

COLLABORATIVE INTELLIGENCE

Gain access to the smart technologies
and intelligent people propelling
aerospace and defense manufacturing.



AUTOMATION-ASSISTED WORK CELLS FOR COMPOSITE COMPONENT MANUFACTURE

Presenter:

Stephan Zweidler | Executive Director | Accudyne Systems, Inc.

Co-Author:

Scott Blake | President | Aligned Vision

May 1, 2019 @ 11:00AM

Agenda Topics



Introduction – Impetus for Development...

Elemental Technologies

Example Work Cells

Conclusions

Question & Answer



Introduction



- ▶ Large-Scale Manufacturing Automation employed worldwide
- ▶ ‘Lights-Out’ automation employed in many industries – where ROI justifies it
- ▶ Aerospace manufacturing adoption of automation has been steadily increasing for many processes
 - ▶ Resin and fiber manufacture, impregnation, and conversion
 - ▶ Ply cutting
 - ▶ Pick-and-place ply and tape lamination
 - ▶ CNC automated fiber and tape placement
 - ▶ CNC component trimming and machining
 - ▶ and many others...
- ▶ **Accudyne Systems and Aligned Vision have been change-agents in this trend...**



Introduction



However...

Manual Layup & Inspection still widespread despite automation advancements...

- ▶ sound business case may not exist to support investment
- ▶ material systems, components, and/or processes may not lend themselves to an automated solution

The solution:

Automation-assisted work cells addressing these challenges with cost-effective solutions that judiciously integrate automation technologies.



Automation-Assisted Work Cell Concept:

- ▶ Apply automation technology where it makes sense:
 - ▶ tasks that require more precision, repeatability, and/or heavy lifting
- ▶ Let the operators do the tasks they can do well:
 - ▶ tasks that require dexterity, hand-eye coordination, human-learning ('the knack')

“Human-Machine Collaboration”

Agenda Topics



Introduction

Elemental Technologies – Recipe for Success...

Example Work Cells

Conclusions

Question & Answer

Elemental Technologies



- ▶ Tool Positioning
- ▶ Integrated Laser-Projected Ply Templates
- ▶ Ply Backing Accountability
- ▶ Work Order and Recipe Management
- ▶ Manufacturing Information System Integration



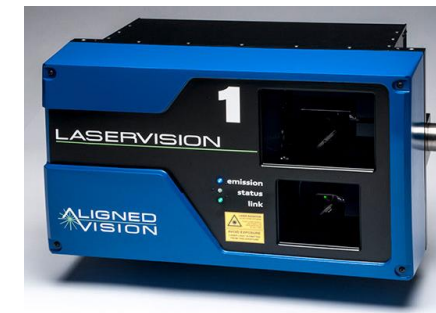
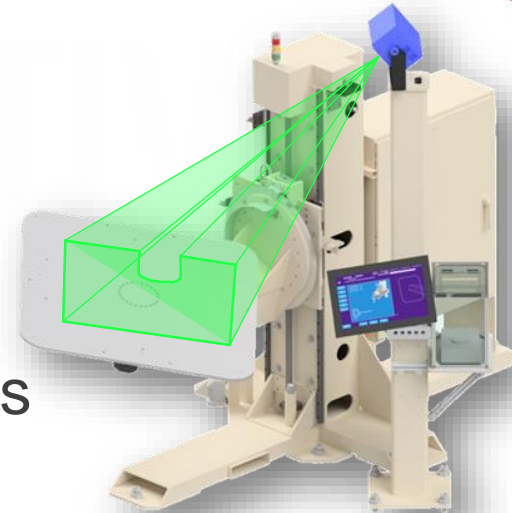
Tool Positioning

- ▶ Primary physical task interface between operator & workpiece
- ▶ Work Cells designed with ergonomics in mind for each operator
 - ▶ Properly positioned tooling reduces fatigue, muscle strain, and possible injury
- ▶ Servo-driven axes for precise control and repeatability
- ▶ Coordinate System Basis for Work Cell



Laser-Projected Ply Templates

- ▶ Throw away those assembly aid templates !
- ▶ Improve accuracy, repeatability and efficiency
- ▶ **The Past:** stationary tooling and Mylar templates
- ▶ **Now:** repositionable tooling and laser projection on same coordinate system
 - ▶ Aligned Vision integration partners have access to an 'SDK' to facilitate this
- ▶ **The Near Future:** Automatic inspection and tool/projector alignment
 - ▶ Enabling one-touch feature verification and accelerating tool re-positioning



Ply Backing Accountability

- ▶ Necessary to prevent inclusion of Foreign Object Debris
- ▶ We are all too familiar with the criticality of this feature
- ▶ A simple letterbox-style accountability system addresses this concern
- ▶ Recipe-based instructions guide the operator and HMI controls recipe advancement

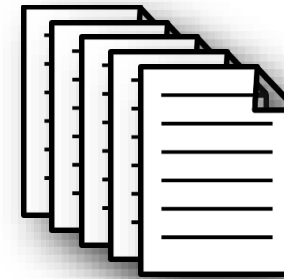


Work Order / Recipe Management

- ▶ Ties all of the integrated technologies together
- ▶ Tracks operator(s) progress throughout the component build
- ▶ Provides step-by-step standardized work instructions and prompts

- ▶ Recipe files can also contain or reference additional data

- ▶ step number / layer / ply
- ▶ component and/or Part Number identification
- ▶ operation type and duration
- ▶ component geometry references
- ▶ laser projection geometry and/or CNC G-Code references;

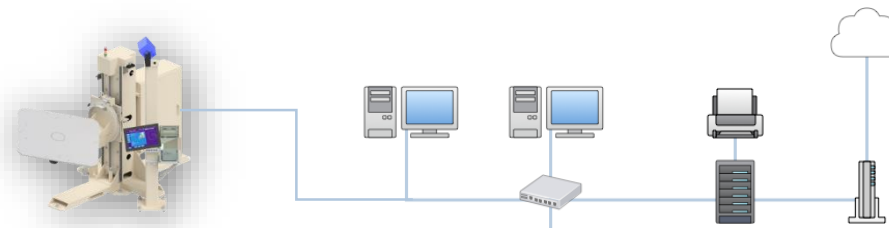


- ▶ HMI incorporates Multi-User Login permissions control access to features

- ▶ e.g. operator, engineer, maintenance, admin, etc.



- ▶▶ Manufacturing Network-Connected Equipment
 - ▶ Version control and security of recipe, component/laser projection geometry, G-Code
- ▶▶ Efficient tracking of scheduled, in-progress and completed tasks & W/O
 - ▶ SQL database architecture
- ▶▶ Firewallled remote-access permits HMI and PLC reprogramming
 - ▶ Feature additions, remote-diagnosis, and software updates without costly delays



Agenda Topics



Introduction

Elemental Technologies

Example Work Cells – Tailored to Part & Process...

Conclusions

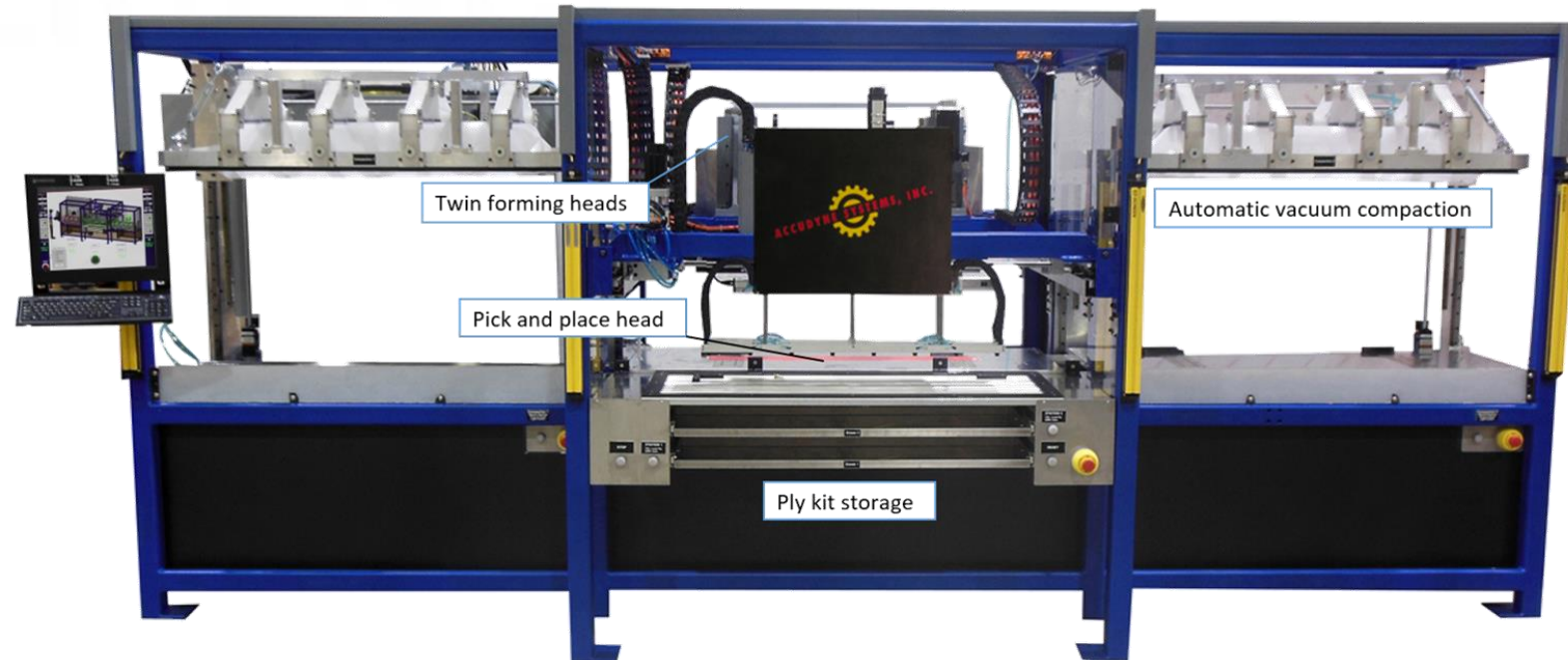
Question & Answer

Pick/Place/Form/Compact Work Cell

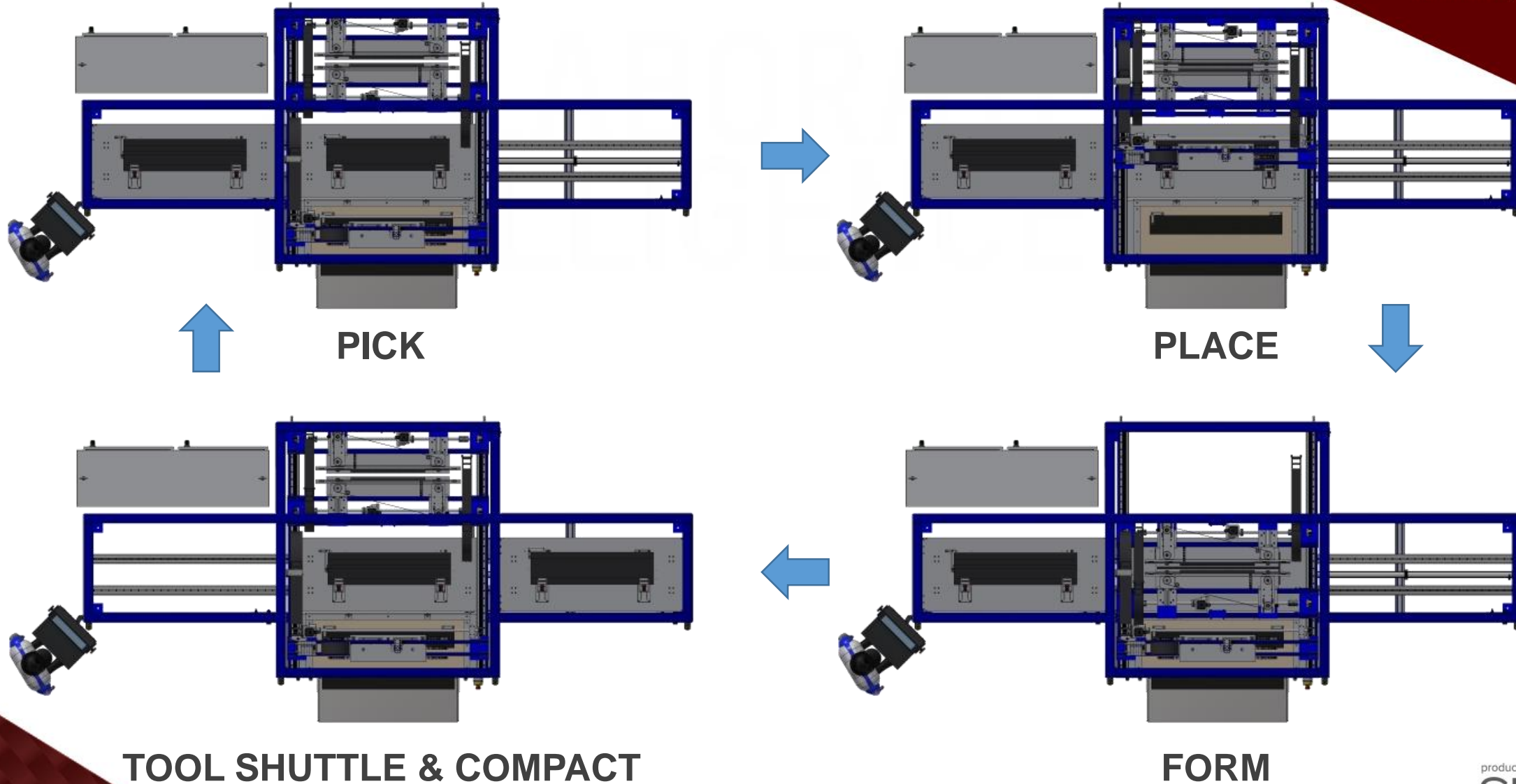
- ▶ Facilitates lay-up of two parts simultaneously
- ▶ Operator and machine work in tandem
- ▶ 'C,' 'T,' 'Z,' 'L,' and other shapes

Key Elements:

- ▶ Tool Positioning
- ▶ Pick-and-Place
- ▶ Work Order and Recipe Mgt
- ▶ MIS Integration



Pick/Place/Form/Compact Work Cell



Stringer Former and Trim Cell

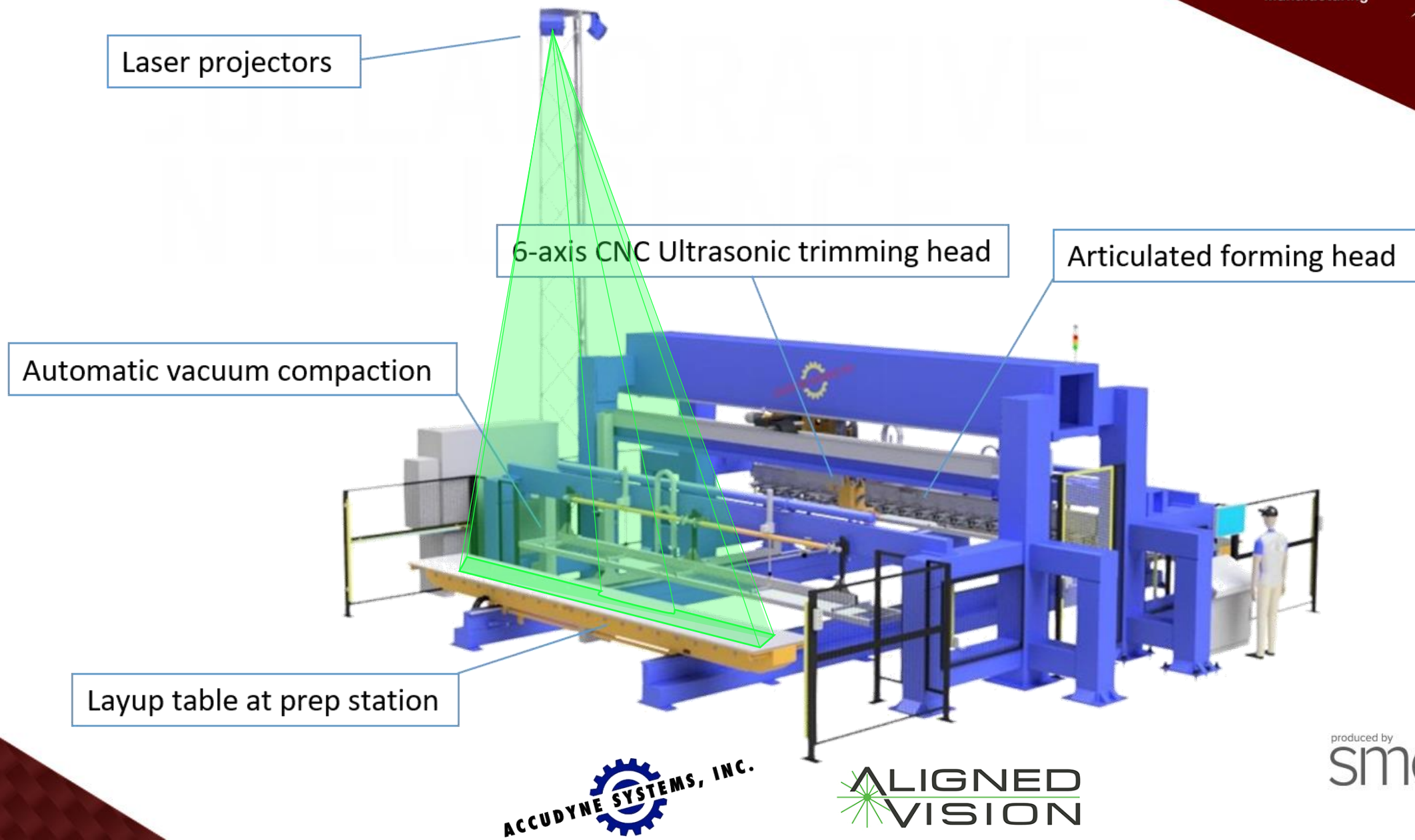


- ▶ Lay-up two parts simultaneously
- ▶ Tandem operator & machine tasks
- ▶ Geometry-adaptive forming mechanism
- ▶ 6-Axis CNC Ultrasonic EOP Trim

Key Elements:

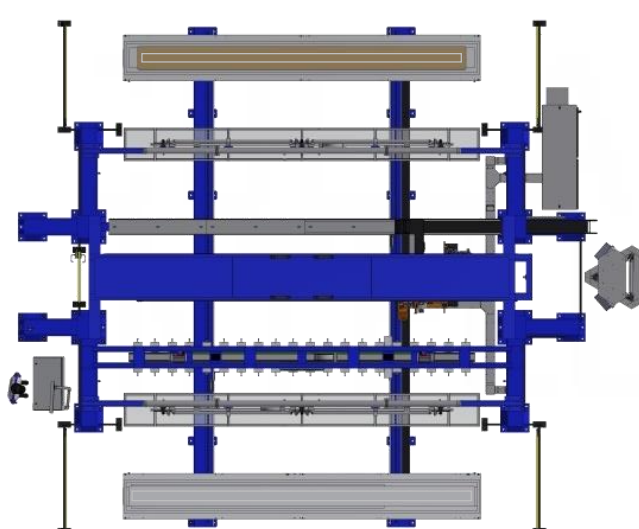
- ▶ Tool Positioning
- ▶ Integrated Laser Projection (x2)
- ▶ Work Order and Recipe Mgt
- ▶ MIS Integration

Stringer Former and Trim Cell

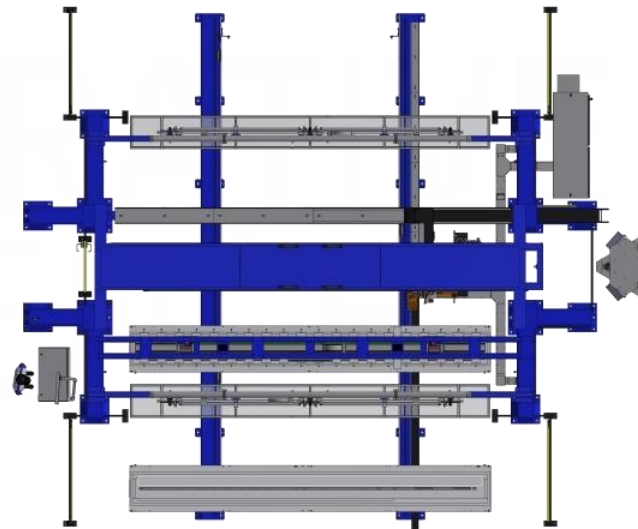


Stringer Former and Trim Cell

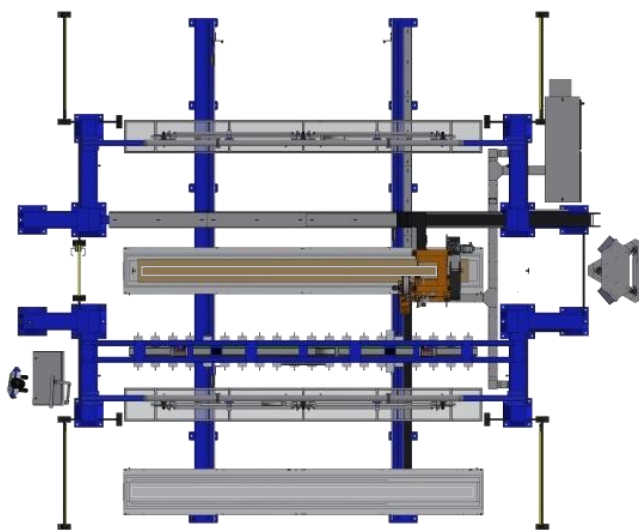
PLY
PLACEMENT



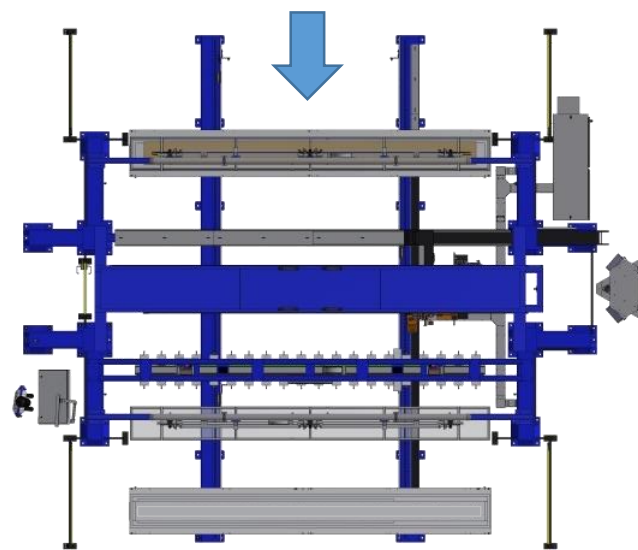
FORM



TRIM



COMPACT

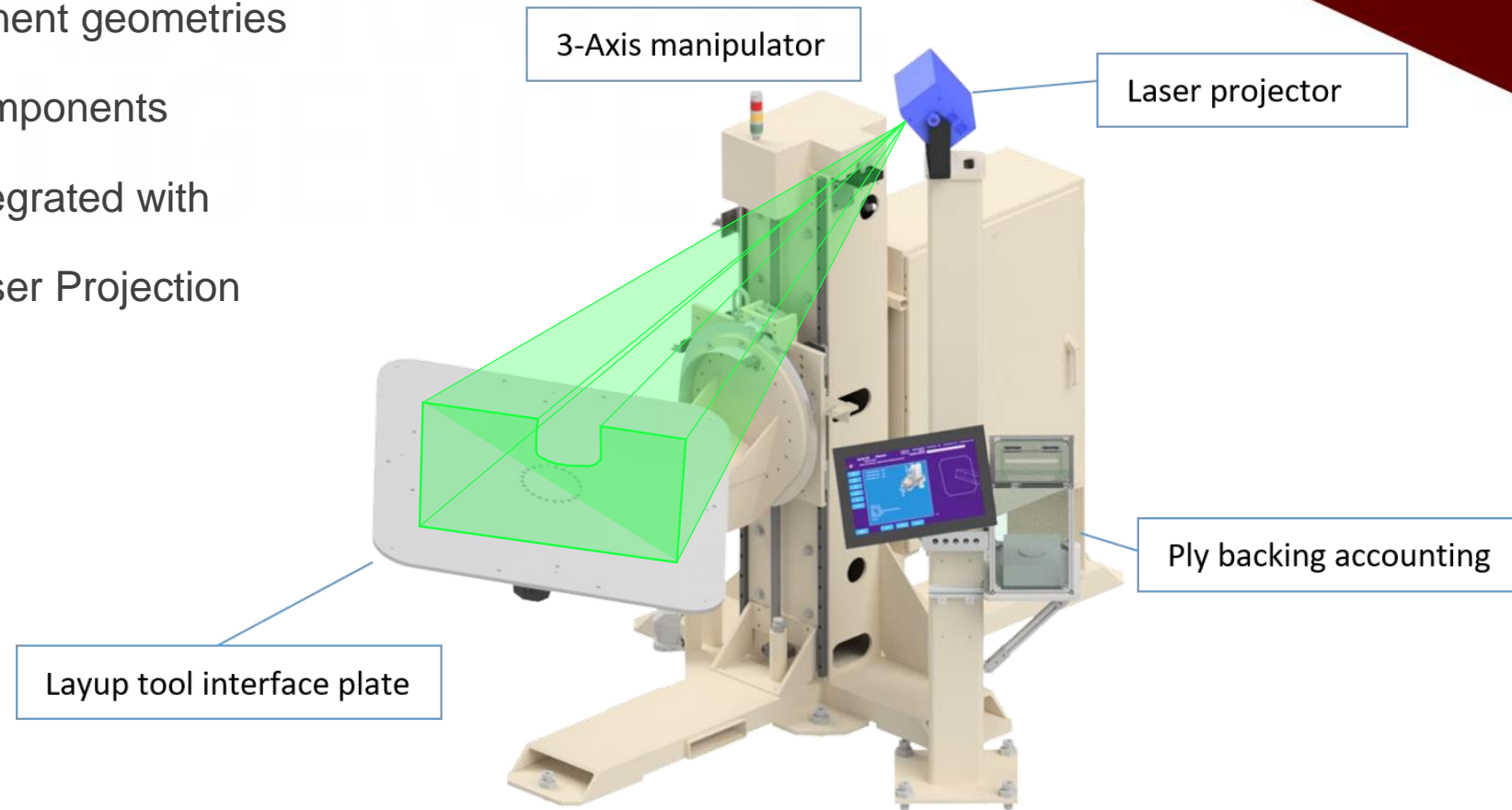


Multi-Axis Work Cell

- ▶ Single or multiple component layup
- ▶ Accommodates multiple component geometries
- ▶ Well suited to high ply-count components
- ▶ 3-Axis servo tool positioning integrated with
- ▶ Common coordinate system Laser Projection

Key Elements:

- ▶ Tool Positioning
- ▶ Integrated Laser-Projection
- ▶ Ply Backing Accountability
- ▶ Work Order and Recipe Mgt
- ▶ MIS Integration



Agenda Topics



Introduction

Elemental Technologies

Example Work Cells

Conclusions – Factory Automation Innovation Continues...

Question & Answer



Conclusions

- ▶ Aerospace industry likely to continue moving toward full automation
- ▶ A 'middle-ground' will remain where Automation Assisted Work Cells will excel
- ▶ Automation assisted work cells have demonstrated:
 - ▶ improved process accuracy, decreased cycle time, and reduced rework and scrap rates
- ▶ Work Cells are designed to be extensible for feature additions in the future
 - ▶ i.e. integration of LASERVISION and TARGETGUIDE on work cells already equipped with LASERGUIDE
- ▶ The Automation Assisted Work Cell concept is adaptable to specific parts/processes

Agenda Topics



Introduction

Elemental Technologies

Example Work Cells

Conclusions

Question & Answer



Thank You for Your Attention !



What Questions do you have ?



References / Sources



Groover, M. P. "Automation." Encyclopedia Britannica. <https://www.britannica.com/technology/automation>

Snyder, G., M. Adams, M. Szuhaj. "The Automation Evolution." Deloitte Insights 11: July 1, 2012.

Björnsson, A. Enabling Automation of Composite Manufacturing through the Use of Off-The-Shelf Solutions. Dissertation. Linköping University, 2014.

CompositesWorld. "Fabrication Methods (2017)." Posted Mar. 23, 2016. <<https://www.compositesworld.com/articles/fabrication-methods-2016>>

Blake, S. "Laser Projection: Envisioning More Than Templates." CompositesWorld 1:2 (February 2015).

Blake, S. "Manufacturing Readiness: The Case for Automatic Inspection in Composites Fabrication." SAMPE Journal 54:2 (March/April 2018).

