

# Robotic Automation Technology in Shipyard Fabrication

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# Large Weldments

- **Past** - What were the limitations in the past
- **Present** - What are the current capabilities in welding large pre-fabrication structures
- **Future** - What are the trends of the future



# Large Weldments - Past Limitations

- Part fit up & tolerances
- Poor motion control – no coordinated motion
- Limited sensor technologies
- Welding process had generally been limited to GMAW
- On-line programming took long periods



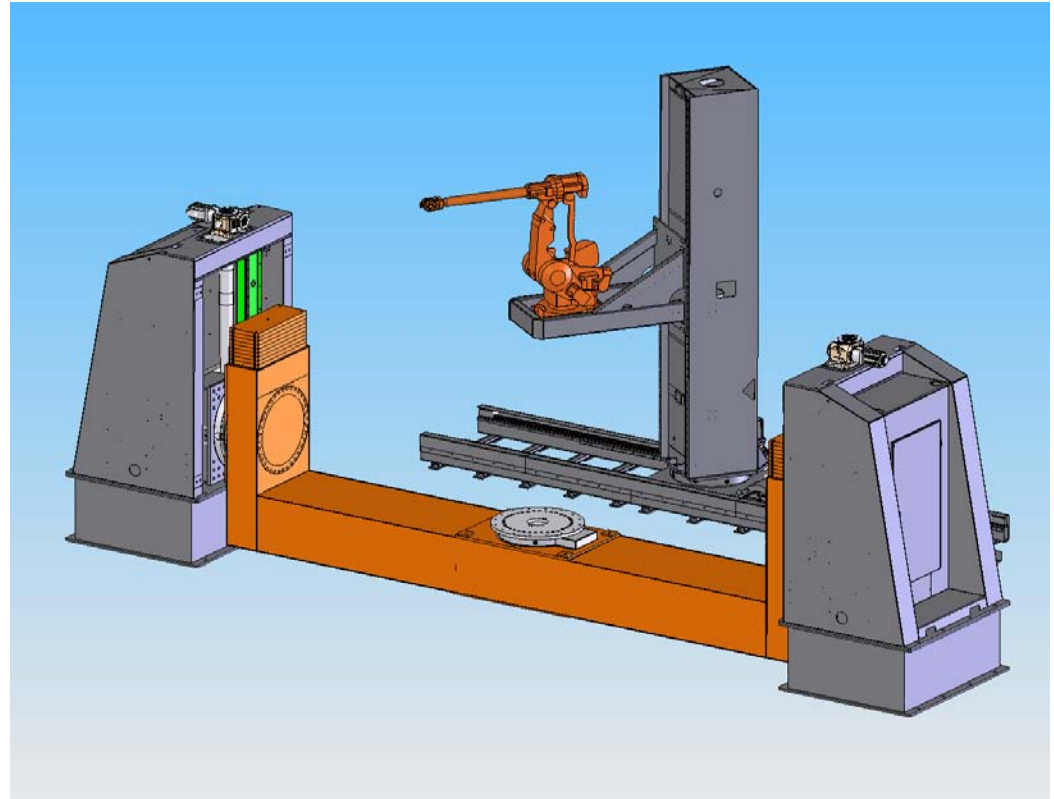
# Large Weldments - Present Status

- Excellent motion control between robot and external axis
- Sensor technologies have evolved – Tactile sensing, Thru-arc-tracking, laser and camera based tracking
- Off-line programming has truly evolved past the simulation stage
- Weld process advancements and the application of processes previously not applicable due to system limitations



# Motion Control

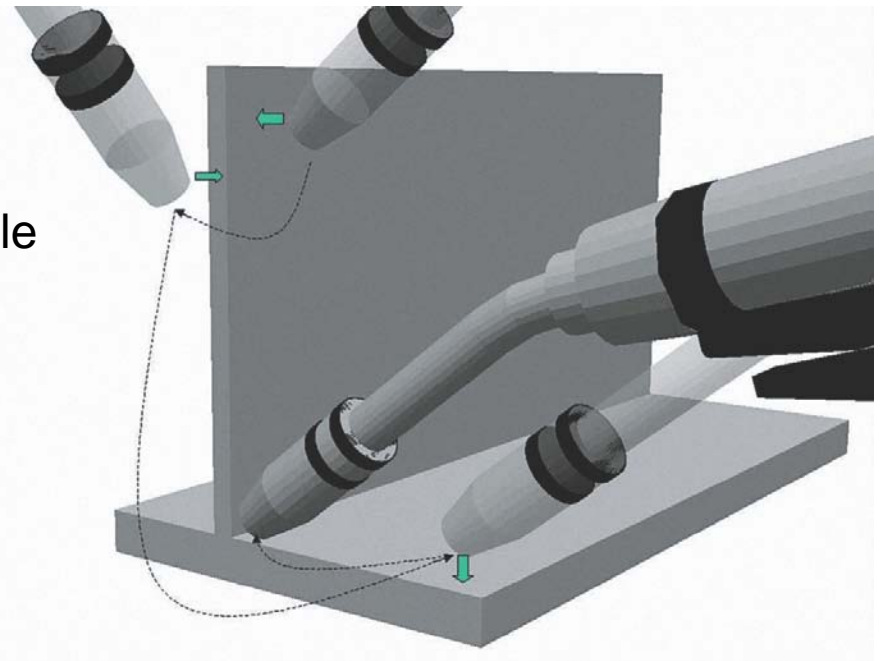
- Multiple axis positioner(s)
- Multiple axis robot carrier(s)
- Multiple robots in cells



# Sensor Technologies

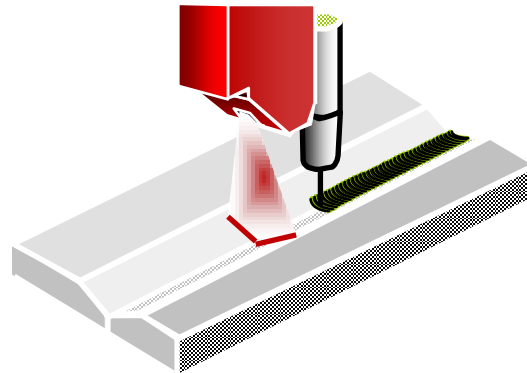
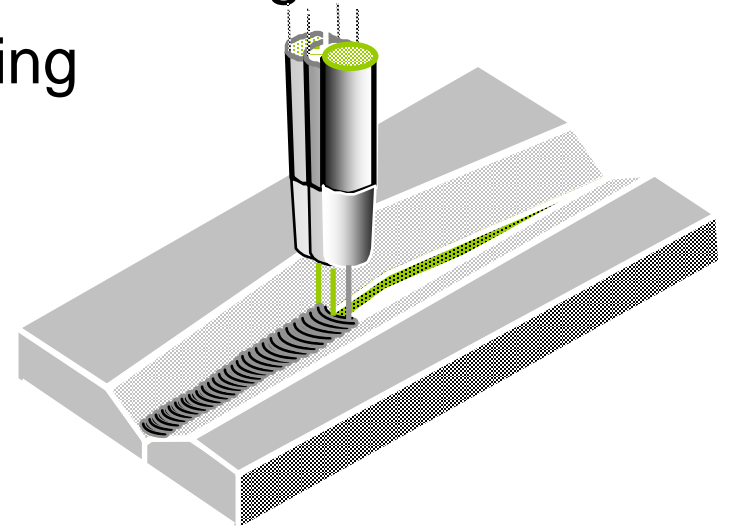
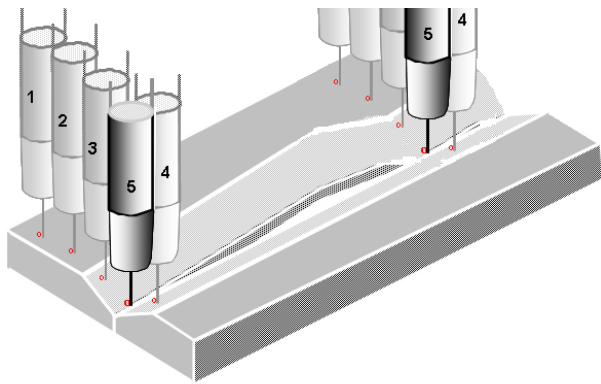
## Tactile Sensing

- The search mode is initiated before welding begins
- Tactile sensing can displace start of weld, end of weld or entire path. Tactile sensing can also displace & redefine work objects
- Can be used to measure groove (calculate fill requirements)
- Can be used for 1, 2 & 3-D displacements



# Adaptive Weld Processes

- Calculated volume adaptive welding
- Through the arc volume adaptive welding
- Camera volume adaptive welding



# Case Study:

## Application of Tactile sensing and thru-arc tracking

Variable volume  
groove weld



Volume calculated  
with tactile sensing  
and tracked with  
thru-arc tracking



# Weld process improvements

## Pulsed power supply

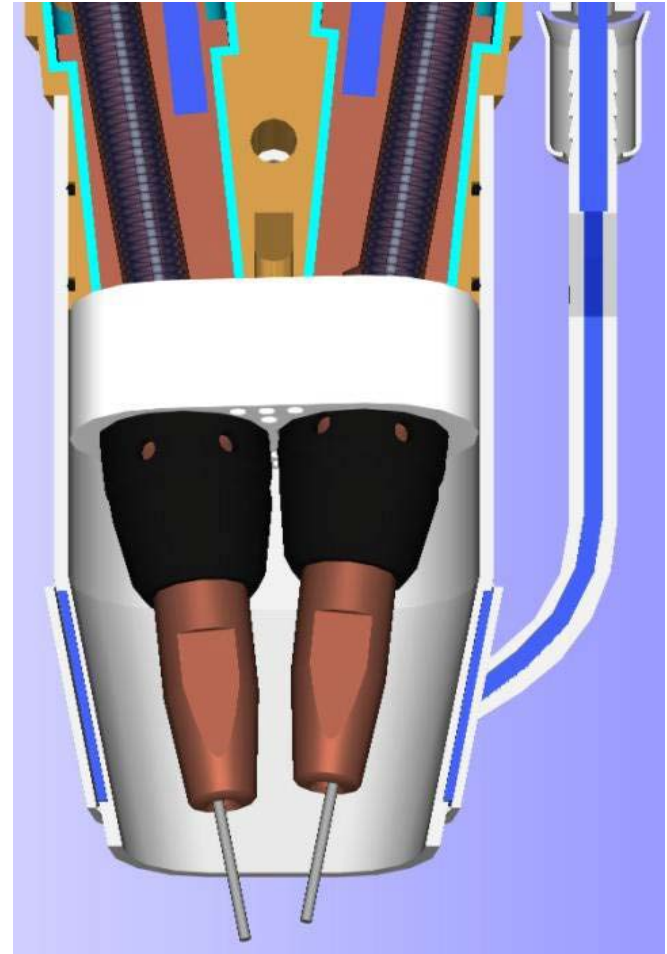
- Inverter technology
- Better arc starts and burn off
- Better communication with robots
- Synergic lines customized to specific needs
- Data monitoring
- Variations of modes
  - RMD, STT, CMT & etc...



# Weld process improvements

## Tandem GMAW

- 2 independent weld wires
- Wires can have separate parameters & mode
- Capable of turning either wire off / on during the welding process
- High speed / depositions possible

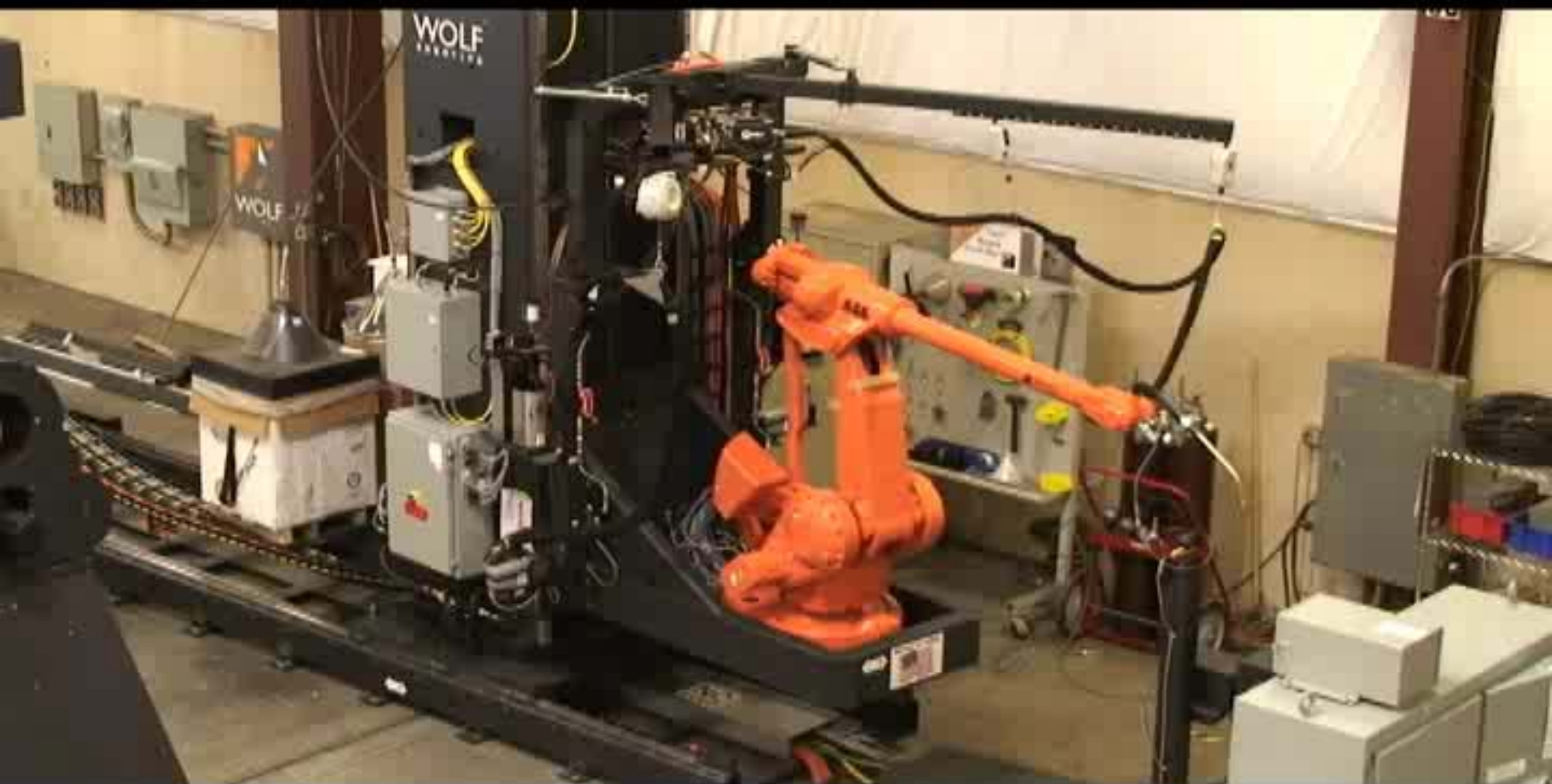


# Weld process improvements

## Multi-process

- Tool changers allow for multiple process systems
  - GMAW
  - FCAW
  - SAW
  - Tandem GMAW
  - Etc....
- Systems can change process mode – cv to pulse
- Robot systems can accommodate multiple TCP's





# Weld process improvements

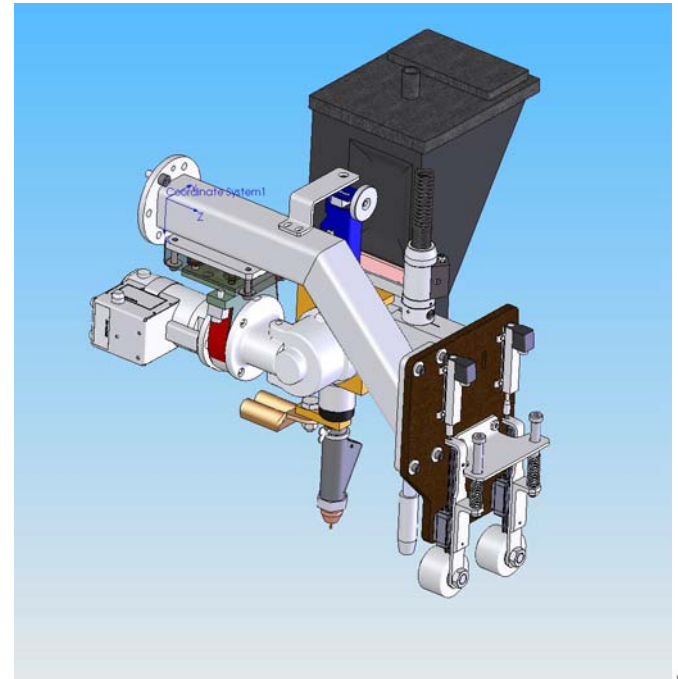
## Submerged arc welding

- S.A.W. process typically limited by position (1G & 1F) and typically required an operator present
- Robotic SAW uses same sensor technology as GMAW
- Automatic flux delivery & recovery systems are available



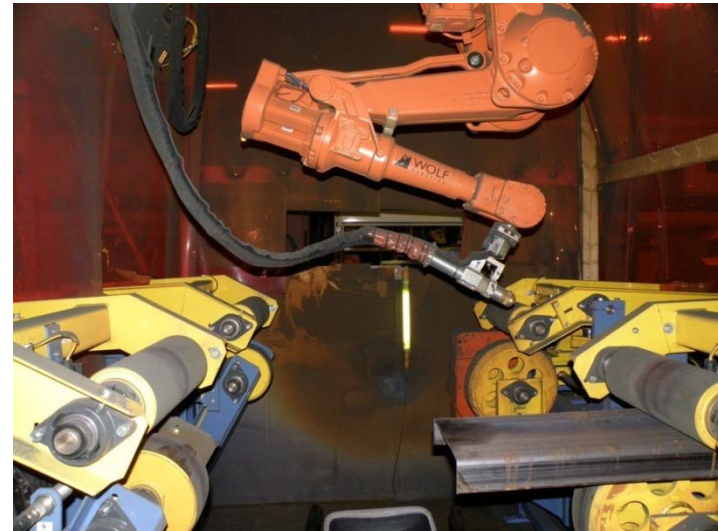
# Weld process improvements

## Submerged arc welding



# Plasma Cutting

- Plasma cutting process typically performed on x-y tables done with robotics
- High definition cutting
- Sensor technology available for height control
- Tactile sensing for part location





# Grinding Applications

- Robotic grinding with force control
- Compensate for cutting wheel wear
- Consistent results



# Grinding Applications



# Off-line programming



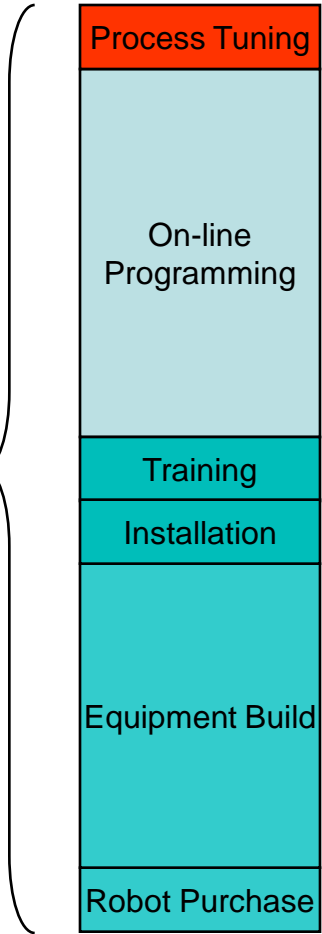
Robot Studio™

Off-Line Programming

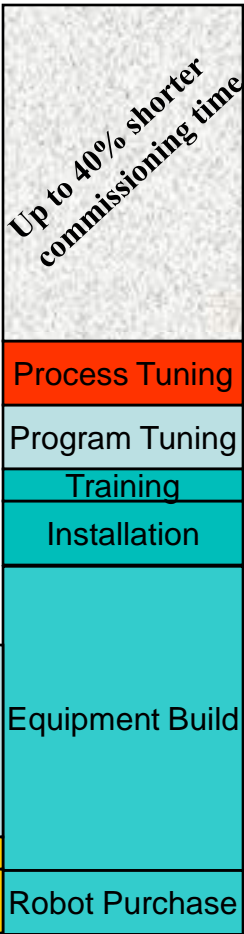
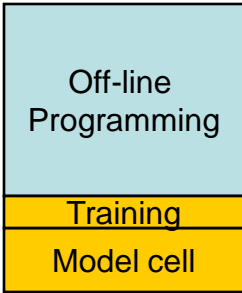


# Off-line programming

Total time between order and production



**On-line Programming**



**Off-line Programming**

Total time between order and production



# Off-line programming

- Easier editing & modifications of existing programs
- Reach & access issues resolved prior to system build
- Tooling issues resolved prior to fabrication
- Low-volume applications fit well with off-line programming
- Ability to view welding sequence up front prior to production run
- With proper preparations programs can be down loaded and run without touch up

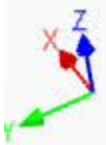
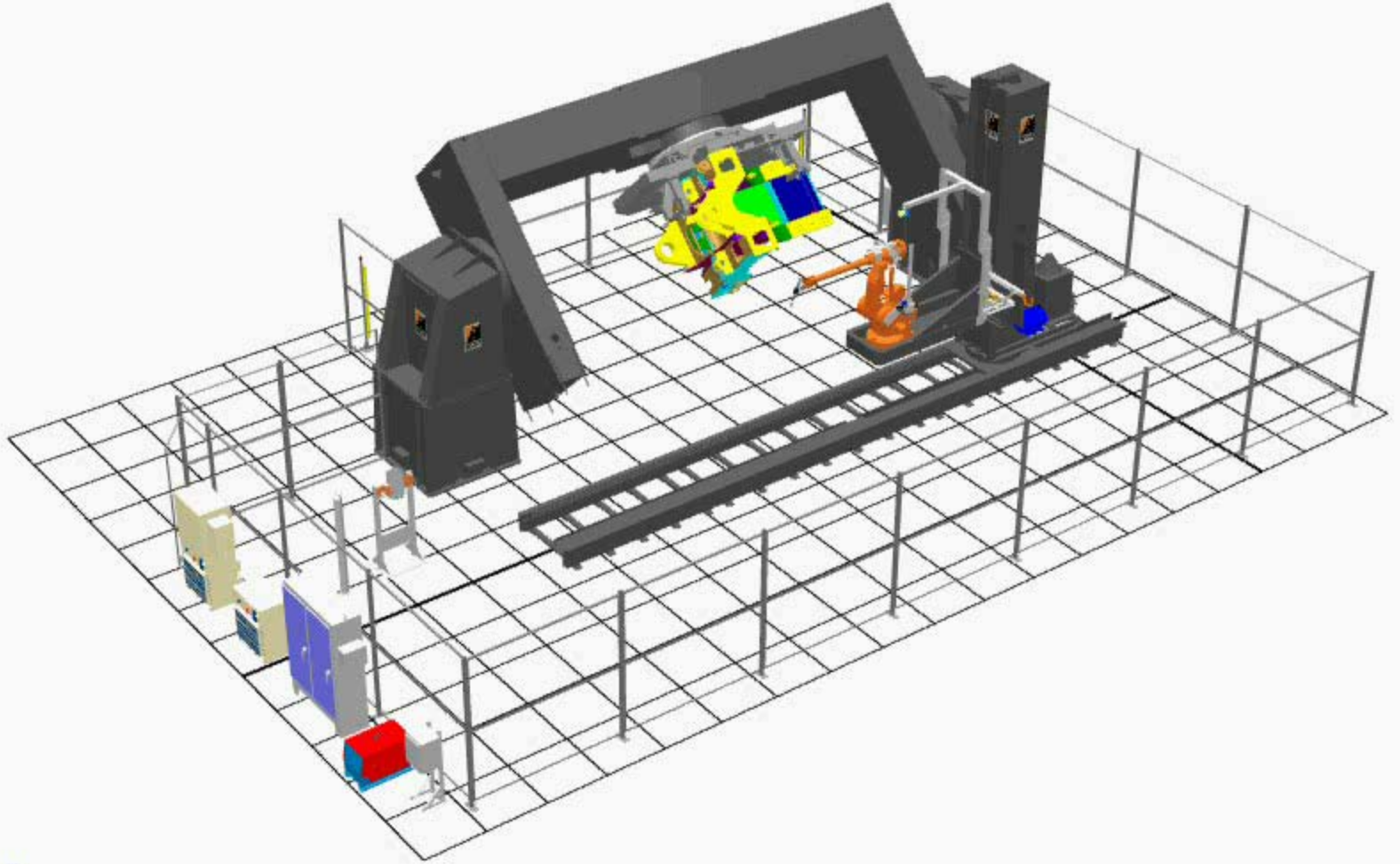


# Off-line programming Case Study



- Universal Cells for Large and Small Parts all programmed off-line
- Multiple different family parts on common cells





# Large Weldments - Future trends

- Systems communicating with the customers production systems
  - OEE , TQM, Maintenance, Remote diagnostics
- Systems moving past off-line programming and to self taught path generation
- Less hard fixed tooling - multiple robots with hold & place capabilities
- Further development of high speed / high deposition “hybrid” processes



# Hold & place systems

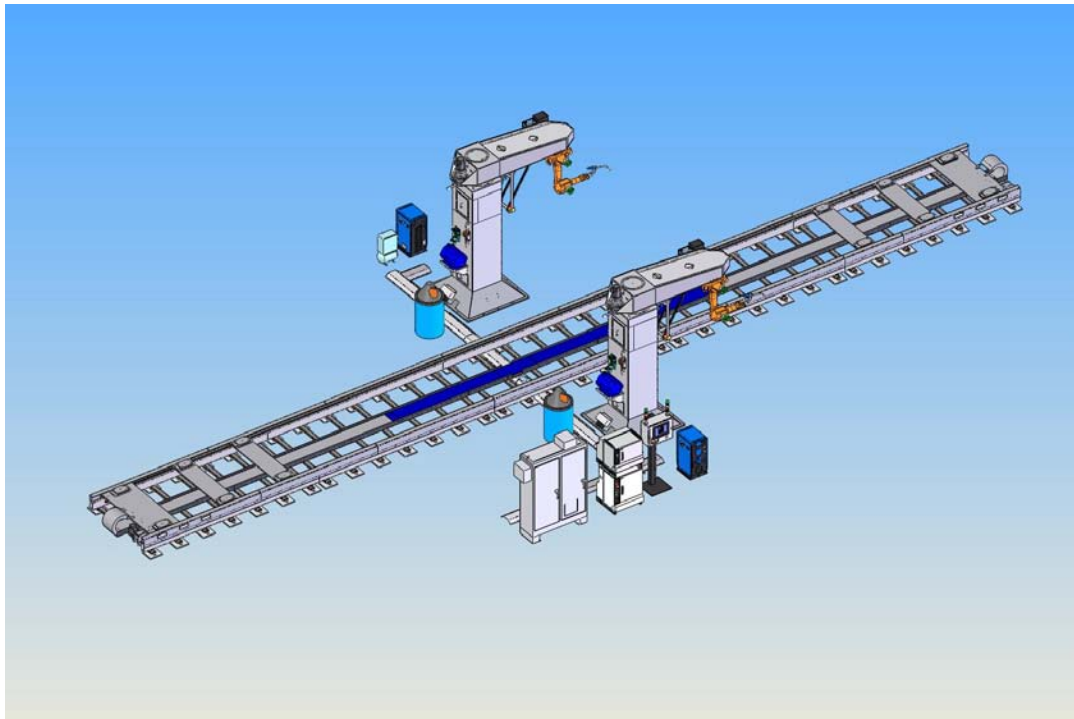
- Little or no conventional tooling required
- Quick change over of part numbers
- Allows for easy re-location & re-orientation of features
- Secondary robots used as positioning devices





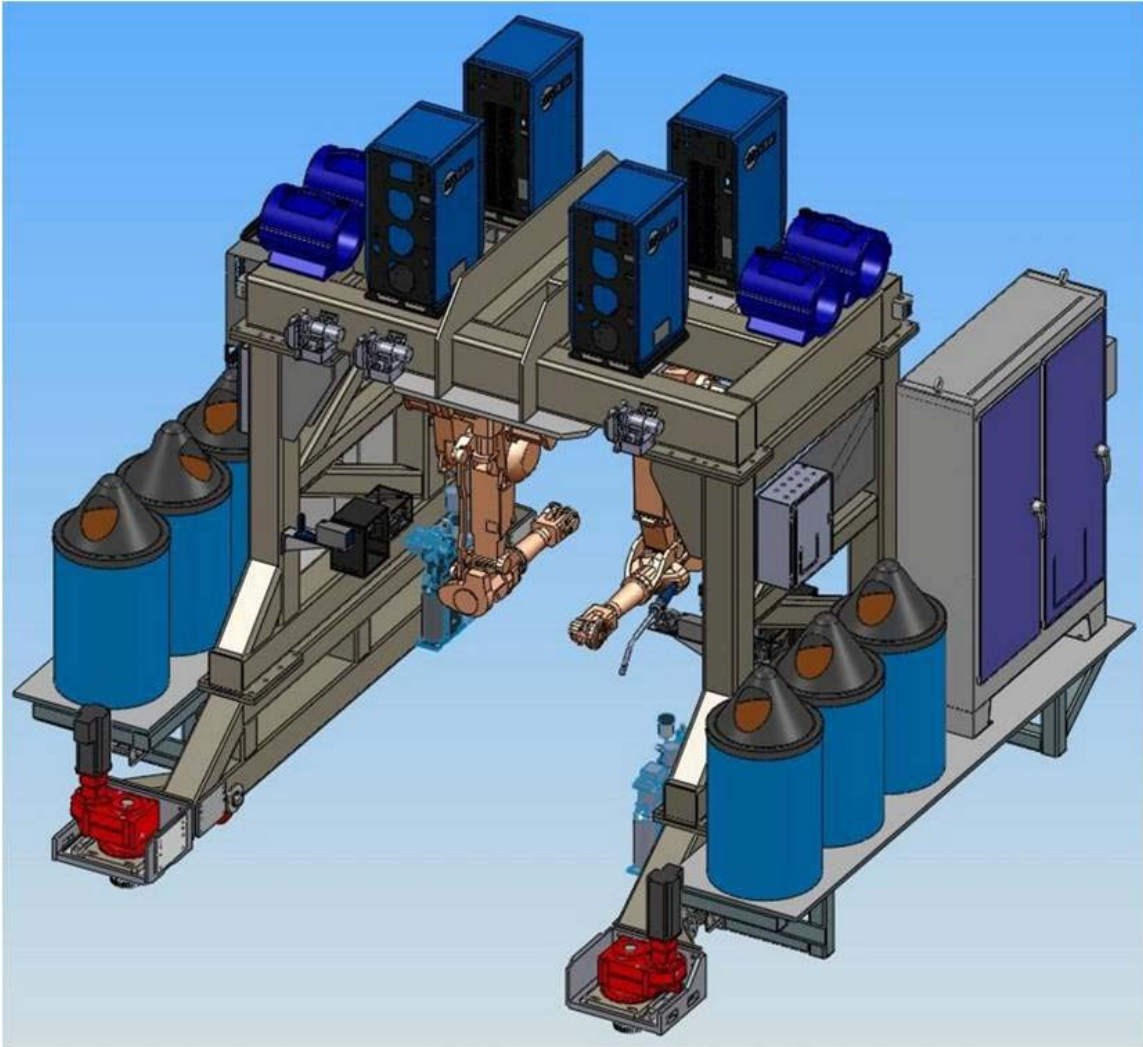
# Multi-Move systems

- Multiple robots working together on a common part
- Multiple robots controlled by one single controller panel

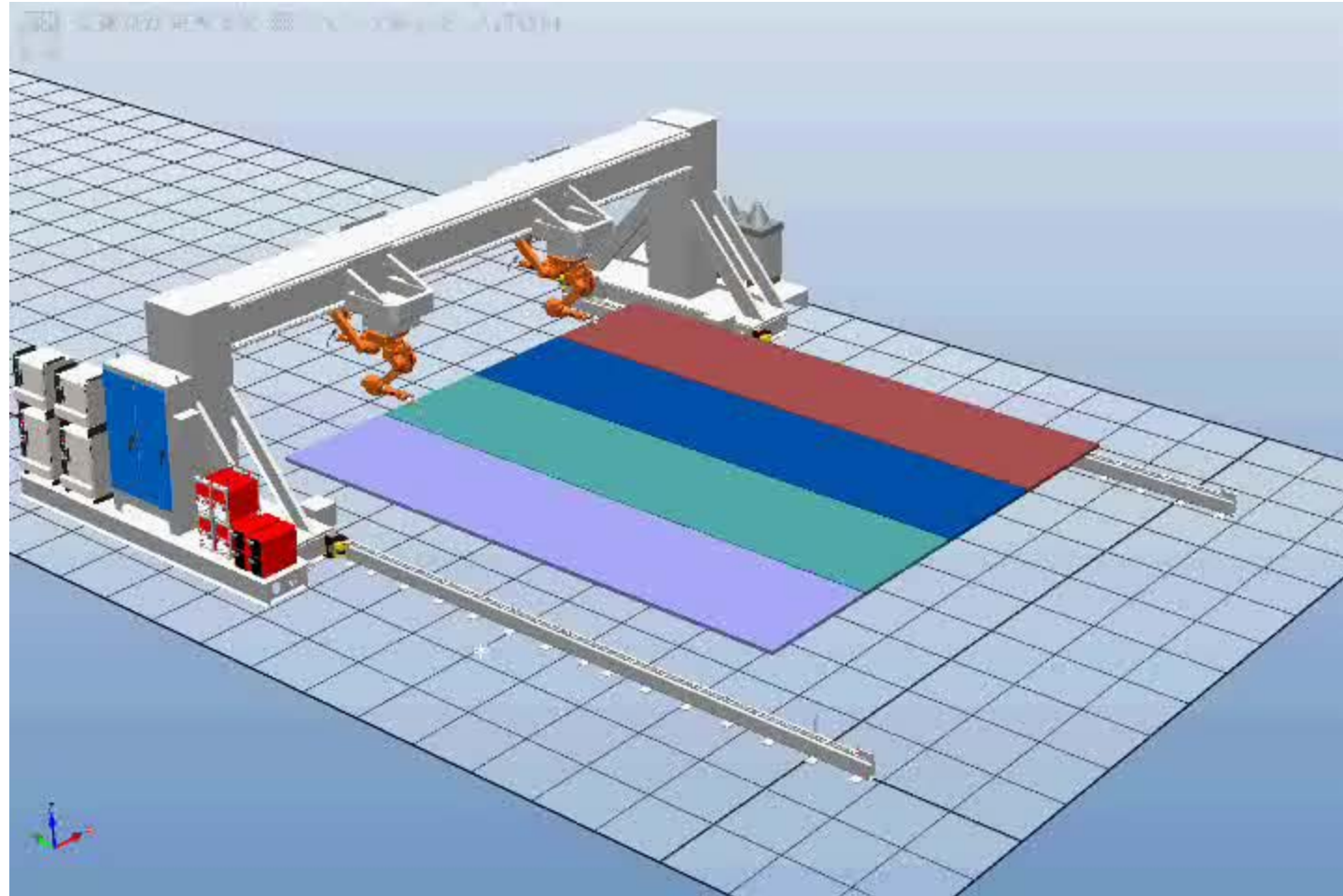




# Multi-move Gantry welding system

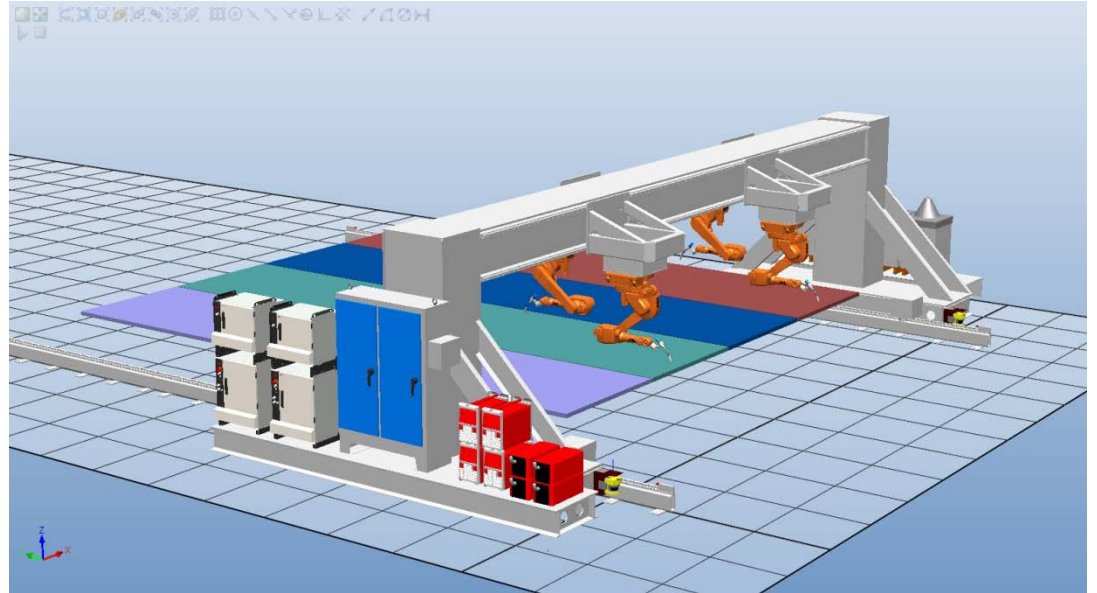


# Possible Ship Panel Gantry Concept



# Possible Ship Panel Gantry Concept

- Multiple robots on one common gantry
- Individual motion on separate carriages for each robot base
- Multiple process possibilities



Shipyard  
Components



Robotic  
Innovation



- **Reduced Manufacturing cost**
- **Increased quality/control**
  - **Repeatable results**



Questions?





**WOLF**  
R O B O T I C S