



Cutting and Stacking Cell

for Automated High Volume Manufacturing of Dry Fiber Fabric Stacks

Schmidt & Heinzmann: M. Ochs

Speakers



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Schmidt & Heinzmann

COMPOSITE EQUIPMENT & MACHINERY

Product and Background

Aerospace part:

**Legacy: Prepreg
Honeycomb
sandwich**

- Hand Layup Process
- Low Cost Country Build
- Autoclave Manufacturing Process

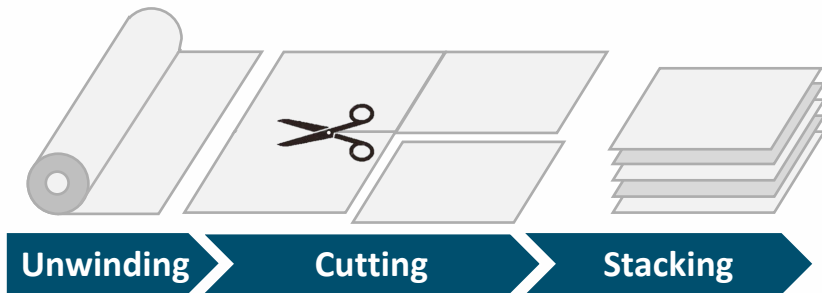
- Increased Automation
- Out of Autoclave Manufacturing

**Now: One Shot
Monolithic RTM**



A Simple Task!

Schmidt & Heinzmann's task:
realize 1st process step - from
fabric to 2D stack



**Input:
Fiber Fabric**

Cutting Table

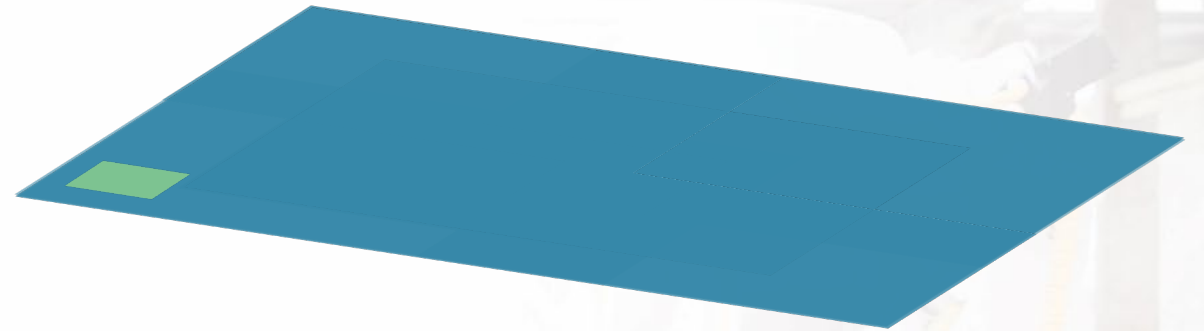
**Stacking
Robot**

**Output:
2D Stack**



A Simple Task?

- ~ On average **8** plies per stack
- ~ Each ply needs to be positioned and stabilized
- ~ Stack needs to be labelled for traceability
- ~ **9** stacks per component
- ~ **10** components per shipset



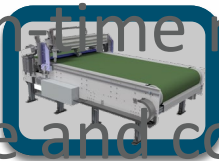
**Number of required
Operations:
2520**

Strategies

Material AutoCut

~ One spoiler at a time

Type I



~ Just-in-time manufacturing
~ Divide and conquer approach

Type II



~ Parallelization of as many operations as possible

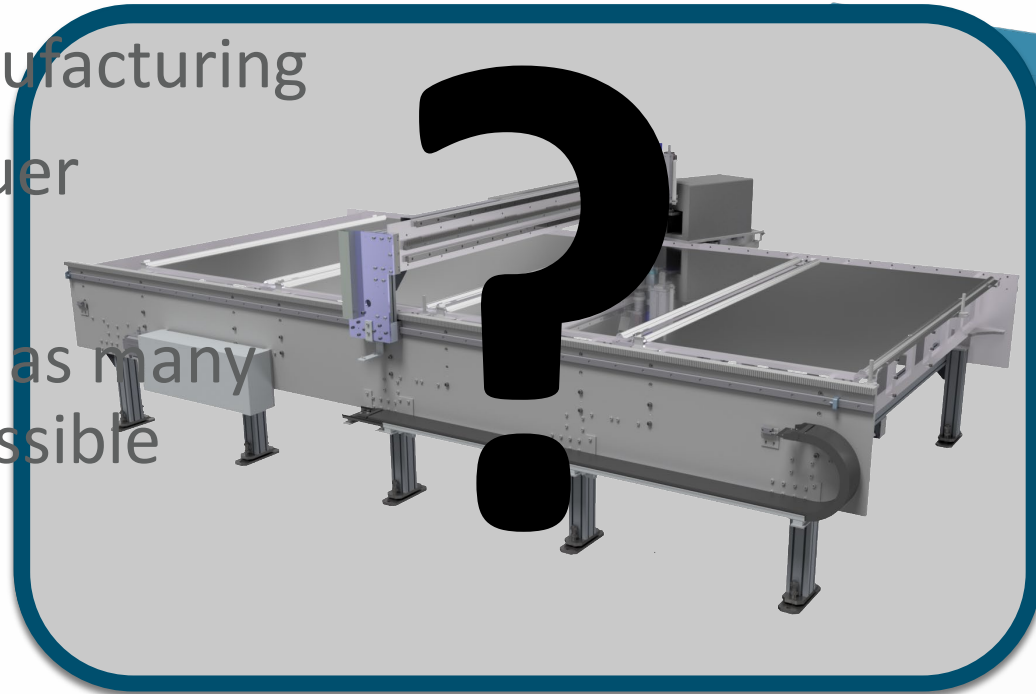
Type III



Type IV



Stacking Table



~ 4 Axis CNC

~ 3 Axis CNC
~ Automated conveyor
~ Space for parallelized

and unwinder
~ stacking of up to 16
~ Compensation of

stacked drift
~ Automated material
defect detection

~ Fully autonomous,
without manual
intervention

Strategies

Controlled and coordinated by one PLC

Material

AutoCut

Handling

Type I



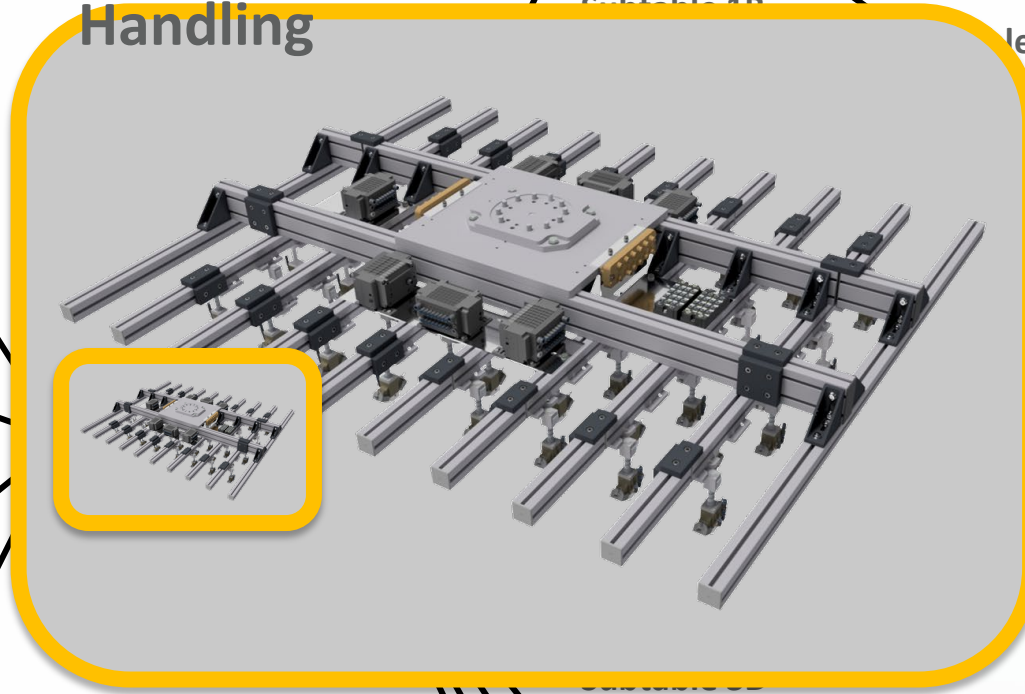
Type II



Type III



Type IV



Subtable 1A

Subtable 1B

Table 1

Table 2

Table 3

Subtable 4A

Subtable 4B

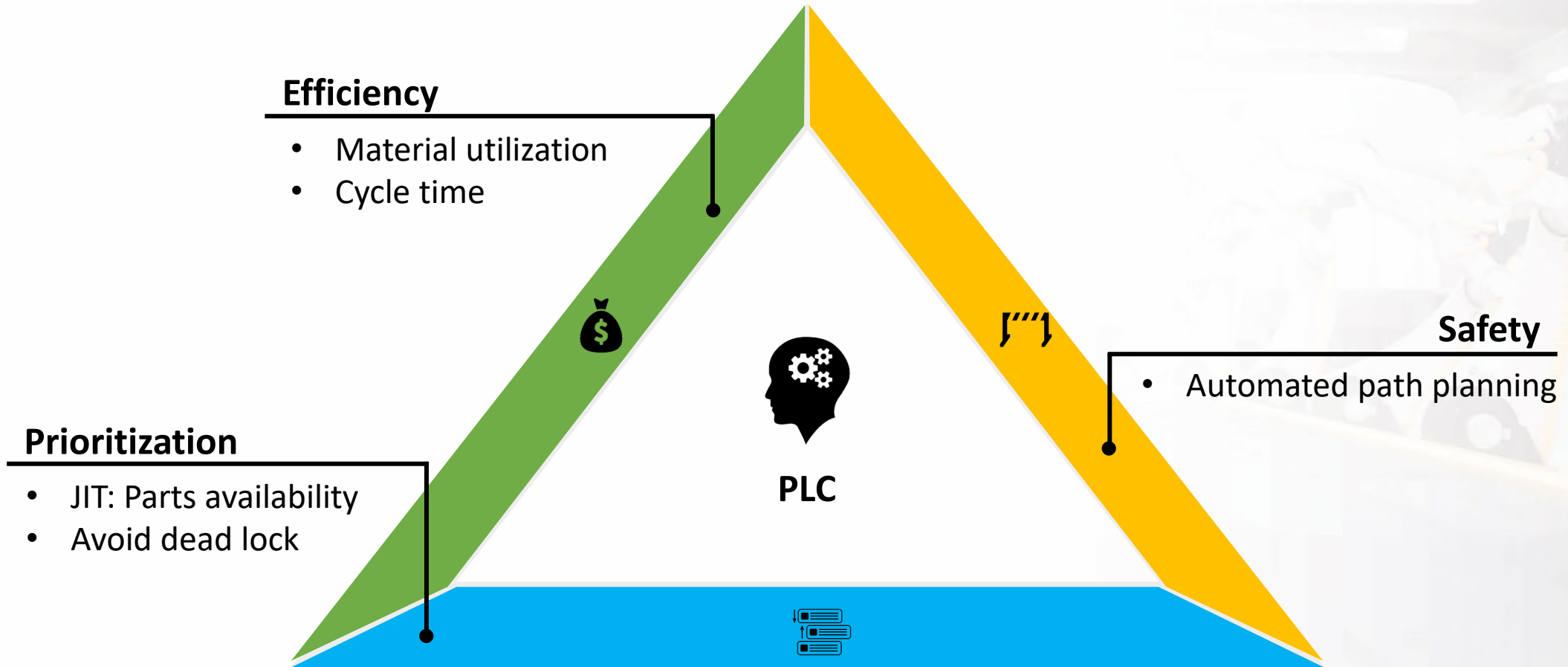
Subtable 4C

Subtable 4D

Table 4

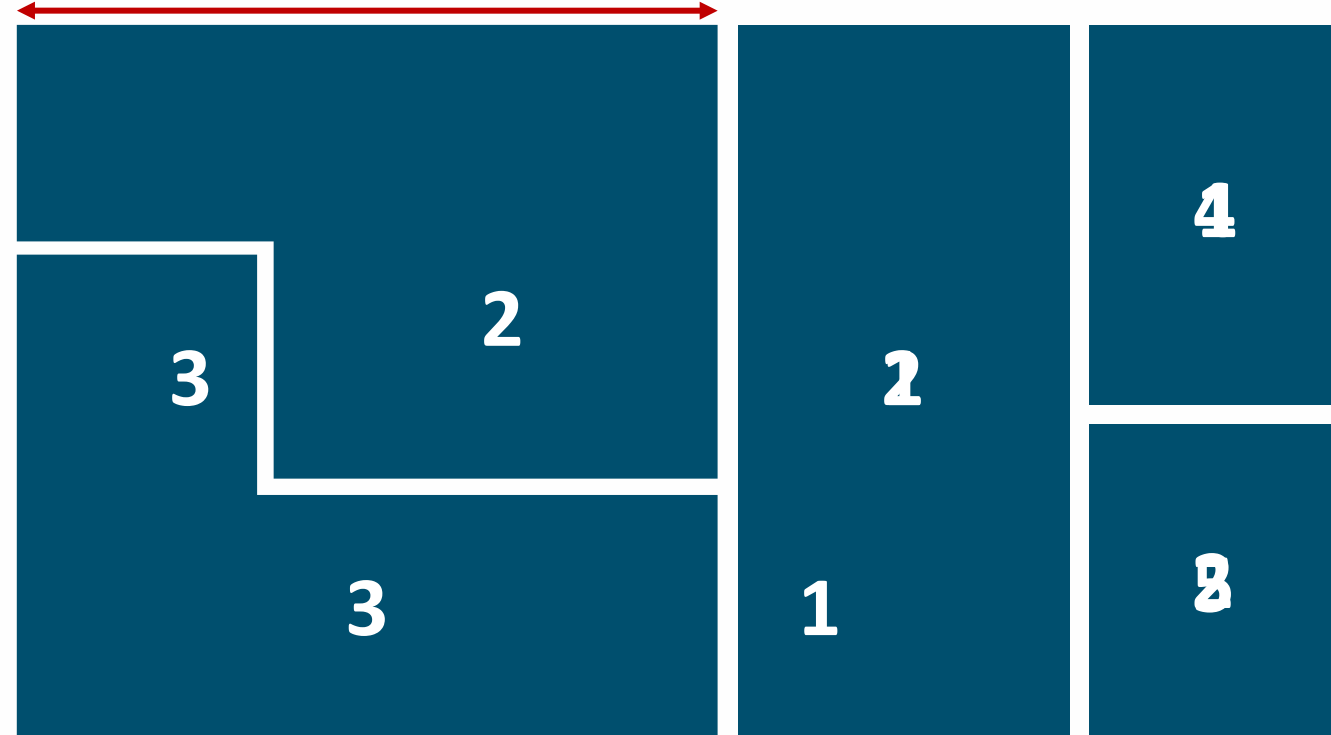
- ~ Matrix EOAT with more than 100 individual zones
- ~ Combined with 7 axis industrial robot
- ~ Best-in-class positioning accuracy
- ~ Best-in-class Orientation accuracy

Production Planning Algorithm



Prioritization

Length of AutoCut working area



1st feed of material
1st feed of material

2nd feed of material

2nd feed of material
3rd feed of material

- Stack 1
- Stack 2



Prioritization

AutoCut 1







AutoCut 2



AutoCut 3



AutoCut 4

-  Stack 1
-  Stack 2
-  Stack 3
-  Stack 4

Material utilization
 Can you tell if this solution is manufacturable?



Can you tell if this solution is optimal in terms of efficiency?

- Prioritization is key to JIT manufacturing and low cycle time
- But Prioritization is only one part of the problem...

Path Planning

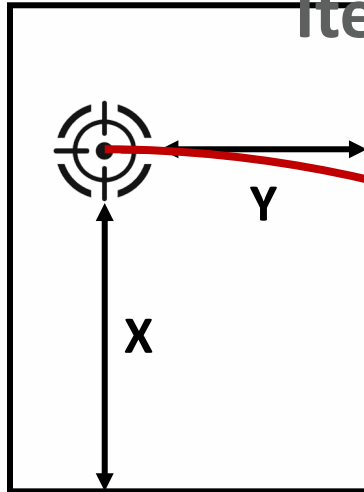
Gripper Position

- Constrained by optimal alignment with gripper elements
- Constrained by ply size

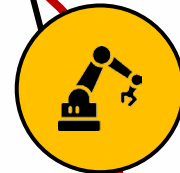
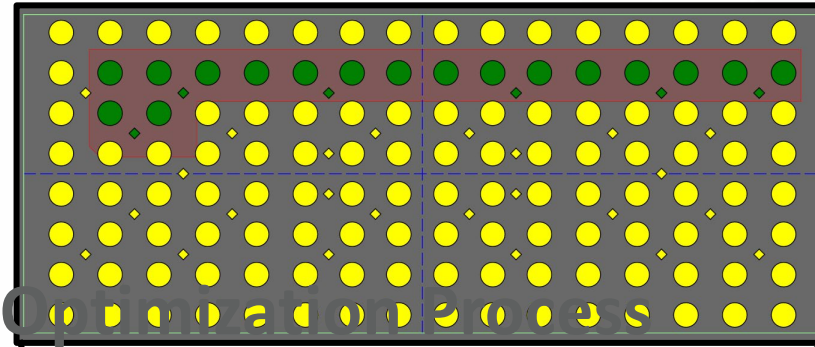
Target Position

- Dictated by the end-user
- Constrained by placing table

Subtable 1A



Iterative Optimization Process



AutoCut 1



Pickup Position

- Dictated by nesting
- Constrained by:
 - AutoCut
 - Robot body
 - Other machine elements

In real time

For each and every ply...

Without crashing)

The Way to Go : User Interface

Schmidt & Heinzmann
COMPOSITE EQUIPMENT & MACHINERY

Operating mode
Equipment
Automatic

07 AM 32 Mar 30

Stack overview

Recipe selection:

Stacknr.	Stack
90	
92	
87	
93	
88	
89	
91	
94	

Stackdefinition data:

No.	Geo name	Ply name	Material
1			
2			
3			
4			
6			
7			
8			
9			
10			
11			

Stackdefinition data:

No.	Offset X [mm]
Geo name	Offset Y [mm]
Material	x0 mirroring <input type="checkbox"/>
	y0 mirroring <input type="checkbox"/>
Ply name	Ply-ID

It's easy to make things look hard, but hard to make things look easy

The Way to Go : User Interface

The screenshot displays the Schmidt & Heinzmann user interface. At the top left, the logo for Schmidt & Heinzmann Composite Equipment & Machinery is visible, along with a warning icon. The top right corner shows the operating mode as 'Anlage Off' and the date/time as '05 PM 21 Mar 15'. The main interface is divided into several sections:

- Recipe selection:** A dropdown menu with a '1' button and a right arrow.
- AutoCut stations:** A vertical list of six stations labeled 'AutoCut 1' through 'AutoCut 6'. The first four stations are currently active, showing green rectangular patterns representing the layout of composite parts.
- Table configuration:** A detailed view of five tables (Table 1 to Table 5) arranged in a grid. Each table has four columns labeled A, B, C, and D. The tables show different configurations of green bars representing parts. For example, Table 1 has a single bar in column A, while Table 2 has bars in all four columns.
- Stack assignment:** To the right of each table is a 'Stack assignment' section with four dropdown menus labeled A, B, C, and D. These menus allow the user to assign specific part types to each column.

Contact

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Thank You

For Your Attention