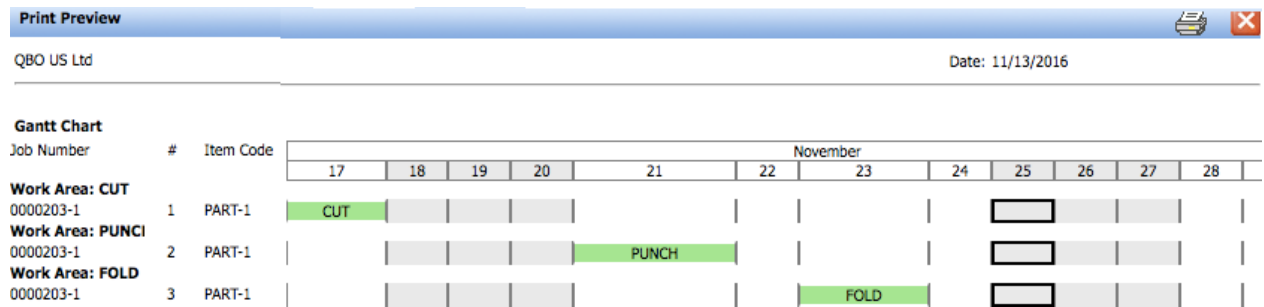

Figure 7 – Amended Gantt Chart for Job

That is the prior operation (Cut), is also scheduled to start earlier. So we can adjust the schedule and move Jobs around to "smooth" out the Work Centre Loading.

This is good. The first question most people ask however is;

> *"Does this mean we have to do this for every Job on every Work Centre?*
> *I have 100's of Jobs on many different Work Centre's and it will*
> *take hours if not days to do this."*

Fortunately, the answer is No and it will not take days or even hours.

You need to identify the critical work center's; Those that initiate Job processing; those that conclude it and those that have critical loading considerations.

An Initiating Work Centre "pushes" work into the factory.
A Concluding Work Centre "Pulls" work out of the factory.
A critically loading work center is a bottle neck and needs to be managed.

The Initiating Work Centre defines what jobs you need to Issue to the factory and the order in which this is done.
The Concluding Work Centre sets the priority of work past the bottle neck.
The bottle neck usually defines what you can and cannot do for the factory. It determines you real capacity.

Referring back to the Work Centre Schedule for the Punch operation (see figure 4), we also had options to Print this schedule and Print a Work List. The two printouts are actually different. The Schedule Printout will list all Current Jobs that still have to be processed through this work center. The Work List (which can also be accessed via the "*Scheduling/Work List*" menu item), will list only Current Jobs that have been released to production.

This action is initiated from the "*Scheduling/Job Issue*" menu item and in addition to adding the Job to the Work List it will also start to appear on the Factory display (accessed from the "*Scheduling/Factory*" menu item).

We examined the Work Priority List and the manual operation of the Job Shop Schedule in the previous Seminar. Let's now look at the Dynamic Schedule is some detail.

The Dynamic (Touch Screen) Schedule

The "Factory" screen display is accessed via the "*Scheduling/Factory*" menu Item or from the user login if they are a "Factory Only" user. Jobs appear on the Schedule when they are fist entered as a Sales Order but they do not appear on the Factory screen until they are issued to Production (as noted above).

The order in which they appear will depend on the Start Date of the operation which as we have seen above in the first case is determined by a Backward Schedule from the Due Date of the Job but may be subsequently altered by the scheduling to achieve a more balance production schedule.

The initial screen on the Factory menu allows the employee to "clock On" and "Clock Off" for the start and finish of the production day.
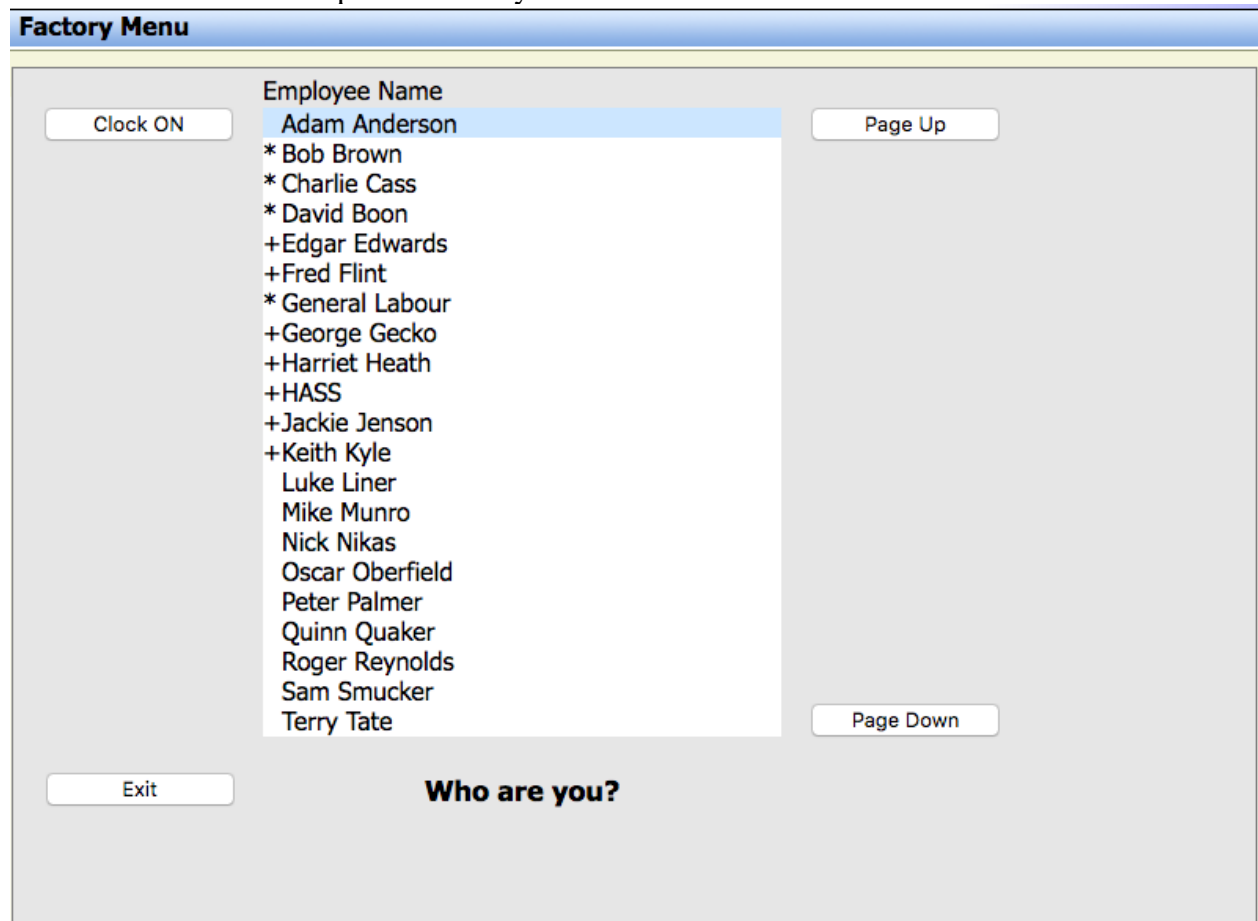

Figure 8 – Factory Clock On/Off Screen

Employee that are "Clocked On" will either have a plus (+) sign against their name or an asterisk (*) if they are also active on a Job. Employees that are not present will have nothing against their name.

Once the Employee is "Clocked On" for the day they should "sign On" to a Job. This is done by the operator first selecting their name, which recalls the list of Work Centers on which work is available to do (as shown below).
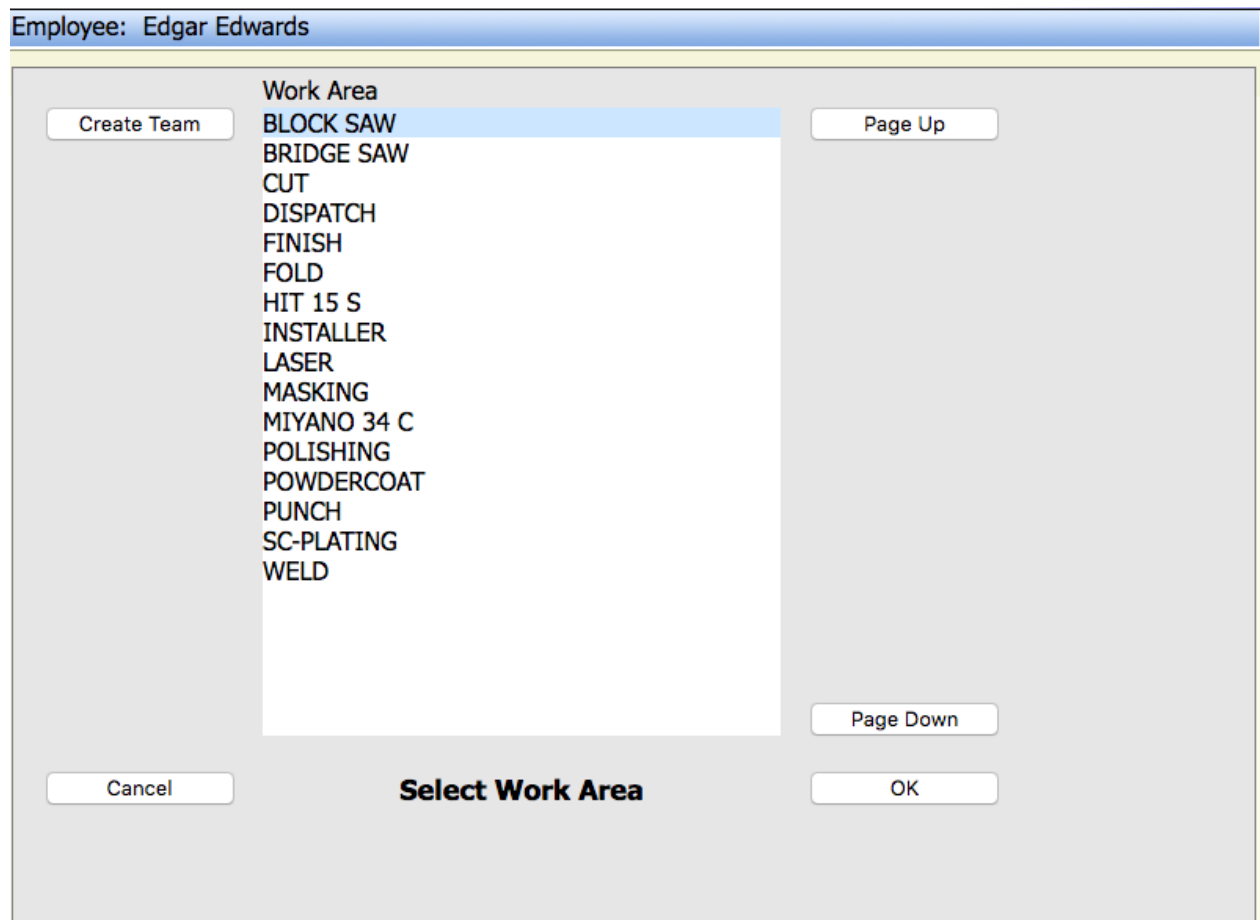
Page 6   © Manufacturing Software – November 2016

Figure 9 – Factory Work Centre Selection Screen

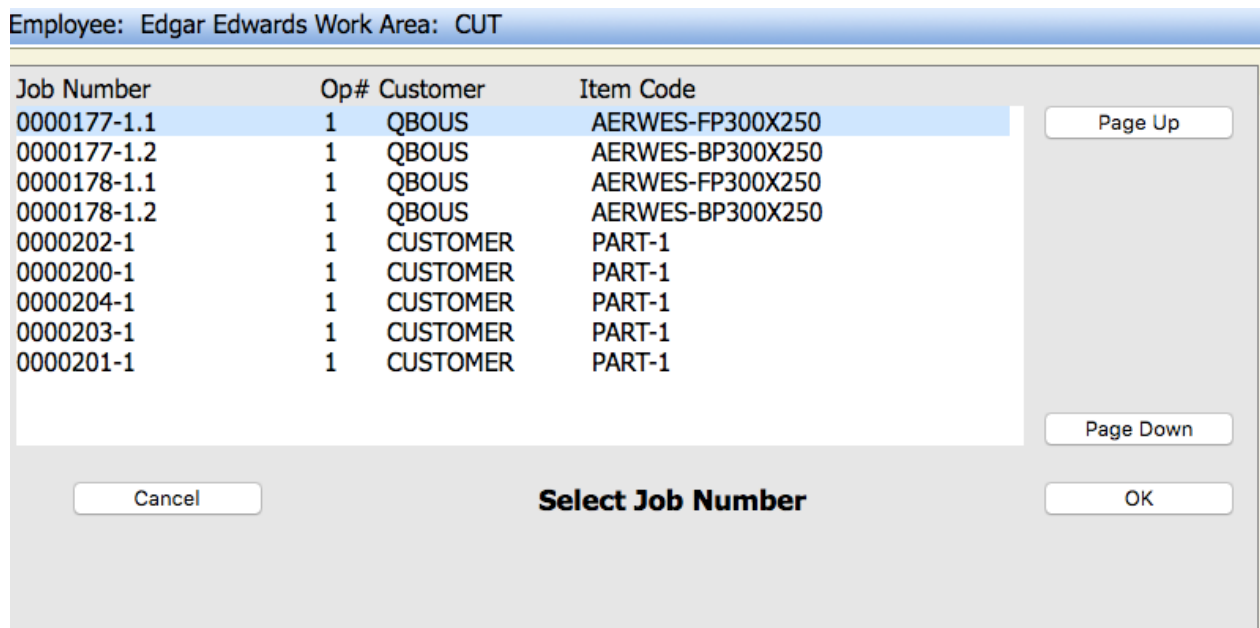Once the process is selected the operator then select the Job on which they wish to work

Figure 10 – Factory Job Selection Screen

This recalls the Job Start screen as shown below;

Figure 11 – Job Start Screen

All the operator has to do to start the Job is select the "Start" button

When the operator finished the Job they return to the Initial Factory screen (see Figure 8) to once again select their name. Upon doing this the Job Update screen will be displayed as shown below

Figure 12 – Job Update Screen

The operator needs to indicate they need to update the job status by selecting the "Update button. This recalls the Quantity dialog shown below;

Figure 13 – Quantity Dialog Screen

The operator can record the elapse time as setup or if they enter a quantity done the time will be recorded as Process Time.

What has been described above is the simplest form by which work can be processed through the Dynamic Schedule. There are in fact five (5) different ways in which work can be done, as follows:

1) One Operator working on One Job. This is what we have basically described above and usually describes about 80% of all work done in a jobbing shop.

2) Many Operators working on One Job. This is a "Team" of people working on a Job and there is a "Team Leader" and there are "Team Members". The team leader performs the tasks of defining the team and clocking onto the job. The members only have an option to leave the team. And, where for example four(4) people work on the job for one hour, then 4 man-hours will be booked against the job Cost and 1 man-hour is booked against each of the employees.

The Team is created at the Work Centre selection stage (see Figure 8) via the "Create Team" button. The first employee is the Team Leader and he now needs to select the team.

A list of available employees (those that have "Clocked On" to the Factory but not active on a job) is displayed and the team leader selects the team. (see below).

Once the first team member is selected the team leader gets an option to select other members and once this is complete the processing moves on to the Work Centre and Job Selection screens.
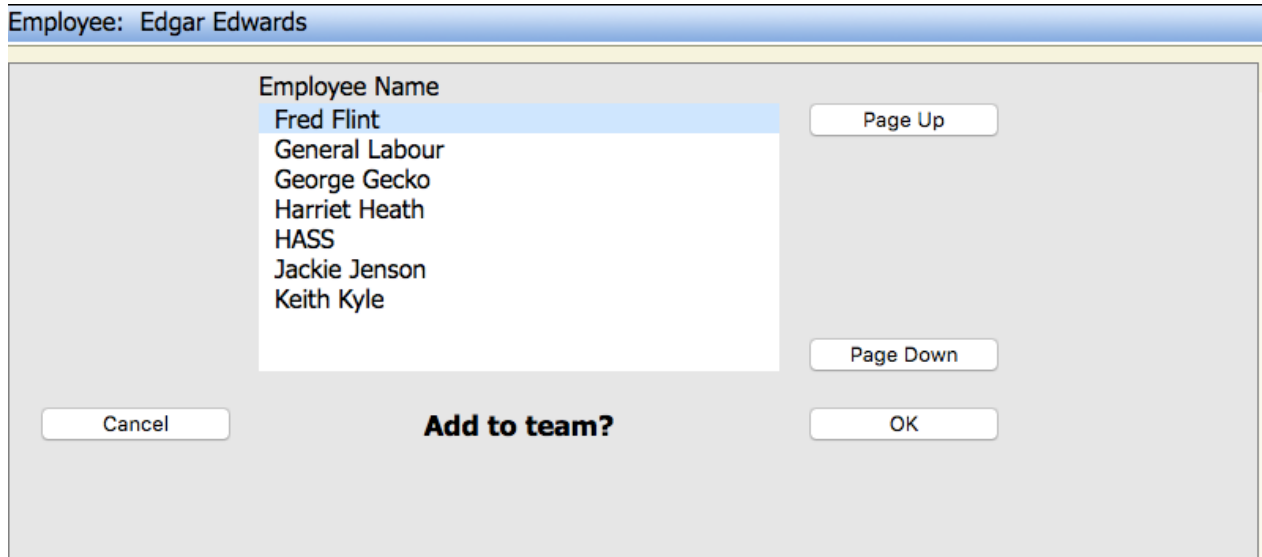
Employee: Edgar Edwards

Employee Name
Fred Flint
General Labour
George Gecko
Harriet Heath
HASS
Jackie Jenson
Keith Kyle

Page Up

Page Down

Cancel

Add to team?

OK

Figure 14 – List of Available Employees

Once the Team is selected the Team Leader then selects Work Centre and the Job in the usual way. All members of the team will be shown as active on the Employee List as shown below.

Factory Menu

Clock ON

Employee Name
Adam Anderson
* Bob Brown
* Charlie Cass
* David Boon
* Edgar Edwards
* Fred Flint
+General Labour
* George Gecko
* Harriet Heath
+HASS
+Jackie Jenson
+Keith Kyle
Luke Liner
Mike Munro
Nick Nikas
Oscar Oberfield
Peter Palmer
Quinn Quaker
Roger Reynolds
Sam Smucker
Terry Tate

Page Up

Page Down

Exit

Who are you?
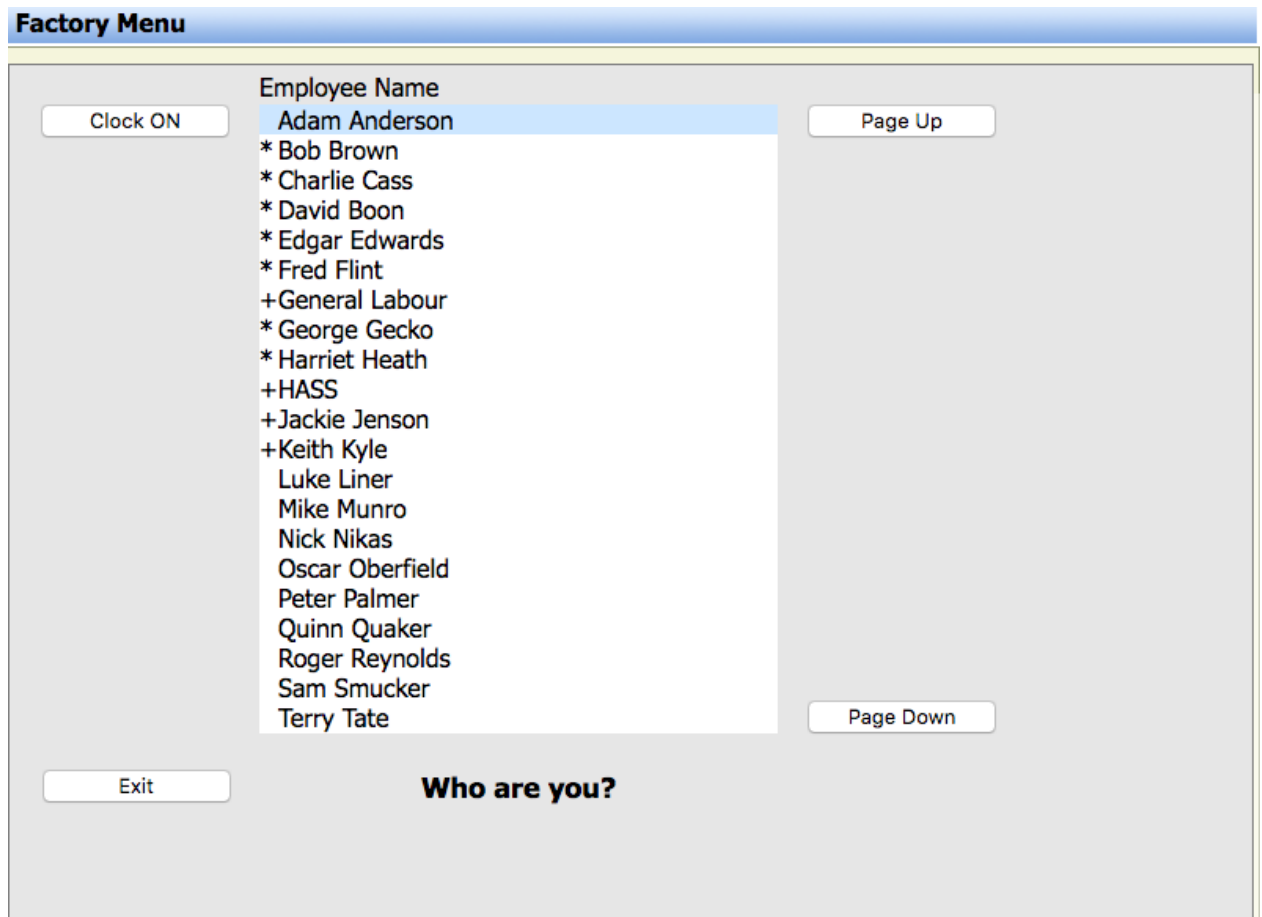
The team member may "quite" the team if they need too. They will not update job status and a zero quantity done will be recorded against their name in the Job Ciost report. Only the time is recorded.

When the Operation is finished it's the Team Leader that update the Job Status and time is recorded for all members of the team.

3) One Operator working on Many Jobs at the same time. Now this operator must be "Superman", because he can do many things at the same time. If 1 operator works for 1 hour on 2 jobs then 30 minutes is booked against each job and 1 hour is booked against the employee.

Note i. The time is averaged, so superman better be capable of making an intelligent decision. He should not for example "sign on" to 3 jobs if one takes 1 hour and the other two take 5 minutes each (approximately). Superman should "sign on" to the two jobs that take about the same time and when finished clock them both off together before "signing on" to the third job.

The operator needs to first be identified as "Superman Capable" before he can clock onto multiple jobs simultainiousely. This is done from the "System Settings/Employees" menu selection where there is a check box that needs to be activated as shown below.
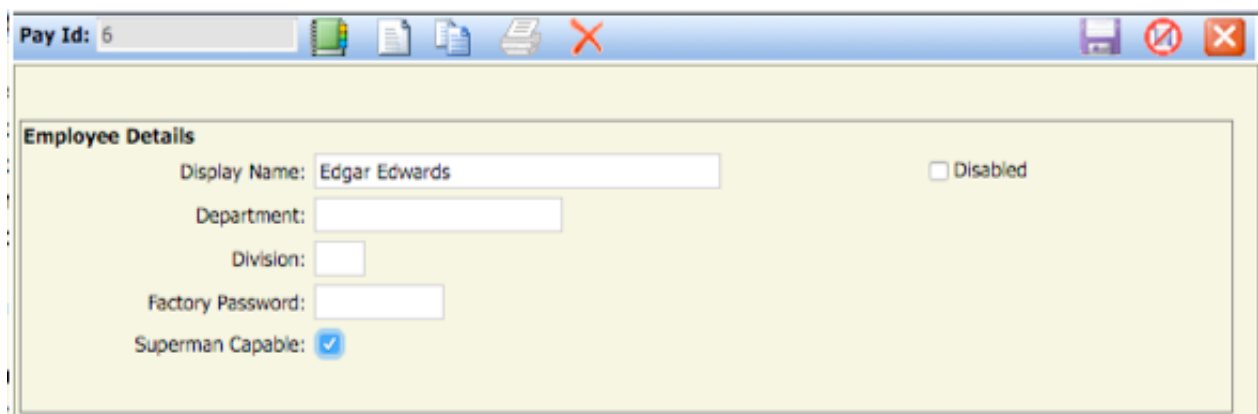

Figure 15 – System Setting/Employees – setting superman option

Once this option is set there is a more challenging sequence of questions for the operator at the Touch Screen. For example, once the first Job is selected the operator will be asked the following question;
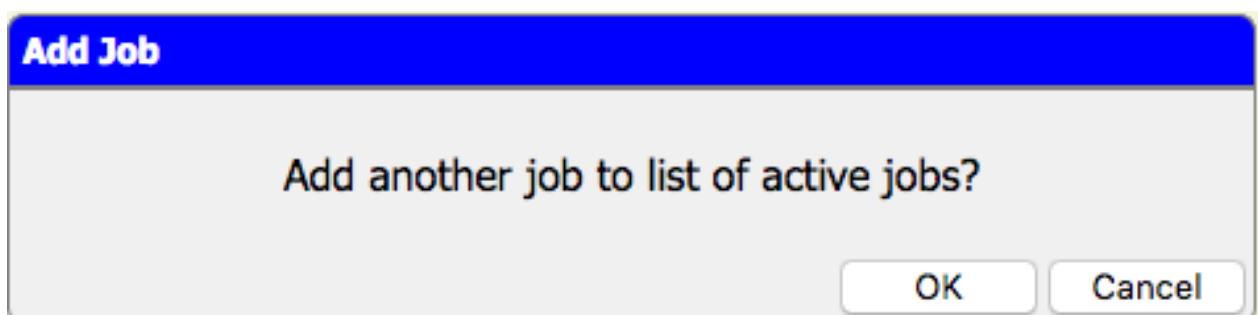
If the operator selects OK the screen processing is returned to the Work Area selecting screen so the operator can select another Job. The jobs may be in the same or different Work Centers.

The procedure is repeated until the operator selects Cancel to the prompt above.

During the "Sign Off" stage, the list of active Jobs is displayed so the Operator can select which Job he wished to update.

Jobs currently active

Job Number	Op#	Work Area	Start Time	
0000183-1.2	3	BRIDGE SAW	11/15/2016 8:58:00 PM	Page Up
0000184-1.1	3	BRIDGE SAW	11/15/2016 8:56:00 PM	
				Page Down

Cancel	**Select Job Number to update**	OK

Once the first job is update the dialog above will be recalled (minus the job just updated), so the operator can select the next to update.

You can see this is more complex, however, Superman is superhuman and should be capable of handling this.

4) Many Operators working on Many Jobs at the same time. This is just a combination of work option 2 and 3 above and represents a "Super Team" with a "Super Team Leader" and "Super Team Members". Once again the team leader does all the work, both selecting the team members and the jobs on which the team is going to work.

Typical examples of this mode of work are a plating line or a powder coating line where jobs are being processed continuously. The job selection and update can either be done on mass at the start and finish of the day, or alternatively a "running" job list can be maintained.

5) The last method by which work can be processed through the Factory is the case where NO operators are working on an active Job. In this case the Machine in running in "Automatic" mode.

For this last method to work the machine must be listed as an "employee" in the Employee List. The machine is a special employee however that "Clocks On" for work when it is commissioned and never "Clocks Off" (until de-commissioned).

Note i. As there is never any finish time for the machine employee a Time Card report is never generated.

A typical example of this type of work is where a Tool Setter loads the die into the machine and once it is set turns the machine to run mode. The Tool Setter should "sign on" to the job for purposes of setup and record zero quantity done. Once the job is set the machine is "signed on" to the job for processing (by someone) and when finished the machine is "signed off" and the quantity recorded (by someone). The table below summarises the various methods of working and also indicates how the Employee Time Card and Job Cost time data is recorded assuming one(1) hour of elapse time.

Touch Screen Work Options

Ways Work can be Done	Employee Time	Time on Job
1) One Employee One Job (1 Employee)	**1 hour**	**1 hour**
2) Many Employees One Job (4 Employees) **Team Leader** **3 Team Members (say)**	**1 hour each** **employee**	**4 hours**
3) One Employee Many Jobs (2 Jobs) **Superman**	**1 hour**	**½ hour each** **Job**
4) Many Employees Many Jobs **(4 Employees 2 Jobs)**	**1 hour each** **employee**	**4 x ½ hour** **each Job**

5) No Employees on Job(s) Automatic Process time distributed as above

The total time booked against the employee(s) is the same as the total time booked against the job(s) for any given working option.

Getting back to the setup for the Touch Screen system the main things that need to be indicated for each employee is whether or not they are "Superman" capable and adding the automatic machine to the Employee List.

Once the setup is complete and the Jobs loaded onto the schedule (by Issuing them to Production), the task of scheduling the work through the facility is all about setting the order (or priority) in which the work has to be done.

The jobs, by default, will be listed on the Touch Screen schedule in either Due Date or Due-by Date order, depending on which option is set. The "Due-By" date is the "Finish Date" for the operation as defined by the Backward Schedule.

There should be nothing else that needs to be done, by way of setting priority order, unless you wish to group jobs together which have a common set-up, or alternatively, to expedite jobs that are running late. You do this by simply highlighting a job in the "Scheduling/Schedule" menu item selection, selecting the Work Centre and then selecting the Job you wish to expedite. This recalls the Proess Information dialog as shown below;

The default priority is 255 for all jobs. If you set this to priority 1 then it will appear at the top of the list regardless of the Due Date or Due-By date status. Jobs with the same priority will be listed together in Due Date or Due-By Date order.

Setting a job priority other than "255" has the effect of expediting the job and placing it at the top of the list.

Don't fall into the trap of thinking that you need to set a priority for every job. If you do that you will completely by-pass the internal default prioritization system (Due Date or Due-By Date), rendering it totally ineffective.

Also, you should not have more than one priority 1 job, more than two priority 2 jobs and three priority 3 jobs etc, at any given time. Priority identification tends to loose its significance if every job is a priority 1 job.

Rule Number 3

Once priorities have been set, there is a simple rule that can be applied to ensure that the work gets processed in the order in which you want it done. This is the third of the Golden Rules for operating the ManuDyn system and goes something like this:

Always work on the job of the highest priority.

Sounds simple and it is. All you need to do is to enforce the discipline within the factory to ensure that this rule is being adhered to. You can do this by simply viewing the job list to check if the top priority jobs are being processed. Active jobs are marked with an asterisk "*" and in the screen display below the operators are not working on the top priority job.

If I was the scheduler then I would go and speak with the operator (or the supervisor), if I saw this situation. I want the operator to work on job 201.1, so why is he working on some other job and why was I not informed.

You only need to do this a few times and people get the message.

Concluding Remarks

Scheduling is a difficult process, particularly in a jobbing shop where change happens constantly. Priorities alter, things go wrong and it seams that Murphy's Law rains supreme, namely, "what can go wrong will go wrong".

ManuDyn can help in these situations because it is a flexible system and you are the driver. You need more than just a software system however to manage a factory. You also need discipline, determination and a set of simple rules that every one understands, and follows, to cover your operating procedures.

A factory without rules is like a society without laws. Chaos will prevail.