



## A3 Autoclave integration project

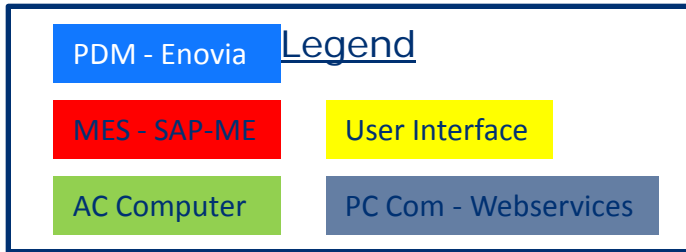
SESG presentation



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## Integration of PDM, SAP-ME and the autoclave computers

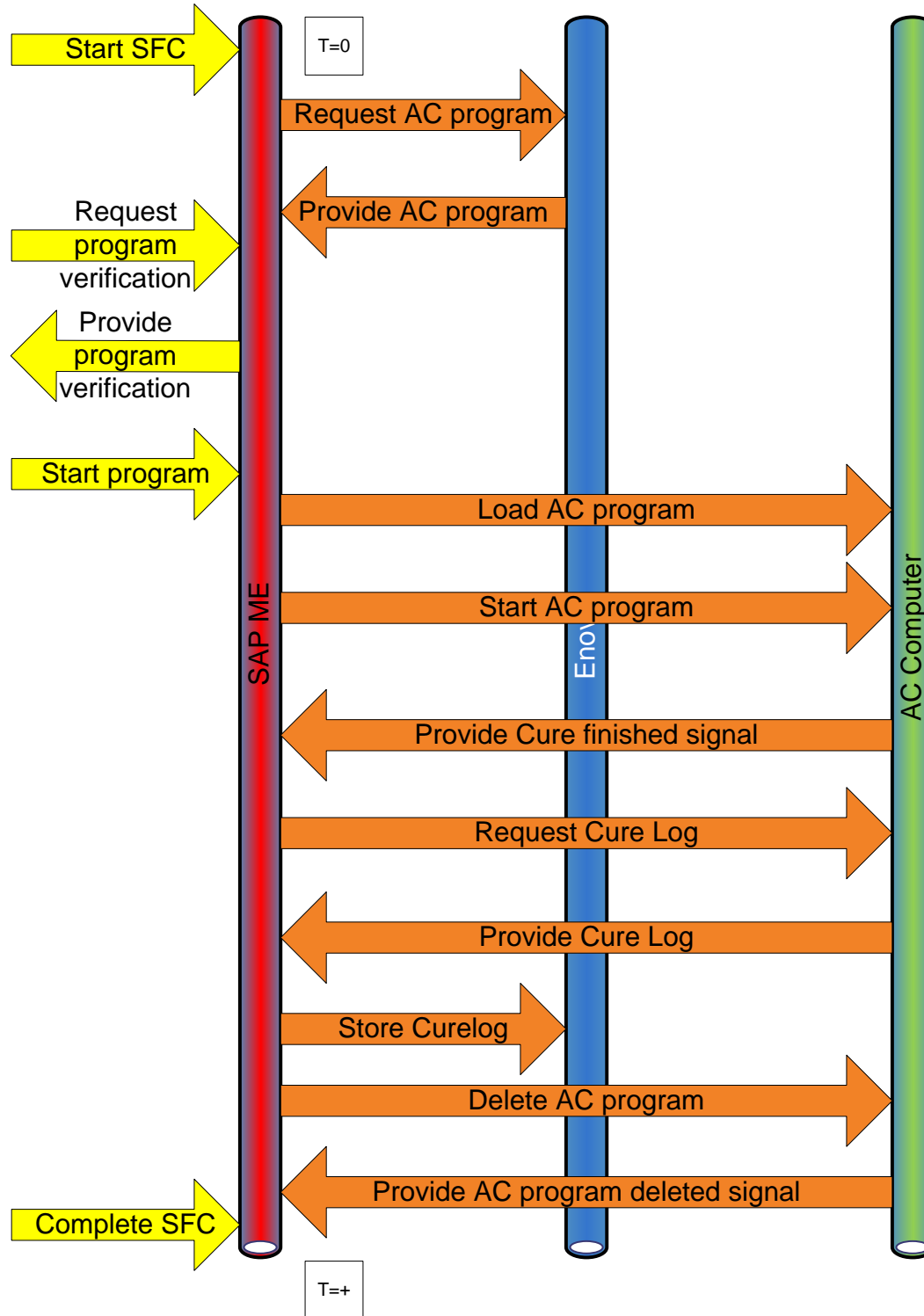
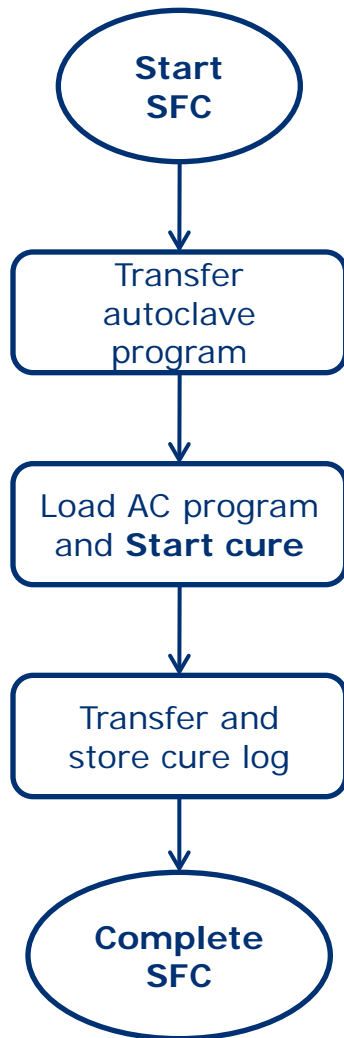
A3 Architecture Overview

**Need: Configuration control of autoclave programs and automatic data collection of cure logs**

### Quantification of Key Parameters

- Number of different cure cycle programs: 6
- Number of parts to be manufactured in one single load: 1-10
- Number of AC programs to be transferred: 1
- Number of cure logs to be transferred: 1-10

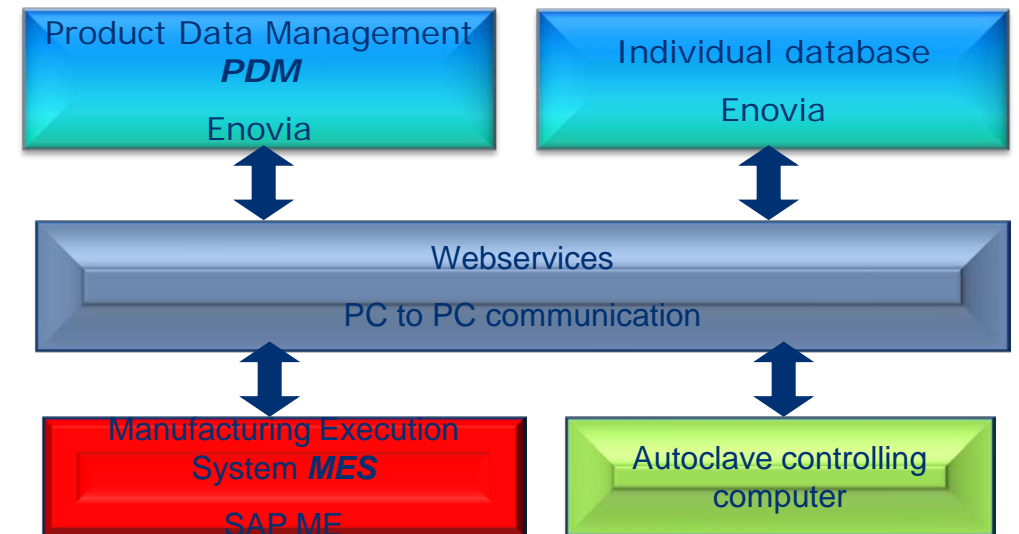
### Functional Flow



### Design Decisions / constraints

- KONGSBERG DMA utilize Enovia as a PDM system
- KONGSBERG DMA utilize SAP-ME as a MES
- KONGSBERG DMA utilize AC computer and software from Weniger & Sholtz
- KONGSBERG DMA utilize webservices to communicate from computer to computer

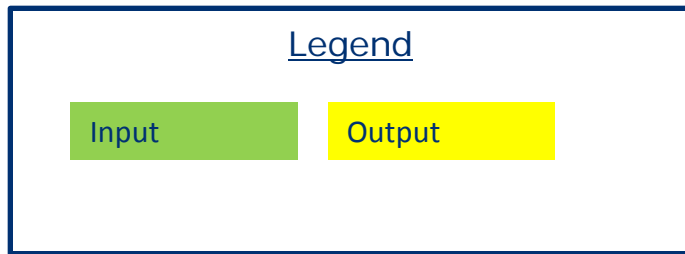
### Physical View (hierarchy presented)



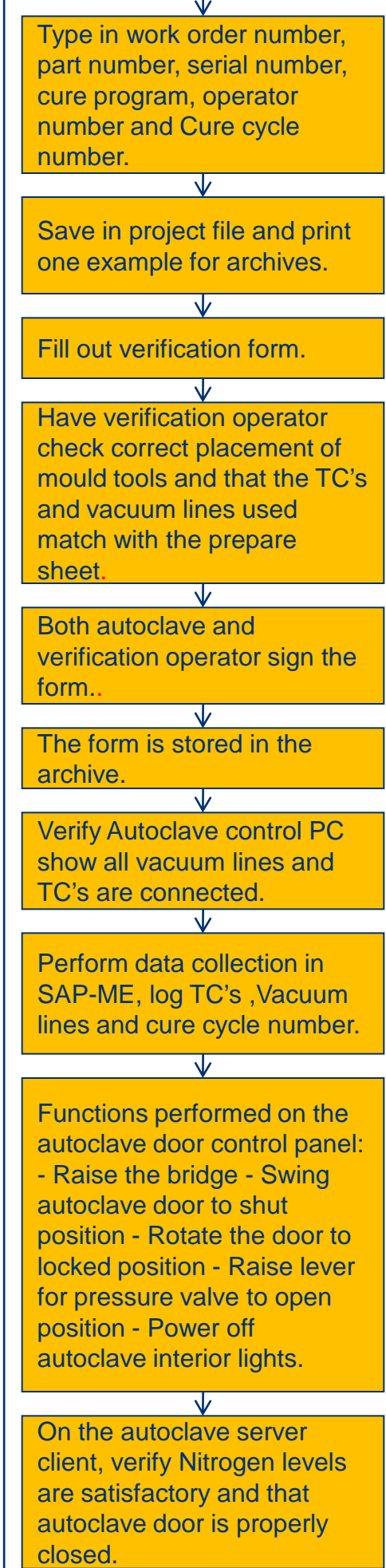
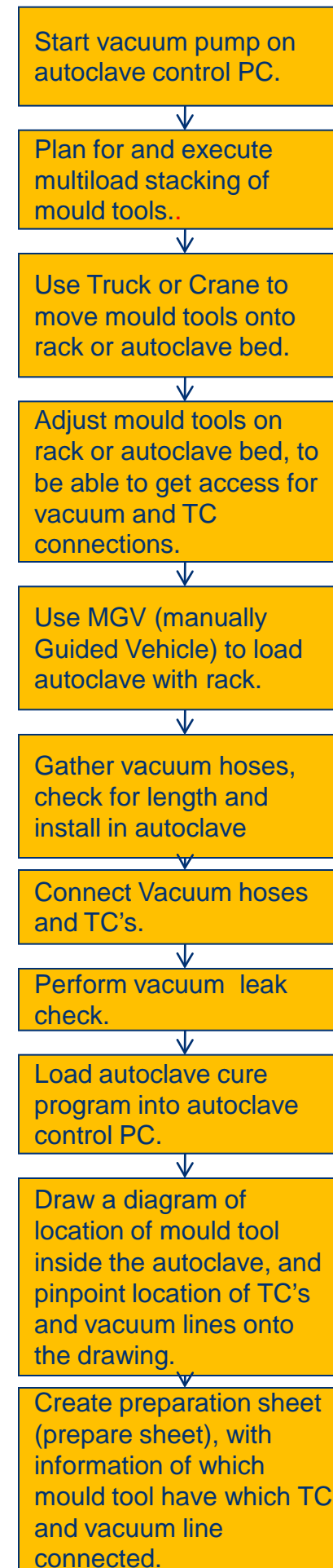
# Value stream mapping



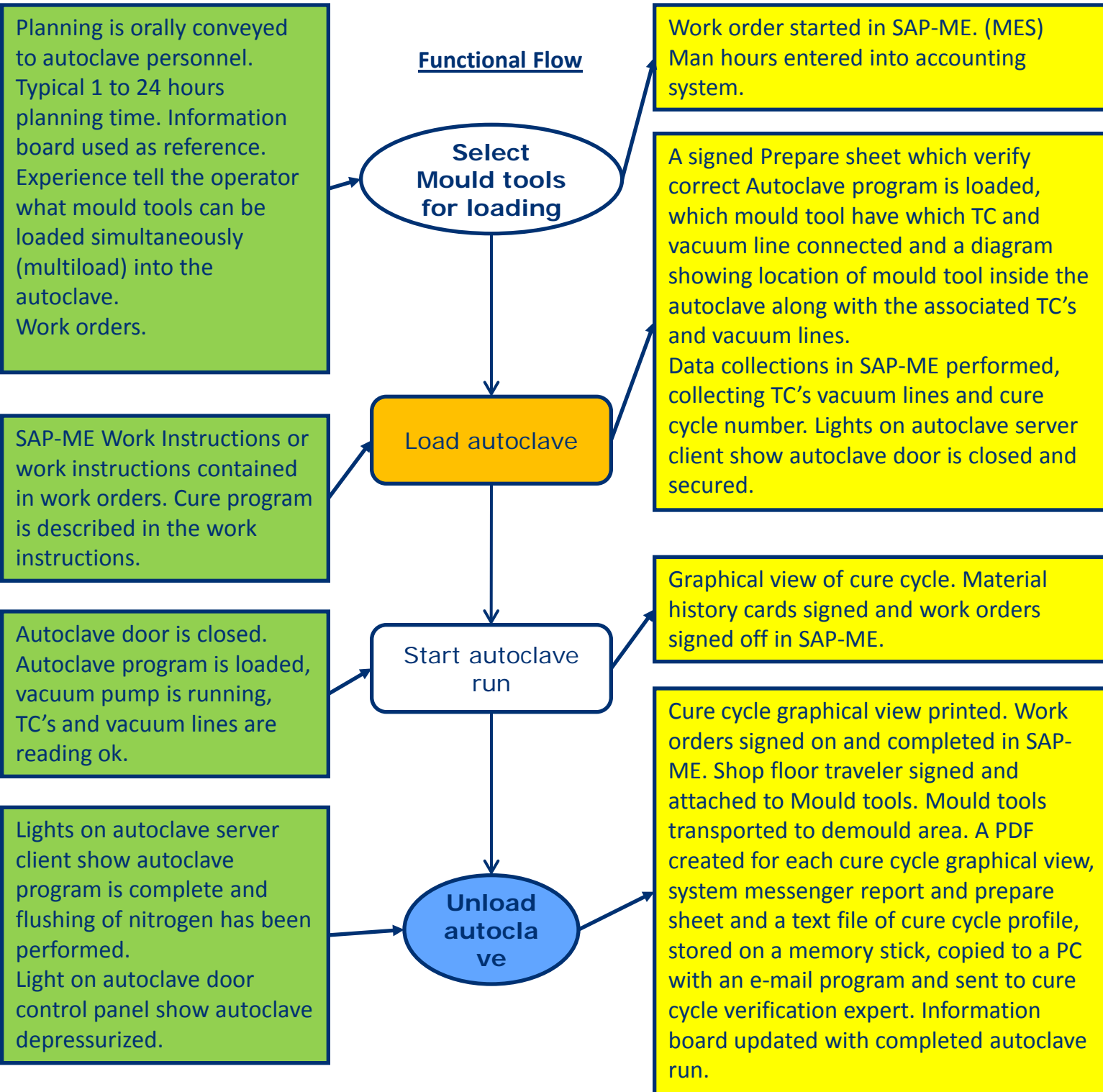
**Integration of PDM, SAP-ME and the autoclave computers**  
 A3 System Context Overview "As is"  
**Need: Configuration control of autoclave programs and automatic data collection of cure logs**



**Work Flow**



**Functional Flow**



## Definitions/Abbreviations

Enovia: PDM System (Production data management)  
SAP-ME: MES (Manufacturing Execution System)  
AC: Autoclave  
SFC: Shop Floor Control number (unique work order in SAP-ME)  
TC.: Thermocouple (device to sense temperature)

## Introduction:

KONGSBERG DMA (Division Missiles & Aerospace) manufacture highly advanced composites part made of carbon fiber reinforced plastic, using an autoclave to provide the pressure, vacuum and temperature needed. This autoclave is controlled by a computer, which monitor the cure cycle. KONGSBERG DMA utilize Enovia as a PDM system for configuration management. In addition to Enovia, SAP-ME is used as a Manufacturing Execution System in order to provide operators and inspectors with work instructions and as a means to collect data from production. This project will focus on the solutions needed to integrate the autoclave computer, the PDM system and SAP-ME, in order to achieve configuration control of the autoclave program and retrieve completed cure cycles for storage in the said system.

## Input:

This is the prerequisite in order to be able to commence operations. It is also describing information operators need to know, in order to start their work.

## Functional flow:

This is the step-by-step flow describing actual part movement in the autoclave area. Only steps with part movement is modeled, as this is the philosophy used to describe route of operations in SAP-ME. However, under each step there are many tasks to be performed prior to the start of the next operation.

## Output:

This is the outcome of each operation. All of which is needed in some way or the other, either as input/prerequisite for next operation, statistical process control or historical archiving as required by specification/aviation standards and regulations .

# Integration of PDM, SAP-ME and the autoclave computers

A3 Architecture Overview "As is"  
Summary

## Step-by-step work flow (For a 3 part multiload):

### 1. Select Mould tools for loading:

Gather shop floor Travelers. Start work orders in SAP-ME. Enter man hours in accounting system. 2.

### Load autoclave: See details on overview side.

### 3. Start autoclave run:

Set autoclave to auto. Select auto from menu and then select the right cure cycle number from the pop-up window. Select OK from pop-up window. (This will start the autoclave run) . Build graphical view of cure cycle:

- Select graphical image and then details
- Choose parts, then color code vacuum lines. (perform for each part in a multi-load)

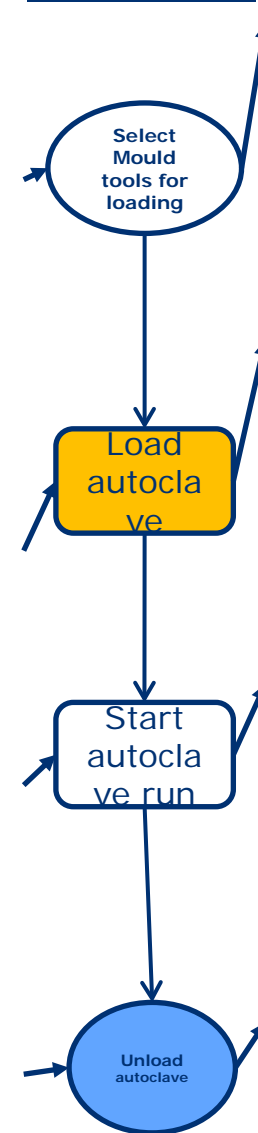
Perform pressurized vacuum leak test for NGC epoxy parts  
Occasionally observe autoclave run progress until abort temperature is reached. Sign Material History cards and work orders.

### 4. Unload autoclave: See details to the right.

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## Work Flow

## Functional Flow



Print cure cycle graphical view for archive and one for each part..

Activate work order in SAP-ME and complete work order in SAP-ME.

Functions performed on the autoclave door control panel: - Lower lever for pressure valve to closed position - Rotate the door towards open position. Program will have you wait 30 seconds before commencing to rotate the door to fully open position - Swing autoclave door to open position - Lower the bridge - Power on autoclave interior lights.

Disconnect vacuum hoses and TC's.

Use MGV to retrieve rack from autoclave and use truck or crane to unload autoclave bed or rack.

Remove external vacuum ports and place mould tools on trolleys.

Attach work orders to the mould tools. Wheel trolleys to demould area. Remove vacuum hoses from autoclave..

Save a PDF of cure cycle graphical view, a TXT of cure profile, a PDF of system messenger report and a PDF of the prepare report into projects folder..

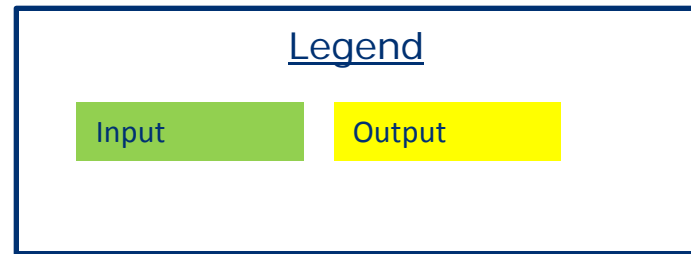
Retrieve any memory stick and collect the said files.

Copy the content of the memory stick to a PC with an e-mail program, to be sent to cure cycle verification expert..

Update information board with completed autoclave runs..

## References:

- Experts: Bjørn Johnny Aunan ([bjorn.johnny.aunan@kongsberg.com](mailto:bjorn.johnny.aunan@kongsberg.com))
- Documents:
- Relation with other models: Child of A3 System Context



**Integration of PDM, SAP-ME and the autoclave computers**

A3 System Context Overview "Ideal state"  
**Need: Configuration control of autoclave programs and automatic data collection of cure logs**

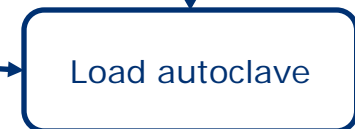
**Functional Flow**

**Input:**  
Parts for Autoclave run



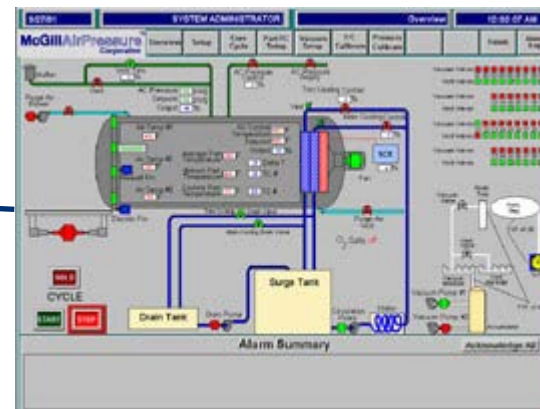
**Output:**  
Work order started in SAP-ME. (MES) Autoclave cure program loaded into Autoclave client PC. Prepare sheet generated.

**Input:**  
Rack for multiload is ready to be inserted into autoclave.



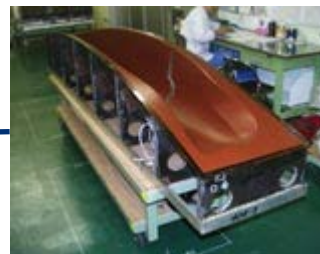
**Output:**  
Diagram/picture of location and orientation of mould tools on the rack. Lights on autoclave server client show autoclave door is closed and secured.

**Input:**  
Autoclave door is closed.  
Autoclave program is loaded, vacuum pump is running, TC's and vacuum lines are reading ok.



**Output:**  
Graphical view of cure cycle. Material history cards signed and work orders signed off in SAP-ME.

**Input:**  
Lights on autoclave server client show autoclave program is complete and flushing of nitrogen has been performed. Light on autoclave door control panel show autoclave depressurized.



**Output:**  
Autoclave Reports generated and stored electronically. Work orders completed in SAP-ME. Shop floor traveler signed and attached to Mould tools. Mould tools transported to demould area. Information board updated with completed autoclave run.

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### Functional flow:

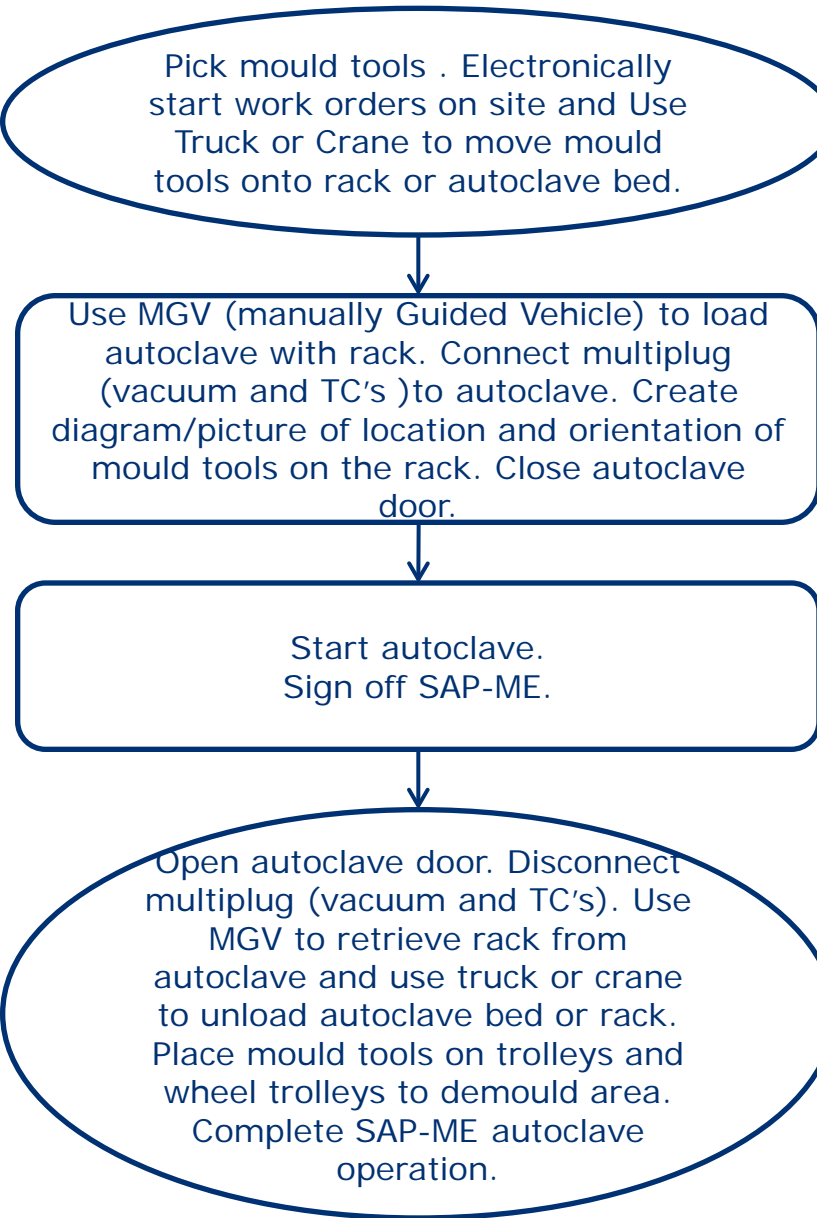
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## Integration of PDM, SAP-ME and the autoclave computers

A3 Architecture Overview "Ideal State" Summary



### Ideal state concerns:

- When picking tools and electronically start work orders, the program already running shall not be disrupted. The new rack(s) of mould tools shall generate a queue of cure programs to be run.
- Using several connectors in order to get connections between autoclave vacuum, rack vacuum and mould tool vacuum pose a risk of vacuum leaks.

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Reviewers:			
Keywords:	Systems Integration		
Product Line:		Date	14.03.08

### Ideal state prerequisite:

Ideal state in the autoclave area is described as loading and unloading the autoclave with as little effort as possible. Our systems demand data collection for every cure cycle, but this should be automatically collected in an ideal state. To simplify vacuum and TC connections between autoclave and individual part, it has been suggested to connect individual parts to a predefined location on a rack, and then connect the rack to the autoclave using a multiplug. Once every autoclave is loaded, they run the length of a program. This usually last between 6 and 12 hours. The operators in the autoclave area can then build the next racks to enter the autoclave, before unloading the racks already inside.

### Ideal state roadmap:

- Standard rack and mould tool lay-out on these racks can easily be implemented. This will remove the work of drawing an autoclave mould tool lay-out every time.
- Picking mould tools and starting the work in SAP-ME shall automatically generate the prepare sheet in the Veniger AC control program, which collect data on which tools are loaded, what program shall be run and what vacuum line and TC line is connect to each tool.
- After every cure, the cure cycle graphical view, the cure cycle profile report, the system messenger report and the prepare sheet shall be loaded automatically into the individual database for each component cured.
- SAP-ME shall display if the completed cure is within specification. If the cure is not within specification, a Non-conformance report shall be generated and sent to the inspectors for internal deviation management.

### References:

- Experts: Bjørn Johnny Aunan ([bjorn.johnny.aunan@kongsberg.com](mailto:bjorn.johnny.aunan@kongsberg.com))
- Documents:
- Relation with other models: Child of A3 System Context
- Model Hierarchy: 1.st level child



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