
# Scheduling Training

## Guide to Use

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## NOTICE

## Overview - Production & Material Scheduling

These functions start with master production schedule data and then use the Configuration & Routing data to schedule all portions of a product, including all subassembly production in the routing for the product. Using these data, the production scheduling functions generate production schedule data for all manufactured parts, linking each level to form a linked network of planned work orders and/or flow/repetitive schedules. The resulting network can then be subjected to a variety of possible scheduling techniques, including finite forward scheduling (to be developed at a later time), as well as simple backscheduling using the routing.

The AIMS/ERP production scheduling and planning concept centers around scheduling production first, then using this data to link in purchased material required at each operation in each routing, giving a time-phased, gross purchased material requirements. This data is then summarized, time-sequenced, and netted against available inventory to develop recommended purchased material delivery schedules.

The production scheduling and material planning process consists of four separate, distinct processes as summarized below.

1. **Master production schedule** - This module/function contains sales forecast data, sales order quantities of each item, current FG inventory & safety stock, and a separate file that specifies exactly what management desires to have as completed production, in end item part number terms, with specific quantities by specific dates. These data "drive" the production scheduling process in that these part numbers, due dates and quantities form the starting process for all back scheduling. While the MPS function is in terms of part numbers, the part numbers can be a planning only product, used to drive the planning/scheduling for a family of products, or use the Multiple Products Option capability.

2. **Production schedule generation** - starting with MPS data, the system backschedules each part, using the Route Name in each part's master file record to select a route to calculate start and complete times for the part being made at each operation in the routing. Subassembly schedules are linked in at the operations where each joins the next higher assembly's production. The initial production scheduling uses a backscheduling algorithm. If backscheduling results in a date earlier than the current first schedule date (normally the next working day), then the program then performs a backschedule compression calculation. If the result is still earlier than the first schedule day, remaining operations on the work order are forward scheduled with compression. If next higher assembly work orders are present, these are forward scheduled also, maintaining full level-to-level schedule validity. Key elements of the overall process are:

- Subassemblies and Manufactured Components Scheduling - scheduling of these items are linked to the operation number of the next higher assembly. These relationships are identified in the Manufactured Part Configuration table records for each Parent Part Number being scheduled and result in a tightly interlinked set of multiple level schedules.

- Stocked Manufactured Parts - The system will schedule the consumption of manufactured parts in inventory prior to scheduling the production of additional quantities.

- Work Order Data - the end result of the detailed scheduling process is work order records containing the parent part number and quantity being scheduled, and the calculated production schedule for each operation in its routing, including extended run times, operation start & complete dates and times, and pegging data for next higher assemblies and independent demand.

3. **Gross purchased material requirements generation** - using the work order data updated and/or created by the production scheduling program, the gross material requirements generation process portion of the Scheduler program reads material required from the Manufactured Part Configuration table records, using the Parent Part Number and Operation number, then extends the requirements to obtain the total quantity of each required part number needed by each parent part number at that operation in the routing on the operation start date. Component scrap and parent part number planned attrition %'s are included in these gross requirements calculations. Parts that are identified as Vendor Furnished = Yes in the Manufactured Part Configuration table record are excluded from this planning process. The result of this process is planned and updated Work Order Material records.

4. **Net material requirements and Demand & Supply Generation-** this process involves reading the Work Order Material records where quantity issued is less than quantity required so that all purchased part numbers required for both planned and open work orders is included. From normalized Work Order Material records, which include routing/work center information, three purchasing demand & supply data tables are generated:

    - Inbound Purchased Material Demand & Supply (PDS table)
    - Drop Ship Purchased Material Demand & Supply (DSDS table)
    - Outside Manufacturing (Services) PO Demand & Supply (OM_PO_PLNG table)

5. **Purchased Material Scheduling** - This process analyzes each of these three demand & supply tables and identifies either PO Changes or new Purchase Requests needed to correct demand & supply imbalances. These results are stored in the PO Changes and Purchase Request table. These entries are cleared eacht ime the Purchased Material

Scheduler is run. Preferrred vendor and expected unit price data is obtained from the Manufactured Part Configuration table, or in a planned development, from the Part Master if there is no vendor data in the configuration data for the component part. This allows preferred vendors to vary with component to product usage if desired.

**Master Production Scheduling - Overview**

This subsystem allows management to enter, maintain and display/report all information related to the decision and commitment process of planning and scheduling production at the completed or end item level. This information in turn is used to "drive" more detailed production scheduling and planning. There are several major functions that, together, make up the MPS subsystem, including:

- Sales Forecasting - entered and maintained in a separate file
- Open Sales Orders - obtained from the Sales Order Entry system.
- Master Scheduled Part Numbers- entered and maintained in a separate table. It defines all independent demand for all products to be sold or otherwise made available, including regular sales, samples, field support, repair, engineering testing, or other uses.
- Finished Goods inventory - obtained from perpetual inventory system.
- Work Orders - obtained from Open Work Orders table, with a status of OP or RNP.
- Planned Work Orders - obtained from Open Work Orders table, with a status of PLND.

The MPS portion of the system provides screens to enter and maintain sales forecast and MPS data, and to bring together other data to assist in decisions regarding production schedules, finished goods inventory levels, and commiting future production to sales orders (using available-to-promise calculations).

## Production Scheduling

### Overview

This section describes the AIMS/ERP production scheduling tools. In AIMS/ERP, scheduling of production precedes the material planning process, which is a derivative of it. Also, both regular, batch/lot flow type work orders and continuous flow/repetitive work order types are designed to be scheduled together in AIMS/ERP, enabling a broad range of production activity types to be modeled accurately and scheduled realistically by the AIMS/ERP scheduler. However, the continuous flow scheduling logic is a planned development and is not now performed by Scheduler. Covered in this section are the following:

- Management pollicy assumptions required for the successful use of AIMS/ERP scheduling.
- Overall functional requirements that the software must meet.
- Data dictionary fields used by the scheduling software, and the meanings of the terms.
- Specific program functions.
- Instructions for using the scheduling tools.

### Management Policy Assumptions

The AIMS/ERP production scheduling function assumes that manufacturing is to be managed in some specific ways. The software logic is designed to support these management policy concepts. These include:

Authorization and control of production - this control is obtained by requiring that all items to be manufactured are to be entered in the Master Production Schedule, regardless off what they are for, i.e., for shipment to customers (sales), samples, R&D units, field support, spares (subassemblies), etc.

Authorization and control of purchased material and services for production - these activities derive from the MPS, and are controlled via production planning and design data (routing, work center, configuration, and other data that is itself subject to clear management controls), that are incorporated into the production scheduling and planning process and as an output, produce data for procurement of production material, outside manufacturing services, hiring of internal production workers, and stocking of items for spares and repair support. Lack of derived demand (ultimately traceable back to the MPS) is de facto evidence that a purchased item is not authorized, for example. The scheduling program and associated planning processes, establishes the items, quantities and dates that are needed to fulfill the MPS.

Definition of production schedule - control over production and purchasing priorities is to be established via system generated processes, performed every day or every other day (not monthly, for instance). The system is designed to easily allow management approved changes to be propagaged quickly throughout the system, quicker than via any other means. This means that "the real schedule" is in the system, not on some unrelated, hand prepared list, or in someone's head due to orally given instructions that are never reflected in a change in schedule data.

Production Traveler Usage - This policy requires that any printed work order traveler type documents, not contain due dates or other schedule information. Individuals must refer to a currently produced report or inquiry to determine schedule priorities. This is mandatory to force the discipline of keeping the system information as the definition of the "real" schedule, not some hand produced "hot list" that may or may not be related to current, management approved priorities.

System Assigned Work Order Numbers - This policy simply acknowledges the fact that the program must create work order identifiers. A manually created work order number will be incorporated into schedule logic as with one with a system assigned record ID. The simplest method is to have the program create planned work orders, and/or work order records that support flow/repetitive scheduling, then simply change the status from PLND (planned) to RNP or OP**.**

**Functional Requirements**

The AIMS/ERP Scheduler meets the following functional requirements:

MPS defines Independent Demand - the program starts with the MPS as the starting point for all scheduling processes. Entering independent demand for any part number in the MPS will cause one or more planned work orders to be created to supply this demand. The only other way to "legitimately" create demand for a product is to enter a safety stock level for the part number. This MPS is "consumed" by completing a work order with the corresponding part number and moving the item to inventory. If the system encounters manually entered work orders, it will perform schedule calculations for it along with all other work orders. This approach permits easy, full control over authorization of what is to be manufactured. Subassemblies, manufactured component parts and purchased items are scheduled and planned as a derivative, via product configuration data, of items scheduled in the Master Production Schedule. The scheduling program's major objective is to continually synchronize all aspects of production activity to support the MPS.

Phantom product structures - incorporates "phantom" subassembly levels in its processing. This logic merges the material from lower, phantomized levels up into the highest, non-phantomized level. All material required is assumed to be consumed and processed at the linked work center. Routing data, if any, is ignored. Phantom

information is carried in the Product Configuration record, and applies to the relationship between one manufactured part and its next higher assembly, or parent part number. Subassembly part numbers, in this process, in effect, lose their identify as their component required parts list is merged with the next higher assembly's list of required parts.

Dynamic rescheduling - The scheduling program will update Open Work Orders having either a RNP or OP status by recalculating the start and completion date/time schedules for each operation to support the current MPS, inventory levels, and open work order status. All scheduling logic updates operation level date and time fields, not the work order Planned Completion Date and Planned Start Dates. This permits daily reprioritizing of production in accordance with constantly changing priorities and problems that arise. The Operation Quantity Remaining at each operation form the quantities to be scheduled for partly completed open regular type work orders. All scheduling calculations are performed in terms of hours with one decimal, using a schedule table that calculated hour numbers and hours available for each work day.

Planning Horizon - the Manufacturing Calendar record contains the number of working days (from the current date) that the scheduling program will schedule up to. The presence of MPS data beyond this horizon will not cause work orders to be planned or scheduled. Open work orders that become unneeded due to MPS changes, will be rescheduled out to this horizon date.

Consume inventory - On-hand balances (in excess of safety stock levels) in warehouse inventory of manufactured part numbers are consumed before generating additional planned work order quantities for dependent demand items.

Demand Data- Creates and updates work order/operation number references for both next higher assembly and independent demand data which is generated and stored in each Work Order's header information, and passed down through successive product structure levels via the Schedule Demand Table.

Operation to Operation Schedule Linkages - Subassembly work order last operation date/time equal the next higher assembly work order's operation used-in start date/times, to link and synchronize level by level schedules at the operation.

Planned Status Work Order Updates - Each time the scheduling program is run it will calculate new schedule date/times for RNP and OP work orders, and for previously generated PLND (planned) status work orders. During scheduling, if the program encounters PLND work orders that are no longer needed, it deletes them. If additional PLND work orders are needed to support the MPS and planning horizon, they are generated automatically. Work orders with RNP and OP status codes are never deleted, nor does the scheduling program change their planned completion quantities.

Scheduling Algorithms - Regular Work Orders - Backscheduled Operations With Forward Adjustments - When scheduling regular work orders, this program uses a backscheduling algorithm that does not consider work center capacity limitations. However, the work order to work order linkages are created and maintained to allow capacity constrained forward scheduling algorithms to be applied later. No schedule dates are calculated for dates that are earlier than the current system date or time. If a backscheduled work order results in any operation start or completion date earlier than the current system date (at the time the scheduler is run), then the program take several steps:

First, it will recalculate the backscheduled operation start and completion times using the work center buffer time compression percent values for operations that still have quantities remaining at them. The compression value reduces non-running time at operations, to shorten the total schedule interval for the work order. If this process still results in times that would be earlier than the current date/time, the scheduler will then calculate the schedule for the work order forward in time, starting with the first operation having a quantity remaining, again using the buffer time compression percent values. The NHA work orders that might be effected by this schedule shift are flagged for forward scheduling upward through the product structure. When all work orders are finished being scheduled initially, the scheduler then forward schedules those work orders that are in this list.

Planned Development - Scheduling Algorithms - Flow/repetitive Type Work Order - Continuous Flow/repetitive Forward - When scheduling Flow/repetitive Type Work Orders, this program uses a schedule period method, built into the same work order data records as regular work orders. Schedule periods are defined from the current period forward, with demand data being converted to hourly rates within each period. One flow can feed another, or can be supplied by subassemblies manufactured in batches on a regular work order. Continuous flow/repetitive schedule logic is in terms of an hourly rate of a part number over a defined period of time, as distinct from the assumed batch/lot movement of a regular type work order. One flow/repetitive work order can feed another by using the Standard Move Quantity to calculate how much overlap to schedule. Variations in quantities per day are achieved by the hourly rate plus hours scheduled on a given day.

**Scheduling Process and Data Overview**

This program starts with end item demand and schedules all manufactured parts by using routing and configuration data. Lower level subassemblies and manufactured parts are scheduled, using the relationships defined in the Manufactured Part Configuration table. These data are also stored in the Routing table to speed processing. Work orders are linked by the scheduling process, enabling linked structures to be independently rescheduled as needed without rescheduling all production by running this program. This data structure also allows the future development of forward and capacity-linked scheduling algorithms, all of which can use these same data structures.

Its result of the scheduling process is a revised Open Work Orders table consisting of planned work order data and updated plus recalculated open work orders. Planned work orders are then released by a production planner for actual production. In its processing, the program considers available inventory of manufactured items prior to creating new planned work orders and will schedule already open work orders out to consume in-stock quantities first.

In a normal processing run, for example, the program will read each part number's MPS record, recalculate operation start and complete date/times for the oldest, already open work orders first, reschedule linked subassembly work orders, then reschedule already created planned work orders, then if needed, either add new planned work order or delete those that are no longer needed. If a subassembly also is in the MPS, its demand is added to that of previously calculated NHA scheduled production quantities.

The planning of purchased material logically follows this process via a separate program. This process involves retrieving the manfactured part configuration record for each planned Work Order, creating a Work Order Material record for each Open Work Order that does not have one, and updating those that have had effectivity changes.

## Scheduling Data Terminology Used

This section defines and explains the tables and data fields within each table that are used by the scheduling program. Definitions of each field in terms of how the scheduling program uses the data field are also provided. The terms are organized by the table in which the data is most commonly used.

## Manufacturing Calendar

This program uses the following data in the Manufacturing Calendar record:

Standard Manufacturing Week Work Days - day numbers (0 through 6) to designate for the scheduler which week days constitute the normal working days.

Standard Work Day Hours - normal work day length in hours, with one decimal.

Number of M-days in Planning Horizon - number of working (schedulable) days from the current date that work may be scheduled into; any calculated schedule date beyond this date is not stored.

Holidays - Normal working days that are scheduled for closing, e.g., Christmas that falls on a working day.

Extra Work Days - Normal non-working days, such as a Sunday, that the scheduler wishes to schedule work into, e.g., a Saturday.

Extra Work Day Exception Work Hours (added) - allows instructing the scheduler to schedule a different number of hours for an exception work day; if an exception day is entered for a normal work day, with exception hours, the exception hours are used by the scheduler.

Default Operation Completion Time (added) - This data is retrieved by the scheduling program and is used to define the starting point for backscheduling where the demand source is a date. It is also used to define the end of the standard working day for Flow/Repetitive schedules.

Default Operation Start time (added) - This data is used to define the start of the standard working day for Flow/Repetitive schedules.

Schedule Period Start Day (added) - Normal day that each schedule period is to start on. A calendar day, advanced if it falls on a holiday or other non-working day in the Manufacturing Calendar; flow/repetitive work order scheduling only.

From these data the manufacturing calendar covering all valid working days is generated through the planning horizon limit.

**Schedule Days/Hours**

CHANGE 3/1/94 - modified to be a Work Center specific set of data fields, calculated and stored for each work center during calendar generation, instead of as a single global table.

End of 3/1/94 Change

This record is generated at the beginning of the scheduling run from the Manufacturing Calendar record. It is used by entering via a Manufacturing Day number, retrieving the appriate Hour Number, adding or subtracting the schedule interval or period value in hours, obtaining the resulting hour number, then retrieving the corresponding day number which that hour number falls into in the table. It consists of these fields:

Manufacturing Day Number - A/Rev internal day number, which can systemically be converted to a specific calendar date or day of the week. Starts with the current day and calculates forward to the Planning Horizon limit.

Day Number Schedule Hours - Hours for each Manufacturing Day Number that are scheduled to be worked. Generated from normal working days and standard hours per day, plus exception days and hours associated with exception days. Exception days may be either a standard non-working day (such as a Saturday), or a standard working day with non-standard hours to be worked, such as when overtime is to be scheduled.

Day Start Hour Number - Calculated sequence of working hours enabling any given time interval to be defined in terms of a begining and ending hour number, with one decimal. The table contains the beginning hour number for each day, its ending hour being the next day's beginning hour. The first hour in the period is hour number 0.0, with the last, at the end of the Planning Horizon's last day, being for example, hour number 1145.9. It is the basis for all scheduling calculations. Each hour number represents one hour in which work may be scheduled.

Exception Work Center ID's - The ID's of those work centers having different working days than the standard schedule days and hours. Causes the scheduler to skip this day's hour numbers when scheduling work for this work center.

**Forward Schedule Work Table**

This table is used temporarily in the scheduling process and contains records identifying work orders that must be retrieved and then forward scheduled. These work orders are the result of a lower assembly level work order that cannot be completed in time to support the next higher assembly level work orders, i.e., the schedules are not

synchronizable. Once retrieved, these are processed via the Work Order Forward Scheduling Algorithm, and if these in turn have NHA demand from work orders, these work orders in turn are added to this table and the process continued until this table is empty. Fields include:

Work Order Number
Operation No.
Start Date
Start Time

**Routing Master**

The Routing Master table defines the parameters used to model the manufacturing environment for each part number. The exception oriented data base allows standard that apply for all parts made with a given routing to be defined for the operation, with part number specific scheduling variables carried in operation-specific Exception Part Number data fields. The key distinction is between a routing type "W" for regular Work Order, which will cause a work order to be scheduled as a batch of parts moving along the routing, and a routing type "F", which is a flow/repetitive, or continuous flow production operation such as an assembly line, where each unit moves pretty much individually along the operations that define the flow for the units. The scheduling calculations and data fields used vary for each routing type. The Routing Type Code triggers different scheduling algorithms.

Operation Number - sequence of manufacturing; primary operation numbers only are scheduled, i.e., those with a decimal value = to 00.

Work Center ID - work center in which this operation is performed; serves as reference for exception non-working days, variations for standard working hours; if contains a vendor ID, identifies work center as an outside manufacturing work center.

Scheduled Before Buffer Time - amount of time in hours that units are to wait before being processed at this operation & work center; regular work order scheduling only; applies to whole batch, not multiplied time scheduled quantity

Scheduled After Buffer Time - amount of time in hours that units are to wait after being processed at this operation & work center; regular work order scheduling only; not multiplied time scheduled quantity.

Scheduled Setup Time - change over time from the last good unit of the previous part number to the first good unit of the next part number; regular work order scheduling only; not multiplied time scheduled quantity.

Scheduled Unit Run Time - amount of time in hours required to process one unit or item at this operation and work center; when multiplied times the Operation Scheduled Quantity, forms the basis for the work center load. Used in both regular and flow/repetitive type work order scheduling

Route Scheduled Hours Per Day - Regular production hours/work day; varied to produce greater or fewer quantity per day; flow/repetitive work order scheduling only.

Routing Schedule Period - Number of regular calendar days between the Schedule Period Start Day and the last day of the period for Routing. Non-working days, as reflected in the Manufacturing Calendar are subtracted from the actual available working days in the Schedule Period when calculating production daily rates. The daily rate remains the same within this time period; flow/repetitive work order scheduling only.

Change Open Schedule Rate? (Y/N) - this option tells the scheduling program whether to recalculate the daily rate for part numbers made with this routing. Yes indicates that changes are allowed, and No will cause the scheduling program to calculate the difference between MPS demand and the current daily rate for the open schedule period, and add it to the subsequent period. Allows for production environments where rate changes must be prepared for in advance.

Standard Move Quantity - Quantity that is to be calculated as produced, held until complete, then moved to the next higher assembly flow/repetitive line; flow/repetitive work order scheduling only.

Buffer Units Quantity - Quantity of units between each operation in the routing; scheduling program calculates these as added production time; flow/repetitive work order scheduling only.

Standard Operation Attrition - this value is used as a planned completion quantity multiplier to increase the quantity to allow for expected loss during processes at this operation number.

Part Exception Operation Attrition - this value is used as a planned completion quantity multiplier to increase the quantity to allow for expected loss during processes at this operation number, for this exception part number.

Manufactured Part Linkage data fields:

The data below is generated from Product Configuration data and is the manufactured part numbers used in this routing. The linkages are defined using phantom product structure flags in the Product Configuration record data. If a manufactured part is indicated as a phantom, it is not linked. Instead, the linkage essentially bypasses this

manufactured part number entirely, dropping to the next lower level where a non-phantom manufactured part number is required.

Mfg'd Part Number Used
Associated Parent Part Number
Operation Used In (this routing)
Effectivity In Date
Effectivity Out Date
Quantity Per Required
Planned Attrition%
Phantom?

**Work Center Master**

Number Workstations - this is used to indicate that more than one workstation within an operation can perform the same task. The scheduling program will divide the unit run time by this value to obtain the net output that multiple work stations can generate performing the same operation in parallel. Flow/repetitive scheduling will regard this as a maximum value, but may indicate fewer than these are needed to sustain a given daily rate.

Scheduled Efficiency Factor - Multiplied time the unit run time to extend the scheduled run time for an operation.

Scheduled Closing Dates - exception/additions to the manufacturing calendar's non-working days; if duplicates, are ignored.
Normal Working Hrs/Day - Planned normal working day for this work center; if blank the standard in the manufacturing calendar is used, or the routing if a flow/repetitive type routing.

Buffer Time Compression % - 2 decimal value (0.xx) used by forward scheduling routine to shorten inter-operation lead time for scheduling regular work order operations. Default is 1.0, no compression. This value is used for operations that have a standard planned scheduling time. It is multiplied times the number of working day/hours in the before and after buffer time fields during forward scheduling for work orders that have operation start or completion dates that otherwise would be earlier than the current system date. If the value is absent, the scheduling program will use the default of zero compression.

**Part Master**

Order Exact Requirements - Work order quantities and dates match demand line data exactly. Also, this rule is the default used if all order rules are equal to "N".

Order Exact with minimum quantity - If Y, also retrieve the Minimum Order Quantity data. Work order quantitities and dates match demand line data exactly, except that if the demand quantity is less than the minimum order quantity, the Planned Completion Quantity will be equal to the minimum quantity.

Order Exact Requirements with a maximum quantity - If Y, also retrieve the Maximum Order Quantity data. Work order quantities and dates match demand line data exactly, except that if the demand quantity is greater than the Maximum Order Quantity, the program will generate one work order for the Maximum, and another for the remainder.

Order Exact Requirements between minimum and a maximum quantity - If Y, also retrieve both the Minimum Order Quantity and Maximum Order Quantity data. Work order quantities and dates match demand line exactly, except that the rounding up to the minimum will occur if the demand is less than the minimum, and the generation of more than one work order will occur if the demand is greater than the maximum.

Order Fixed Order Quantity - If Y, also retrieve the Fixed Order Quantity data. Demand data is converted into planned completion quantities in the work orders in terms of the number of work orders, each having this fixed order quantity, that is required to meet the demand dates and quantities.

Order Exact Maximum - If Y, then the scheduling/planning programs will order the exact quantity for the time period up to the maximum. The Maximum Quantity is contained in the Maximum Order Quantity field.

Order Monthly - If Y, then the schduling/planning programs will plan a work order or purchase order that the exact quantity needed within a given calendar month, so that this single order for the month includes all requirements that fall within that time period.

Order Weekly - If Y, then the scheduling/planning programs will plan a work order or purchase order that the exact quantity needed within a given calendar week, so that this single order for the week includes all requirements that fall within that time period.

**Open Work Orders**

Open work order records are generated from a combination of routing and demand data. The resulting data fields in the work order record therefore contains some fields that are copied directly from the routing master record without change, some that are read, a calculation performed, the result then stored in the work order record, and some that are unique to the work order record itself, containing dates, demand and supply linkage data.

There are several major groupings of data fields in the Open Work Orders records. Where the demand for the Parent Part Number comes from is identified in the Next Higher Assembly demand fields. Manufactured part numbers (i.e., subassemblies or manufactured

components) that are required for this parent part number are identified as Manufactured Parts Required. Exact sources of supply to satisfy this demand are identified in the Subassembly Work Order fields. Scheduling fields are used to store scheduling calculations for dates, times, and quantities for both regular and flow/repetitive type work orders. These data fields are identified and their functions defined below:

Source of demand fields:

Next Higher Assembly Work Order No. (multi-value) - contains either the MPS Date which is the source of demand for this mfg'd part number, the work order number of the next higher assembly work order number, or the term "SS" which stands for Safety Stock. Multi-value stack sub-key for demand data.

Next Higher Assembly Operation No. (multi-value) - contains the operation number from which the demand for this manufactured part number is coming. If the source is independent demand, this field contains "00".

Next Higher Assembly Quantity (multi-value) - quantity required by the demand source, either the MPS quantity, a portion of the MPS if lot sizing rules are in effect that require the WO Planned Completion quantity to be smaller than the MPS Date's associated Quantity.

NHA Assembly Parent Part Number (multi-value)- Symbolic retrieving the Parent Part Number on the Next Higher Assembly Work Order Number referenced. Blank if either MPS or SS as demand source.

Independent Demand Part No. - key to sub-value multi-value stack linked to each Work Order. All independent demand items ultimately driving dependent demand for this subassembly work order. If the work order is generated solely to satisfy independent demand, the data will be the same as the NHA Work Order data.
Independent Demand Date - Date of MPS or SS demand associated with
Independent Demand Quantity - Quantity of this MPS line in the MPS record.

Scheduling Fields:

Work Order Header data:

Planned Completion Quantity - Read only for RNP & OP work orders; calculated for PLND work orders.

Planned Completion Date - on PLND type work orders, equals the last operation's Scheduled Completion Date

For each operation line:

Operation Number - sequence of manufacturing; primary operation numbers only are scheduled, i.e., those with a decimal value = to 00. Backscheduling logic reads these from the last to the first, from the largest number to the smallest.

Operation Attrition - copied from the corresponding routing master field; inflates planned completion quantity to account for expected loss during processing at this operation.

Scheduled Operation Quantity - quantity to be scheduled for this operation, including Operation Attrition.

Operation Load Quantity - Net quantity remaining at an operation to be scheduled; Scheduled Operation Quantity minus Operation Quantity Cmpleted; symbolic.

Efficiency Adjusted Extended Run Time - Extended Run Time multiplied times Work Center Efficiency %. Symbolic.

Loaded Extended Unit Run Time - Operation Load Quantity X Efficiency Adjusted Extended Run Time/ Work Center Number of Workstations; symbolic.

Scheduled Operation Start Date - calculated by scheduling program.

Scheduled Operation Start Time - calculated by scheduling program.

Scheduled Operation Completion Date - calculated by scheduling program.

Scheduled Operation Completion Time - calculated by scheduling program.

Scheduled Before Buffer Time - copied from Routing Master for operation or exception part number at operation.

Scheduled After Buffer Time - copied from Routing Master for operation or exception part number at operation.

Scheduled Setup Time - copied from Routing Master for operation or exception part number at operation; not used for Flow/Repetitive type routings and scheduling.

Scheduled Unit Run Time - copied from Routing Master for operation or exception part number at operation.

Scheduled Extended Run Time - calculated from Scheduled Unit Run Time before creating or updating PLND status work orders X Operation Scheduled Quantity; symbolic.

Parallel Operation Factor - copied from Routing Master for operation or exception part number at operation.

Flow/Repetitive Scheduling Variables - Future Development Planned

Route Scheduled Hours Per Day - copied from Routing Master.

Schedule Period - copied from Routing Master.

Scheduled Daily Rate - calculated by scheduling program.

Buffer Units Quantity - copied from Routing Master.

Standard Move Quantity - copied from Routing Master.

Calculated Cycle Time - calculated by scheduling program.

Average Daily Rate (symbolic) - calculated from Schedule Period Days divided by Planned Completion Quantity

Maximum Units Per Hour - calculated by scheduling program; ceiling hourly rate that can be schedule through this routing as a flow/repetitive type; actual hourly rate may be less, depending on schedule demand, but may not exceed this value; applies to all exception part numbers for the route.

Workstations Available - copied from the Work Center Master for each operation with Unit Run Times in the operation data. Shows the basis for Maximum Units Per Day calculation.

Required Workstations - Calculated from the unit run time and the scheduled daily rate. This is the number of workstations at each operation in the flow needed to sustain the scheduled daily rate. Will always be a value of one if the unit run time for this operation is less than required to maintain the daily rate.

**Scheduling Demand Table**

Data fields in the table carry and pass down independent demand data from the level it originates down through all intermediate subassembly levels to the lowest level work order. Provides a peg-to-the-top visibility as to the ultimate source of demand for all subassemblies, and enables retrieval of work order related data by independent demand source. This data is also carried through to PO Changes and Purchase Request records, so they, too can be easily and quickly identified as to “why they are here.”

The table is then updated with MPS data to initialize its demand functions, sorted into Low Level Code sequence, and is then ready to be processed by the scheduling program. The table is organized by Low Level Code so that each part number is scheduled only once.

Data is in four distinct groups. A set of single value fields is used to store part number specific data such as Route Name. A multi-value stack with one line for each operation number in the routing for this part number is used to store operation specific data, including precalculated data for use in the scheduling process. A second multi-value stack is used to store demand data for this data, with one line for each demand date. A third multi-value stack stores manufactured part numbers in the required parts list for this part number, and associated planning data, retrieved from the Routing Master where they are maintained.

Low Level Code - Record ID - obtained from Part Master record for this Part Number

Part Number - Record ID - Part number to be scheduled, for which there is demand as indicated by data in the record for this part number.

Route Name - route name from the Part Master record for this part number.

Demand line multi-value stack (in Demand Date sequence) one line for each demand & source:

Demand Date (multi-value) - date which the demand quantity is required by; either the MPS date, current date if the independent demand is SS, or the operation scheduled start date of the operation on the NHA work order if a dependent demand.

Demand Quantity (multi-value) - quantity associated with this demand line, either the MPS date's quantity, the safety stock quantity from the Part Master table, or the required quantity from a NHA Work Order dependent demand line.

NHA Work Order No. - (multi-value) (demand source) contains "MPS" or "SS" if an independent demand source, or the Work Order Number if the source is a dependent demand, i.e., it is from a NHA work order.

NHA Work Order Type - (multi-value) identifies whether the demand source is a flow/repetitive type work order or a regular work order.

NHA Operation No. (multi-value) - operation number associated with the NHA demand; "00" if an independent demand source.

Demand Time (multi-value) - blank if demand source is MPS or SS. Equals the Operation Scheduled Start Time on the Operation Scheduled Start Date of the Operation of the Next

Higher Assembly Work Order where this Part Number is required. Enables scheduling to flow consistently in hours with decimals from one assembly level to another without arbitrarily aadding in a fraction of a day

Independent Demand Part No. - key to sub-value multi-value stack linked to each Work Order. All independent demand items ultimately driving dependent demand for this subassembly work order. If the work order is generated solely to satisfy independent demand, the data will be the same as the NHA Work Order data.
Independent Demand Date - Date of MPS or SS demand associated with the demand part number and quantity for the part number.

Independent Demand Quantity - Quantity of this MPS line in the MPS record.

## Multiple Products Option Use Guide

### Overview

This section describes how the multiple products, or power supply assignment capability that is being added to AIMS/ERP works, how to use it, and what steps are needed to convert to its use.

The primary purpose of the multiple products capability is to substantially reduce the number of work orders, transactions, BOM levels, and related activities needed to manufacturing what are essentially 23 products.

### What The Multiple Products Option Does

Multiple Products accomplishes its objectives via the following tools:

Part Number Power Supply Assignment- any part number can have a list of power supply codes, a set of associated Finished Goods Part Numbers and default planning mix associated with that part number. This list is termed the Multiple Products (MP) List. For example, the QV part number will have a list like this:

| Power Supply Code | Part Number | Default Mix |
|---|---|---|
| UL | QV-UL | 50% |
| EU | QV-EU | 25% |
| etc. | | |

Scheduler Product Mix Enhancement - The schedule program, when creating planned work orders to satisfy a master production schedule demand for the product will retrieve the MP List from the Part Master record and use it to retreive the required part data from the power supply associated part number, i.e., the QV-UL, QV-EU, etc., and extend these requirements times the Default Mix values for each and add them to the Work Order Material data for the product, in this example, the QV's BOM data.

Thus, in the QV example above, if the Master Production Schedule contained an MPS demand for 1000 QV's for 8/15/94, Scheduler would create a single work order for 1000 QV's, and would break down this 1000 units into 500 QV-UL's, 250 QV-EU's, and so on. It would also retrieve the production configuration (BOM's) for the QV-UL and others in the mix, filter out the QV itself (and any other manufactured part number), and add the power supply specific required parts to the QV's Work Order material record, multiplied times the 500 in the mix (not the 1000 for the QV as a whole). To some degree, this cability combines the flexibility of a multi-level product structure with separate work

orders for each option with the simplicity of a single, grouped work order. The chief missing capability is the ability to have separate schedule dates for each item in the mix. All have the same work order/operation start & completion dates.

Manual Work Order Entry - performs the same process as the Scheduler when creating a new Work Order's records.

Open Work Order Power Supply Mix - this new screen allows direct maintenance to the Mix data in a work order that was created using the MP List data. When the list is changed, and the work order saved, the program replans the purchased material associated with each power supply in the Mix, according to the new mix data's values.

Work Order Completion & Move to Stock - this existing transaction has been changed to prompt first for the Work Order being reported as having units completing on it. Depending on whether the work order has Multiple Products associated with it (which is picked up at the time the work order was originally created) it will either function the existing way, i.e., for regular, non-multiple products part numbers, or will prompt for the Power Supply code to designate the completed units with. A single transaction can have multiple completing part numbers. For example, a work order for an AD with 10 units moving to stock can be 6 AD-UL's and 4 AD-EU's. The Work Order is updated with both the work order Parent Part Number ("AD" in the example) and the completing Part Number ("AD-UL" in the example). The completing Part number is the one used to update on hand balance in the Inventory table, and appears in the Inventory Transaction History record.

Receipt to Dock (Outside Manufacturing PO's) - Same Work Order completion functions as the Work Order Completion & Move to Stock transaction. The Parent Part Number is the Line Item part Number on the PO, and the program will update these data fields as it does now for regular part numbers. The Completing Part Number appears in the Receiving Lot master record, is printed on the Receiving Report, and in the Receiving Transaction History record.

**Related Issues**

Use of the Multiple Products/Sexed Work orders capability assumes the following policies regarding product documentation:

1. Bills of Material/Product Configuration data - no changes should be made to the way products are configured. In particular, the top level in the BOM must continue to be the power-supply level. The Cost Calculation/Rollup system has not been changed and will product invalid cost calculations if the single level BOM for the power-supply designated part number/assembly does not include the main product assembly's part number to link it with. Changing the cost calculation system logic is a significant

amount of work. Validating the revised system and, in effect, rebaselinining all costs used in the inventory & production accounting system is a major amount of work, with little identifiable benefit, and so is not recommended.

2. Routing Master data - Currently, the outside manufacturing costs and schedule data are at the power supply level. For example, the QV-UL is identified as being made with the SST route, and cost for each power supply'd part number are called out as Exception Part Number data. The QV, on the other hand is shown as made with the KITSST route, and has no cost or schedule data.

   For Multiple Products/Sexed Work Orders (and the new Bill of Material report) to work correctly, as each product is transitioned from the current method to the new method, the routing data must be changed for both scheduling purposes and cost calculation purposes. Routing data changes include:

   - Remove O/Mfg part exception cost data from the XX-UL type part numbers.
   - Add O/Mfg part exception cost data for the XX ("QV") type part numbers instead, in the route that is actually used to plan and track the production itself.
   - Eliminate the use of the KITSST type route structures.
   - Change the route for the XX type part numbers from KITSST type routes to the actual route, i.e., "SST".
   - XX-UL part numbers may have their routes left at the actual route used, i.e., the "SST" type route, in case a work order is created at this product level, until a full transition is achieved from the current to the new method and all "XX-UL" type work orders are flushed from the system.

   With these changes, both the new capability will work correctly, and so will all other, older costed BOM type reports, and the cost calculation/rollup system without any changes. All that will appear differently is that the labor cost will move down one level in the product structure from the XX-UL level to the XX (product) level.

3. Part Master/Mix Data - for each product, the Power Supply Assignment/Multiple Product list data must be entered, including a default product mix for each power supply code and associated part number. This information becomes an essential part of planning, scheduling and is used by the new Bill of Material report to retrieve and display the "Destination Configuration" part numbers and costs. Someone must be assigned responsiblity for maintaining this information correctly.

4. Sales Forecasting & MPS - Since a primary objective of the Multiple Product/Sexed Work Order option is to dramatically simplify how Alesis's products are planned and tracked in the system, there are changes here too. With the multiple products option, all power-supply visibility shifts from the Sales Forecast and MPS records, "down"

to the Open Work Orders, effectively removing the entire issue and complexity from the Sales Forecasting and Master Production Schedule data maintenance process.

A new report, called the Summary Manufacturing Plan selects only work orders with the multiple products data in them and then prints, on one page, the entire production plan for a selected month, by product, with the planned mix data for each power supply version shown on the same line.

The idea is that power supply mix is handled more informally, not at the FG part number level, and via a spread-sheet appearing technique. Sales can communicate desired changes more close in by simply marking up this report, via E-Mail or similar technique, rather than constantly tinkering with a cumbersom part-number level sales forecast for each power supply version separately. This reduces the number of sale forecast records from the current 150-160 or so, down to about 23.

With the multiple products option, Sales Forecast data in AIMS/ERP is maintained at the product part number level, i.e., at the "QV" level, not the "QV-UL" level.

By the same token, the Master Production Schedule data shifts to the product level also. The result is that all normal product MPS data will consist of aggregate-level dates and quantities for the product, approximately 23 MPS records to maintain, in place of the current 160 or so.

## Making the AIMS/ERP Scheduler Work For You

### Overview

In AIMS/ERP, Production Scheduling (work order operation scheduling) and gross purchased material requirements generation are performed by a single, integrated process. There is no separate MRP and CRP cycles as in traditional MRP II systems. In a single run taking about 1 hour, the Production Scheduler performs the following tasks:

- Reads the current Master Production Schedule file data and safety stock quantities, to develop a total statement of Independent Demand.

- Recalculates all Operation Start and Complete Dates & Times for all operations on all work orders so these fully support the Independent Demand data, deferring those with no demand into the future, creating new planned work orders, and deleting unneeded planned work orders. Any changes in Production Configuration or Routing data are incorporated into all Planned Work Orders during the run. Work Orders with Open, Pick (OP) or Released, Not Picked (RNP) statuses do not have their routing or configuration data changed.

- If an Independent Demand Date and Quantity is inside the cumulative schedule intervals of all work orders required to meet that date, Scheduler will calculate the earliest possible date by which this demand can be satisfied, via the following procedure:

    1. Backschedule work orders, using standard scheduling data values.

    2. If a start date earlier than the first working day being scheduled is encountered, Scheduler will recalculate the work order's schedule using compression of Before and After Buffer times.

    3. If compressed back scheduling still results in a Start Day earlier than the first working day being scheduled, it is forward scheduled, starting with the first operation having a quantity to be completed.

- Scheduling is performed from the top of all product structures (finished good level) downward, in Low Level Code squence, with each level's dependent demand being passed "downward" via a Demand table, using manufactured part numbers and quantities shown as required in each Work Order Material record. This results in valid quantity and date relationships between each product structure level, and enables Scheduler to identify all demand for a part number before planning and scheduling work orders to meet that demand. This demand data is stored in each work order

record, so one can quickly determine what demand data was used to plan/schedule the work order.

- If a lower level subassembly work order is forward scheduled, the next higher assembly demand data is examined and passed to a forward schedule working table. After all backscheduling is completed, these work orders are then forward scheduled, their next higher assembly work orders passed to forward scheduling, the process continuing until the FG level is reached. This process preserves the date relationships between product structure levels, but shifts them all to into the future.

- The result of this process is that the end item level work orders will contain the earliest date that it can be completed, regardless of what the Independent Demand data are. It also enables one to know what the "real" schedule is, and to accurately prioritize work at individual work centers, based on the independent demand data in the MPS, approved by management. "Schedule" dates in the past are meaningless as a guide to how to prioritize work, so Scheduler does not generate them. Dates in the past are what we would like to have done, not what we are going to do today, or tomorrow.

- There is no separate planned order table in AIMS/ERP. Scheduler creates and maintains a single set of work orders that have real work order numbers and function in every way like “live” work orders except for their status, which controls what scheduler can do to them. Otherwise, PO’s can be placed for planned status work orders, and the numbers used, routing changes such as assigning alternate workcenters, or other uses all while the work order is in a planned status. If the MPS is stable, the work orders generated from it will be stable as well, adding new ones as needed at the end of the existing list for a part number as MPS demand is added, with production consuming those at the top of the list.

The Scheduler is designed to be run every work night, to re-update the schedule data based on each day's activities and changes. Its power means that a small amount of data changed in the work center and routing data can produce a large change in scheduled work and material requirements. So those using it should strive for a small number of changes at any one time, instead adding in and changing a little at a time, once a valid, workable schedule is generated.

Once Scheduler is run, a series of short processes are run which normalize the work order and purchase order data, then create the three separate demand and supply tables. In each of these there is a matching of purchase order data with associated demand (work order data), and for Inbound Purchased Material Demand & Supply, projected inventory calculation using available stock:

- Inbound Purchased Material Demand & Supply (PDS table)
- Drop Ship Purchased Material Demand & Supply (DSDS table)

- Outside Manufacturing (Services) PO Demand & Supply (OM_PO_PLNG table)

A family of reports and inquiries are available in AIMS/ERP taken from these and other tables, all using the work order operation start & complete dates/times, and planned status work orders generated by the Scheduler and related processes. These include:

- Purchased Material Demand & Supply Reports & Inquiries
- Purchased MRP Exception Reports
- Outside Manufacturing PO Planning Reports
- Work Order & Part Number shortage reports
- Work Order Material Allocation reports
- Work Center Production Schedules

The Work Center and Routing data in AIMS/ERP is virtually the sole source of scheduling data used in calculating start and completion dates/times, so it is important that those creating/entering this data fully understand the effects of various entries, as used by the Production Scheduling program.

The main features of the Production Scheduling system include:

Work Center Specific Work Calendars - Each Work Center has its own manufacturing day calendar, generated from the standard Manufacturing Calendar record data, plus Work Center specific exception data.

Work Center Specific Scheduling Parameters -The Work Center record contains scheduling parameter data that is either used directly by Production Scheduling, or used as default values in the routing operation lines that call out the work center ID, and thus incorporated into the scheduling logic via this method.

Routing Data Drives Scheduling Calculations - The Routing Master table records, with their associated work center record data, contain virtually all data that impacts the scheduling process. In order to preserve relationships between independent demand and dependent demand data, the Scheduling program has full control, guaranteeing that the resulting schedule definitely will support the MPS data, without constant intervention by production planners at a more detailed level. It is a fully integrated scheduling method.

Independent Demand Driven - The Master Production Schedule data (with safety stock values) is the sole driver of the Scheduler. All independent demand is entered in the MPS record for each manufactured part number. Techniques such as Planning Bills of Material can reduce and simplify the planning for repair parts and other low volume but essential items. The Scheduler will align all dependent demand and resulting work order scheduling to support the MPS as closely as possible. Work Orders that are for items that have no

demand are either rescheduled out to the end of the Planning Horizon, if they are already released or open (RNP or OP status), or deleted if Planned (PLND status).

Integrated Production Schedule, Material Requirements Planning - Changes to the schedule, therefore, are made by altering routing data, not by changing work order completion dates, or other manual, ineffective methods. The demand for purchased parts and services (outside manufacturing PO's) are all driven by the process of scheduling manufactured parts via work order scheduling. Once the start date of a particular operation on a particular work order is calculated, all material linked to that operation is therefore needed on that date.

The effect of this process is to develop highly accurate, consistent material requirements dates, directly from work center/operation specfic work schedules, but without having to perform a complex planning process for purchased part numbers at all. Since these part numbers are inevitably much more numerous than manufactured items, this method greatly speeds up and integrats the overall planning process. It is simply brought together on the P/MRP reports, using the demand dates generated for the operations on the work orders.

The guidelines below explain how to make the Scheduler work for you, how to make it do things the way you need them to be done. With the use of named routings, enabling many parts to use the same routing data, and the exception oriented data structure in the Routing records, a small number of changes in the routing data can alter the scheduling for many manufactured part numbers, and therefore the purchased material requirements for all of their related purchased items. Each data field in the Work Center and Routing records are explained, and include comments as to what to enter in order to achieve certain end effects in the resulting schedules.

## Work Center Master Data Use Guidelines

Some Work Center Master data is used directly by the Scheduler, while others serve as defaults for the Routing Master maintenance program. These distinctions are noted in the data explanations below:

Normal Working Hours/Day - this value is used as the standard for this work center. If left blank, the calendar generation program will use the manufacturing calendar record value for the standard work day length.

*Use Guidelines:* Leave it blank unless this work center, as a normal practice for an extended length of time has a different day length you wish to be scheduled. For a short period, the Exception Days fields may be used.

Scheduled Efficiency Factor - divided into the extended unit run time for an operation calling out this Work Center ID to adjust for lower/higher than standard efficiency at that work center. For example, a work center efficiency of 80% will increase

*Use Guidelines:* Leave blank, or at 1.00 (100% efficency), to cause the Scheduler to not adjust extended unit run times. Enter a lower (or higher value) to cause the Scheduler to increase or decrease Extended run times to account for efficiency that is greater or less than the standards.

Parallel Operation Factor - This value is an integer, in hours, that is added to an operations completion date/time to offset it, allowing it to be later than the subsequent operation's start date/time. This is used in situations where the quantity to be moved from one operation to the next is significantly less than the expected run quantity, allowing the subsequent operation to be started before all units have completed the operation carrying the parallel value. In the Work Center record, this value serves as a default, appearing during the routing maintenance for an operation. In the routing, it can be overridden, with either a different or no value entered.

*Use Guidelines:* Leave blank, unless the routings that call for this work center ID are a step by step production flow, where parts are to flow directly from one work center to another during production.

Work Center Count - This value is used to indicate that multiple people, workstations, or machines are available to perform the same task simultaneously. Production Scheduling uses this value by dividing the extended unit run time by it to reduce the total run time.

*Use Guidelines:* Leave blank, or set to 1. If the Unit Run times that are to be entered in the routings calling for this work center are the total hours for a group of workers, all of whom are working on the same item at the same time, then enter the average group size of these workers in this field. Scheduler will divide the Extended Run Time by this number, shortening the scheduled time to perform this operation at the work center considerably.

Buffer Compress Factor - This value is used by Production Scheduling under two circumstances. Its effect is to reduce the Before and After Buffer values in the Operation line in the routing calling out this work center ID. Production Scheduler will multiply the value in this field by the buffer times to obtain a compressed (shortened) buffer (wait) time. The two circumstances that this process is invoked are:

During backwards scheduling of a regular work order when a calculated operation start date/time is obtained that is earlier than the schedule start date/time (would be in the past, in other words). The work order's operations are then backscheduled with compressed Before and After Buffer times to reduce the total schedule

interval for each operation. If this process does not result in a start date/time in the past, the process is complete.

If the backwards scheduling process still fails this validity test with compressed buffer times, forward scheduling is invoked, which always uses compressed buffer times.

*Use Guidelines:* Leave blank or set to 1 if you do NOT want Scheduler to reduce total schedule interval during compressed backward or compressed forward scheduling routines. This will cause it to always schedule the same total interval for an operation during regular work order scheduling. If you DO want Scheduler to compress the Buffer times, enter the proportion of Buffer time you want it to remove during the compressed scheduling routines.

Work Center Start Time - this value is an exception time of day work starting time for this work center. If it is blank, the calendar for the work center will use the same time of day as is the standard in the Manufacturing Calendar record.

*Use Guidelines:* Leave blank unless the Work Center always has, or for an extended period of time is expected to have a non-standard starting time. For short periods, the Exception Days fields should be used, which will automatically drop off the Work Center calendar when they fall into the past.

Exception Dates - Includes Date, Start Time, Hours(per day) values to create a different than standard manufacturing calendar. Exceptions can be either a regular working day that is, for this work center, a non-working day, or a regular non-working day (e.g. Sunday), that is being worked in this work center. Work Center specific start times are entered for exception days, and the hours to be worked that exception day are entered also.

*Use Guidelines:* Leave blank except for known specific days where you want Scheduler to schedule work for that work center when most other work centers are NOT working. If most work centers ARE working, it will be easier to enter Exception Days in the Manufacturing Calendar, which will cause Scheduler to add these days to the Calendars for all work centers, then enter Exception Days with zero hours per day for those that are NOT working. The advantage of Exception Dates over system wide (global) values such as changing the length of the standard work day, is that these values automatically drop off, or are specific in their impact on the results Scheduler creates.

Changing the length of the standar work day, for example, changes the day length for the whole calendar, not just a specified period, requiring re-tinkering with the calendar values more frequently.

**Routing Master Data Use Guidelines**

Routing information is linked to Manufactured Part Numbers in the Part Master record via the Route Name. In AIMS/ERP, Routes are named, rather than identified to a specific part number to enable a single collection of routing data to provide the manufacturing basis for many part numbers. The Route Name is a unique identifier for a given standardized flow of movement of material through a production cycle common to one or more manufactured part numbers. Data used for Standard Cost calculations is carried in the Routing records, but is visible on a separate window. Routing Type Codes are either W, for regular work orders, or F for continuous flow work orders (not supported by Scheduler at this time). The Scheduler uses the Routing data as described below:

- When creating new or updated PLND work order records, the routing structure is set or updated by using only the primary (xx.00) operation lines, including all the Scheduling Time values shown, and and Scrap and Parallel Operation Factors.

- If the PLND status work order has had its routing changed (an alternate operation is substituted for a primary operation number) by the Work Order Operation Change program, a flag is set in the work order record "freezing" the routing. In this case Scheduler uses the operation numbers in the Work Order record as the structure, retrieving current Scheduling Time and other values from the Routing for the operation numbers in the work order record, including the alternate. Scheduler will schedule the alternate operation in place of the original, standard primary.

When accessing the routing data, scheduler will examine and use Exception Part Number Scheduling data as follows:

- If, for an operation line, an Exception Part Number equals the Part Number being scheduled, and the value present is not blank, that value will be used in place of the standard for the operation. A zero is data, and is interpreted to mean that you wish for that zero to override the value in the standard operation data.

- If the Exception Part Number is either blank, or not present, then the Scheduling data for the standard operation line will be used.

Data field explanations follow. Guidelines for their use address all data fields together, because they are interrelated.

Operation Number - Numbers with a decimal value of zero (xx.00) are defined in AIMS/ERP as Primary Operations, i.e., the normal, standard flow of work along the routing. All costing and regular scheduling processes use these operation numbers. Alternate operations are identified as those operation lines with a non-zero decimal value, (xx.xx). For example, operation 20.10 is an alternate to operation 20.00.

Operation Description - The description of what occurs at this operation. Applies to all part numbers using this route. AIMS/ERP provides for part number specific operation descriptions to a limited degree via a data field in the Manufactured Part (Product) Configuration record.

Work Center ID - The identifier for the Work Center where this operation number is performed. If it contains a Vendor ID, it is identified in AIMS/ERP as an Outside Manfacturing Work Center, and will be selected for the Outside Manufacturing PO Planning report, and will have its indirect costs calculated differently. The work Center may be additionally identied as a foreign work center via the Foreign? flag.

Parallel Operation Factor - This value is an integer, in hours, that is added to an operations completion date/time to offset it, allowing it to be later than the subsequent operation's start date/time. This is used in situations where the quantity to be moved from one operation to the next is significantly less than the expected run quantity, allowing the subsequent operation to be started before all units have completed the operation carrying the parallel value. In the Work Center record, this value serves as a default, appearing during the routing maintenance for an operation. In the Routing, it can be overridden, with either a different or no value entered. The scheduler always uses the value present in the Routing record.

Scrap Rate - This is an attrition, scrap or loss rate expected to occur to the parent part number (being manufactured) during its processing at this Operation number or at this work center. Its effect in Scheduler is to inflate the work order or subsequent operation's quantity by this decimal fraction to allow for this expected loss. For example, a Scrap rate of 0.05 (5%) will increase a planned quantity of 100 to 105. This value is then passed to preceding operations as its planned quantity.

Before Buffer - this value represents the amount of time the scheduler wants to allow for the work order's material to wait at the work center before actual production work on it begins. When combined with the Work Center's Buffer Compress Factor, a smaller value will result.

SU/Changeover - this value represents the time a work center's productive resources (machines, assembly line, etc.) require from the last previous work order's manufactured part number being produced to the first good part number for this work order's operation. It may also be used to enter a fixed schedule interval ("lead time") the scheduler desires to enter for this part number. This value is NOT used in standard cost calculations. It is for scheduling use only.

Unit Run - this value represents the amount of time, in decimal hours, required to perform the work required at this work center for one of the parent part number using this routing. The Scheduler divides this value by the Work Center Count value to adjust for multiple

resources (people or machines) working on the parent part number simultaneously, thereby shortening the total time required to product the planned quantity.

After Buffer - this value represents the amount of time the scheduler wants to allow for the work order's material to wait at the work center after actual production work on it is completed, but before it is moved to the next operation. When combined with the Work Center's Buffer Compress Factor, a smaller value will result.

Part Exception information is access for a given operation line via the Shift + F1 keys together. Each operation line has separate Part Exception data.

Part Exception Setup - If a Part Exception line is present and matches the Part Number being scheduled, the scheduler will not use the Part Exception Setup value it if it is null (blank). If zero or another, positive value is present, it will use it instead of the standard values on the main screen.

Part Exception Unit Run - If a Part Exception line is present and matches the Part Number being scheduled, the scheduler will not use the Part Exception Unit Run value it if it is null (blank). If zero or another, positive value is present, it will use it instead of the standard values on the main screen.

During Operation Scheduling, the Scheduler calculates the total Schedule Interval from the Schedule Times and other data as described below. Total Schedule Interval is the difference between Operation Completion and Operation Start Date/Time.

Before Buffer Time (uncompressed or compressed)
+ Setup Time
+ Extended Run Time (see below)
+ After Buffer Time (uncompressed or compressed)

The Quantity to be scheduled is calculated by taking the Work Order Planned Completion Quantity and passing it to the Operation lines for scheduling. The Scheduler adjusts this quantity by:

Inflating it with the Operation Scrap Rated
Reducing it by the Operation Quantity Completed

The result is the Operation Scheduled Quantity

Extended Run Time is calculated from:

$$\frac{\text{Operation Scheduled Quantity} \times \text{Unit Run Time}}{\text{Work Center Scheduled Efficiency Factor}} = \text{Total Gross Load}$$

Total Gross Load
Work Center Count

= Extended Run Time

Use Guidelines: Use these values according to the degree of schedule flexibility you want Scheduler to use:

Fixed Schedule Interval - If you want the calculated schedule interval to always be the same, under all circumstances, enter this interval in the Setup Time, leaving Before and After Buffer times blank, or enter Buffer Time values, and make sure the Work Center records called out have a Buffer Compress Factor of 1.0 (no compression)[.

Buffer Time Compression Only - If you want some flexibility, enter the non-variable time interval in the Setup Time field, and compressible values in the Buffer time fields, and enter the decimal value you want Scheduler to compress these values in the called out work center records.

Run Quantity Sensitive - If you want the Schedule Interval to be fully dynamic and sensitive to the quantity required, enter an appropriate value in the Unit Run time field, and an appropriate value in the Work Center Count field if needed.

NOTE: This field has a great deal of power. Decimal point errors can cause Scheduler to calculate a Schedule Interval greater than the entire manufacturing calendar period, resulting in an invalid schedule. Schedule will terminate its run if this condition is encountered, because it has no way of calculating the related dependent demand items and other factors, or of determining what you really wanted it to do.