



## AutoGen

### Automatic Generation of Control Programs for Robotic Welding

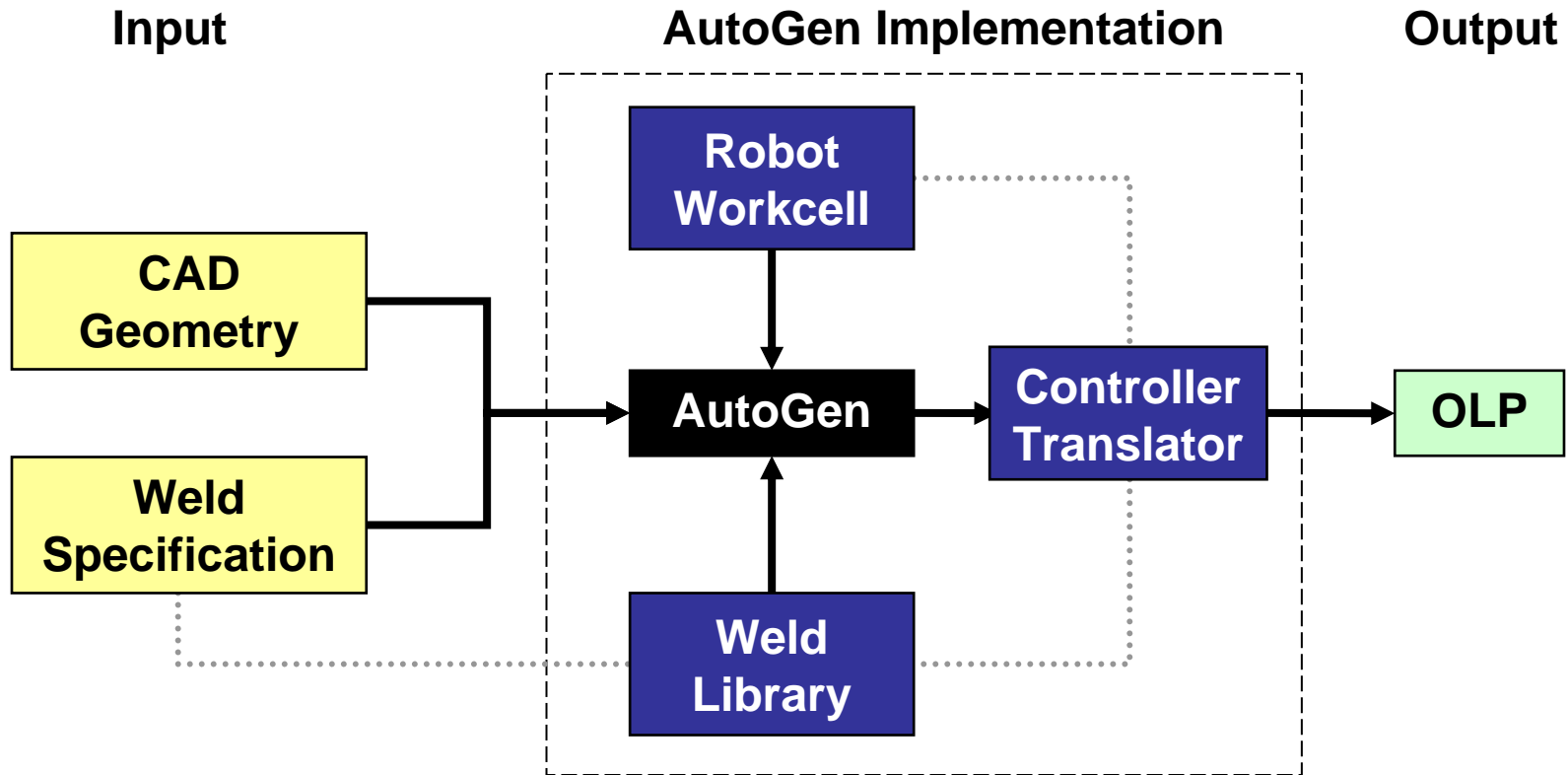
Gregory T. Dobson, Ph.D.  
Simulation Based Design Center  
University of New Orleans

- Robotic welding offers many benefits to the shipbuilding industry
  - Capability of greater accuracy, speed & overall arc time percentages
  - Improved weld quality of finished parts
  - Accurate and automatic monitoring of welding parameters
  - Repeatability (for batch runs)
- Problem is programming of thousands of assemblies

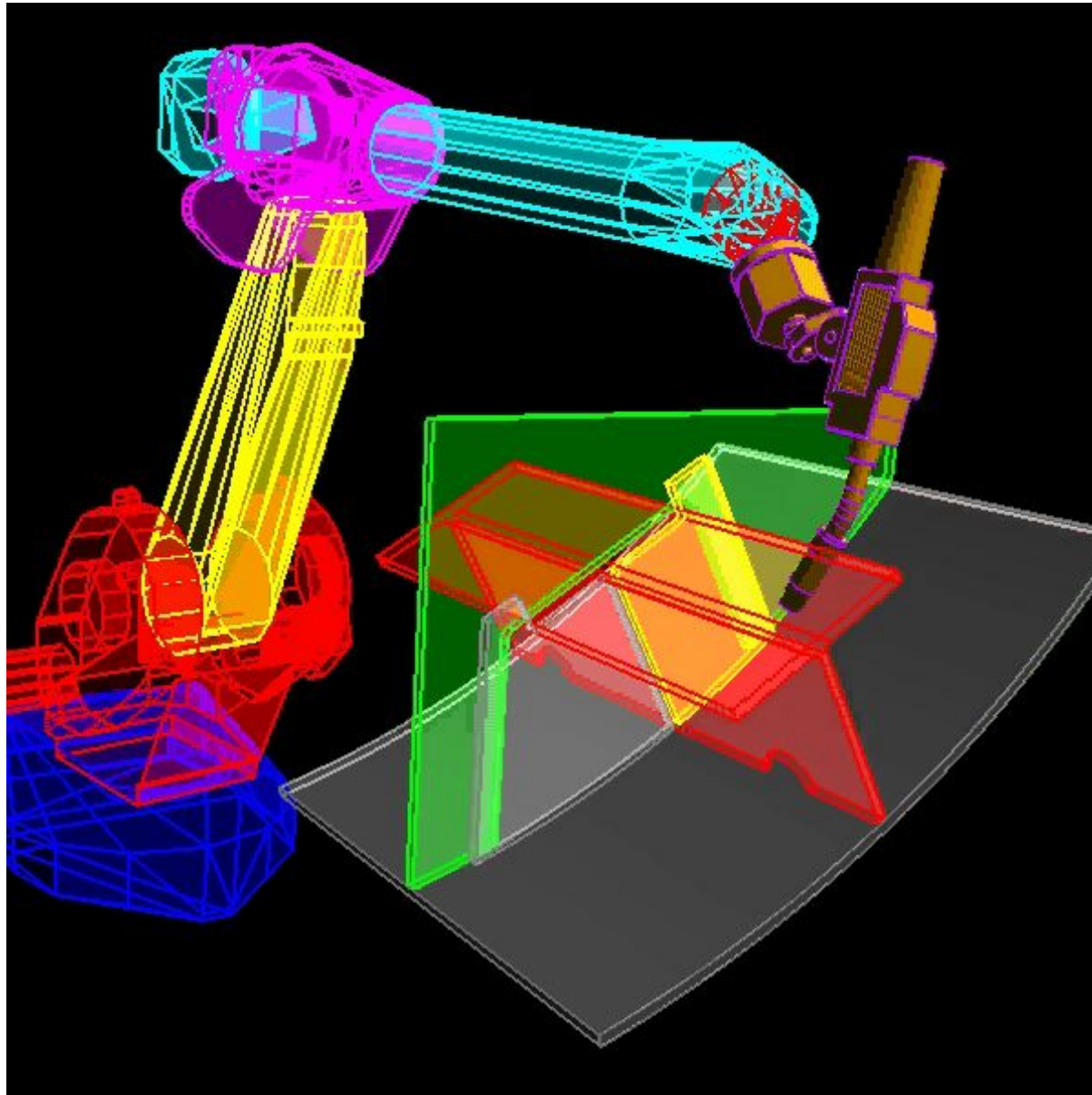
- Live use of the robot to program its movements
- Examples: **Pendant Teaching**
- Pro's:
  - simple, straightforward technique
  - can verify quality of path immediately
  - aligned to “program once – run multiple” applications (e.g. automotive industry)
- Con's:
  - uses valuable production time to program robot
  - too costly for “one-off” production

- Create the program separately from the robot
- Examples: **Macro, Simulation**
- Pro's:
  - program developed outside of production
  - development and reuse of weld path templates
  - aligned to low-volume, custom production
  - offers ability to test producibility of product
- Con's:
  - more complex programming tools required
  - replaces blue-collar labor with white-collar labor
  - more time to program versus time to manual weld

- Automatic, Off-Line creation of robot programs from design models
- Pro's:
  - no user interaction required
  - offers ability to embed best practices
  - support for process optimization
  - required for economical, low-volume production
  - could be utilized by any robotic application
- Con's:
  - cutting–edge technology
  - needs additional testing and function development to address broad spectrum of applications



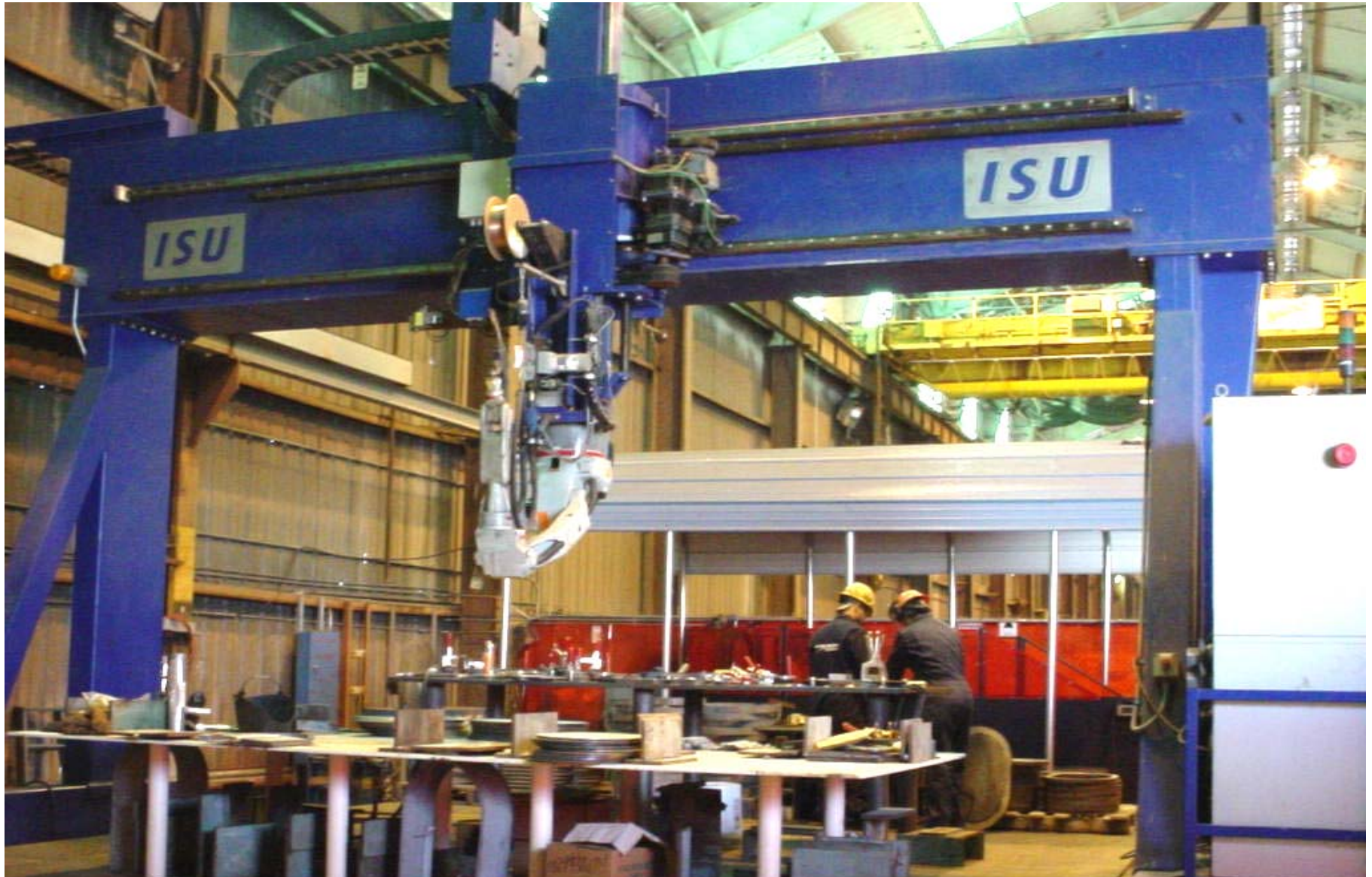
- NSRP Project
  - August 1999 - December 2003
  - NGSS – Pascagoula Operations
  - Sandia National Lab – Albuquerque, NM
  - Developed state-of-the-art offline robot programming system
  - Demonstration on UNO's ABB IRB400 robot welding system





- Planned 3-year effort to enhance system
- Year 1: 2004 – 2005
- NGSS, SNL, Spatial Technologies, UNO
- Address additional product complexity
- System platform expansion
  - UNO Motoman UP6 on 3-axis gantry
  - Electric Boat PAWS system
- Demonstration at UNO in July 2005

# UNO Gantry Robot Welding System





- Enhance code to assure robust performance with non-expert operators
- Restructure code to meet industrial architectural standards
  - user interface
  - error handling
  - modularization



***NORTHROP GRUMMAN***  
*Ship Systems*



## Program Management

- Develop Commercialization Partner
  - Market research & analysis
  - Business model development
  - Business planning & product direction
- Technical Advisory Board
  - Shipyards (Large & Small)
  - Research Centers
  - Vendors (robot systems, system integrators, software)
- Coordinate work with Shipyard Partners

- NGSS
  - Additional system specification
  - Use case development
  - Implementation support & worker training
- Electric Boat
  - Interface to shipyard-developed systems
  - Incorporate coordinated DoF for PAWS robot
  - Support for multi-pass welds
- Third Shipyard (tbd)

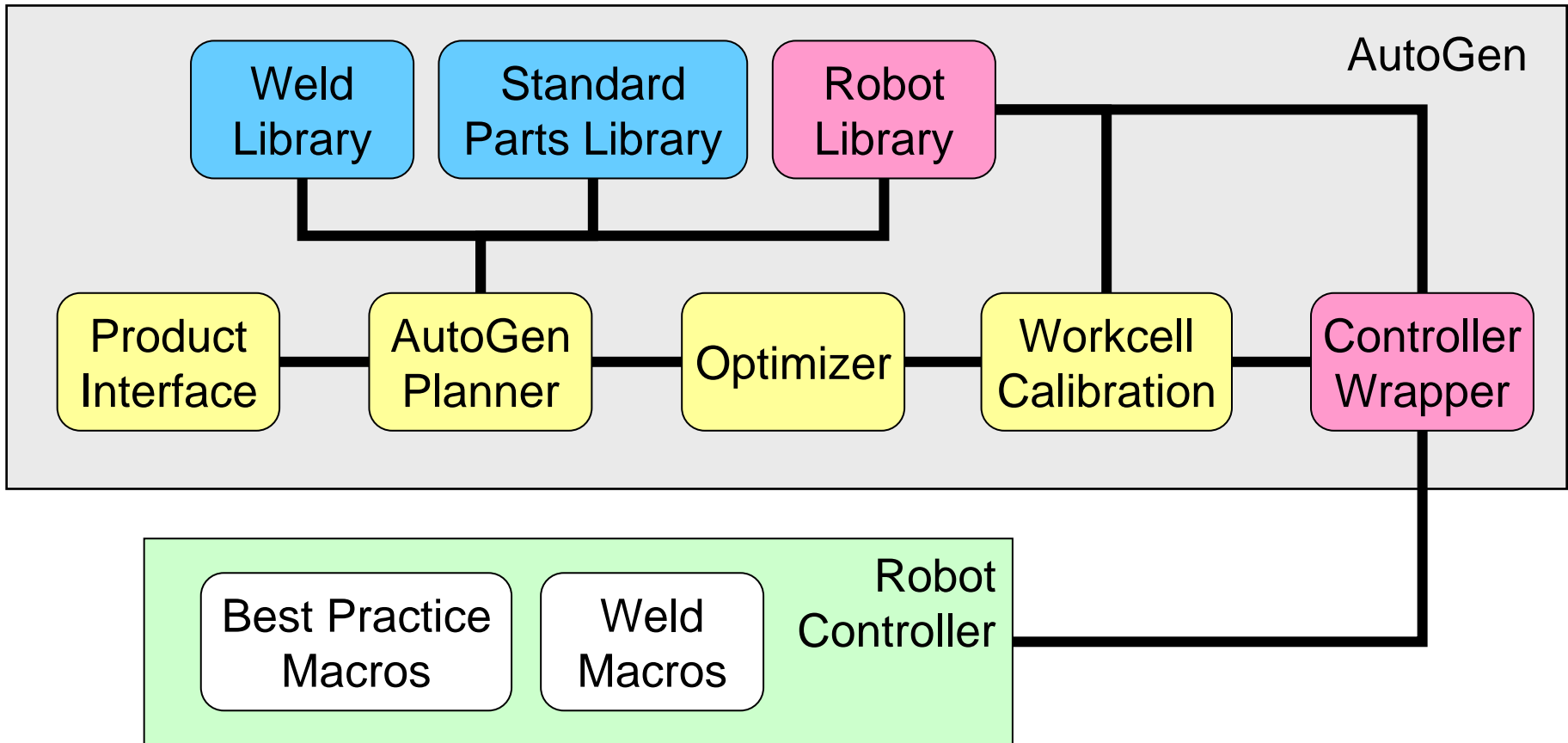
- **Software Transition Plan**
  - modularization of code
  - exception handling, documentation...
- **Software Quality Assurance**
  - test part library
  - system development/config management
- **Advanced Robot Manipulation**
  - improved gantry placement & “air” path creation
  - torch position optimization
- **Graphical User Interface**
  - workcell definition, part interaction, environment set-up

- Develop Product Commercialization Plan
  - Platforms and languages
  - Usage of third-party libraries
  - Interoperability & modularity
- System “Robustness” & Stability
  - Undo/Redo management
  - Memory Management
  - Additional exception handling
- Transition Plan

- DELMIA – AutoGen Integration
  - use Delmia as virtual test environment
  - import AutoGen code
- AutoGen Calibration System
  - define processes and required equipment
- Define required AutoGen libraries
- Define AutoGen Use Cases

- Virtual and Real testing of system
- Establishment of verification and validation protocols
- Conduct validation tests in support of Software Development
- Develop improved AutoGen Calibration System

- Sub-Contracts in place/progress
- Gathering TAB members
- Repairs to UNO robotics lab
- Familiarization with software
- Initial discussions on
  - “commercialized” architecture
  - high-level use cases
  - implementation specifications

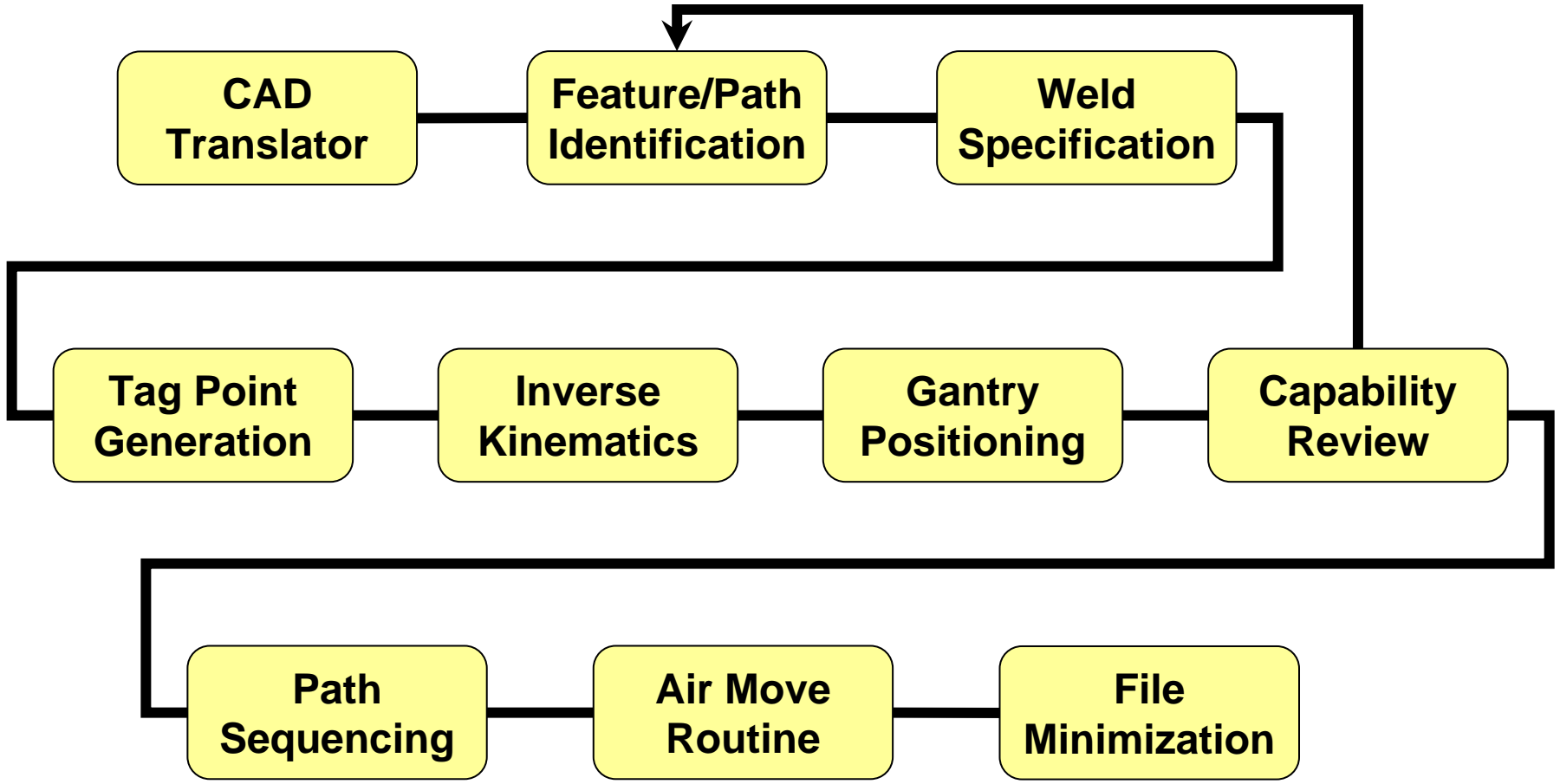


Support Libraries

Robot Library

Core AutoGen

Robot Controller



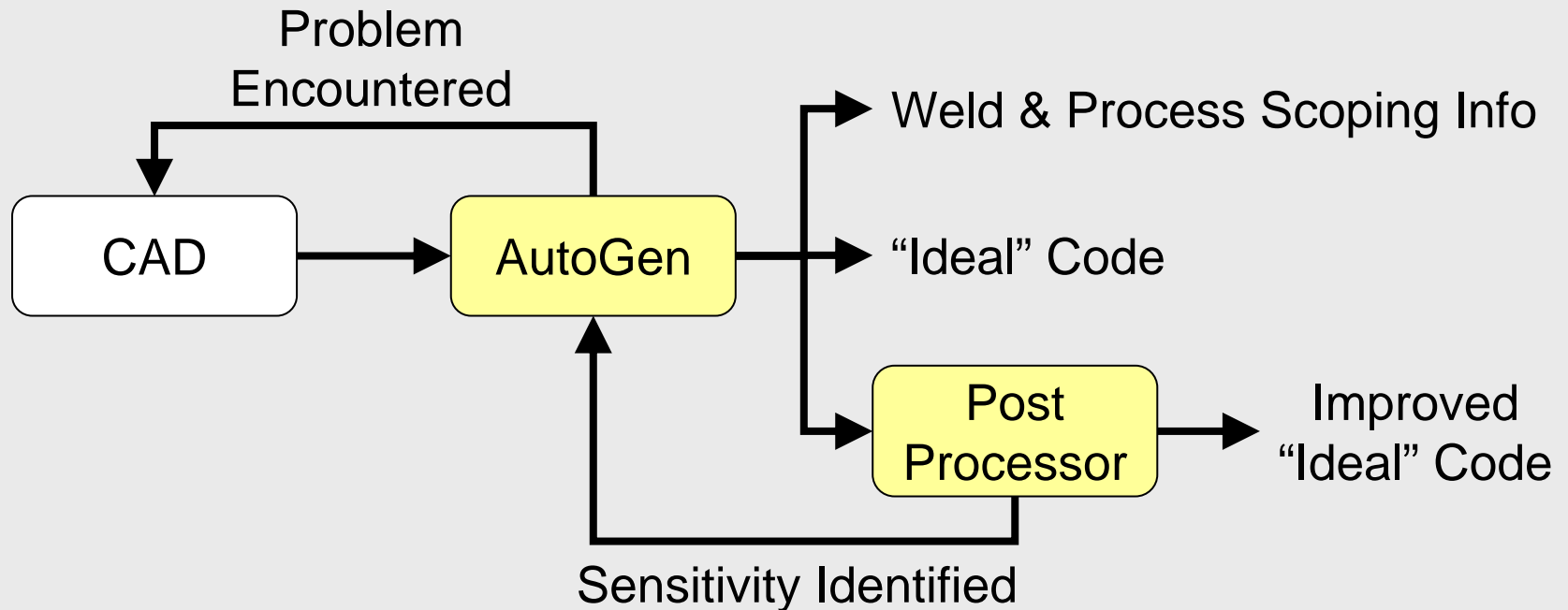
- Determine what the shipyards need
- Identify additional functionality
- Specify how the tool(s) should be “packaged”
  - Platform
  - System interface requirements
  - User interface requirements
- What other applications can be addressed by using existing AutoGen capabilities

- At-Floor programming tool
  - reduce problems with config. management
  - runtime inefficiency ?
  - “end-of-the-line” tool

OR

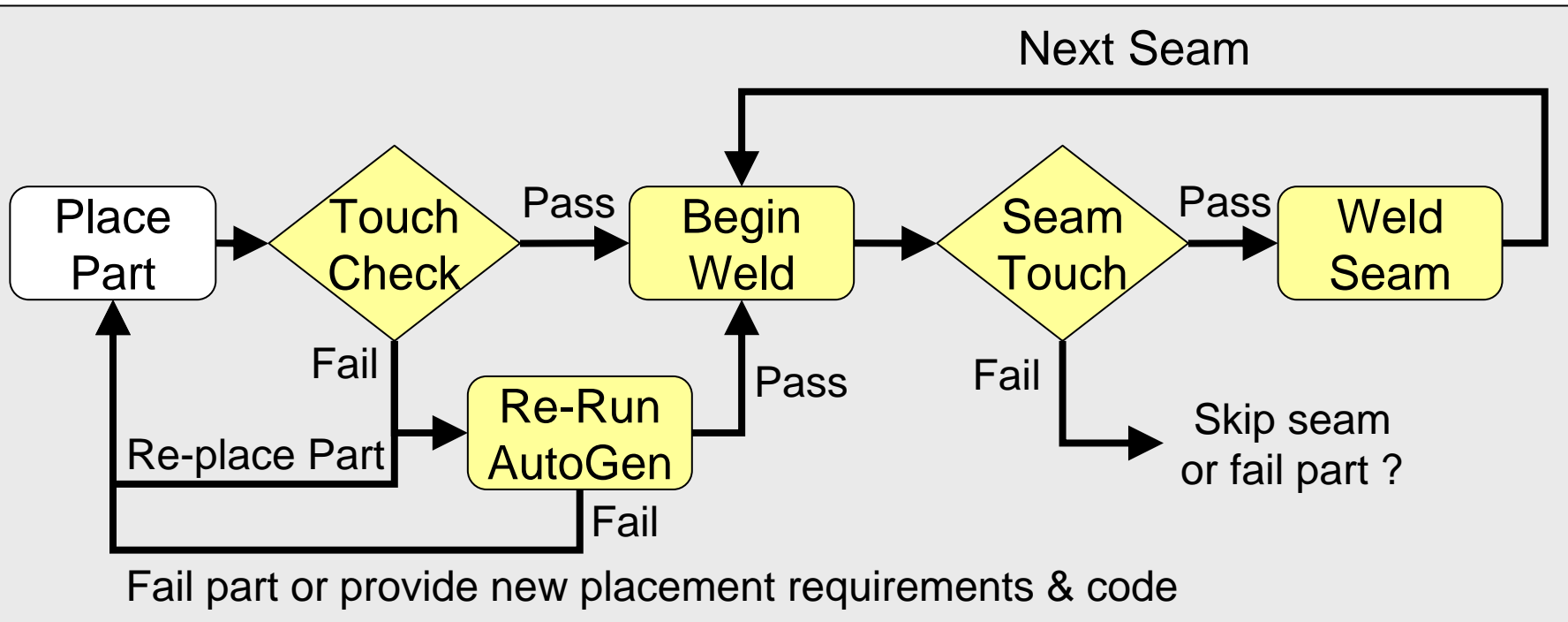
- In Production Planning w/ At-Floor Support
  - support decision-making
  - Design for Production/Robotics
  - more configuration management needs
  - additional utilities required

**Input:** CAD file; calibration information from Shop Floor; Weld, Standard Part and Robot libraries



**Output:** "ideal path" code, design modifications, preferred part placement in workcell with tolerances

**Input:** Ideal path code, CAD file, preferred part placement within workcell, tolerances for part placement



**Output:** Part calibration information for AutoGen, feedback on problems encountered

- Coordinated multiple robots
- Incorporation of sensors
- Expansion of support libraries
- Utility development
- Weld path optimization
- Create “AutoGen” controller
- Additional applications beyond welding

*UNO Simulation Based Design Center*

Station 721-1-1

5100 River Rd.

Avondale, LA 70094-2706

(504) 654-3880 (fax)

***autogen@gcrmtc.org***

Gregory T. Dobson, Ph.D.

Site Director

(504) 654-2773

[greg.dobson@gcrmtc.org](mailto:greg.dobson@gcrmtc.org)

Frank M. Bordelon

Director, GCRMTC

504-654-3932

[fbordelo@uno.edu](mailto:fbordelo@uno.edu)