NSF Engineering Research Center for

Reconfigurable Manufacturing Systems

TA2: Manufacturing Information and Control

Overview

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ERC/RMS from 1996 to 2007

During the years 1996 - 2007 an investment of $45 million was made to the Engineering Research Center for Reconfigurable Manufacturing Systems (ERC/RMS)

The majority of the funding was awarded by the National Science Foundation (NSF) in Washington. $8.5 Million were paid by industry as discretionary membership fee (GM, Ford, Chrysler paid $200K/year each)

We saved $4 million during the 11 years

Decisions of the ERC Executive Committee (October 2006):

- **Continue to operate the center at $1.7 million per year, for 4 years**

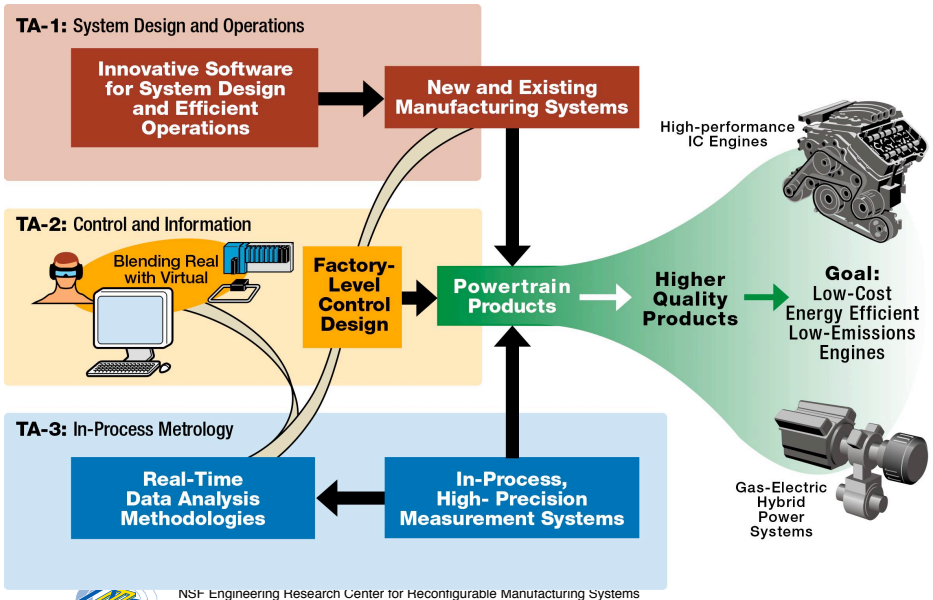
	Annual Total [$]:
• Spread the available $4 million over 4 years (2007 - 2011)	$ 1,000,000
• Chrysler, Ford and GM will continue to commit $200,000 per year	600,000
	100,000
• Other industries (e.g., Cummins, Siemens, Piltz, Coherix)	$ 1,700,000

- **Have Quarterly Review Meetings – GM, Chrysler and Ford**

How Does the Center Operate?

- **Consortium:**
  - **12 long-term NEW projects suggested by the industry partners started in Jan. 2007.**
  - **The ERC is working on additional 8 projects that started earlier**
- **Companies pick projects for tech transfer** (Pull)
- **Pool of money directed to projects** (discretion of Center Director)
- **Industry involvement at all levels**
  - **Annual Executive Committee Meeting (in October)**
  - Technical Advisory Committee Meetings (industry folks + ERC researchers)
  - **Quarterly Review Meetings** (September, Dec, March, June)
  - On-going individual project level meetings

ERC/RMS Focus



Current ERC Projects

Yellow Background = projects recommended by GM, Ford and Chrysler

TA1: System Design and Operations	TA1-1: Gear Noise Reduction in Transmission Systems
	TA1-2: Cyclic Waveform Signal Analysis for Monitoring & Diagnosis of Powertrain Mfg. Systems
	TA1-3: Computer Aided Simulation Model Verification, Testing and Optimization
	TA1-4: Performance analysis of mfg. systems
	TA1-5: Complexity Modeling & Analysis for General Assembly
	TA1-6: Complexity Analysis of Assembly Supply Chain Configurations
	TA1-7: Supply Chain Operations in Production/Assembly Systems
	TA1-8: Quality Assured Optimal Setup Planning for Multistage Machining Process
TA2: Manufacturing Information and Control	TA2-1: Virtual Fusion: Integrating Virtual Systems into Manufacturing
	TA2-2: Manufacturing Network Time Synchronization Best Practices (NIST)
	TA2-3: Reducing Unscheduled Downtime Through Automated Event-based Control
	TA2-4: Wireless Network Analysis and Testing
	TA2-5: The Reconfigurable Factory Testbed (RFT)
	TA2-6: Factory Control Logic Consolidation
	TA2-7: Fault Diagnosis using Automated Model Generation
	TA2-8: Development, Application, and Transfer of a Network ROI Cost Calculator (on hold)
TA3: In-Process Metrology	TA3-1: Cylinder Bore Inspection
	TA3-2: Small Diameter Bore Porosity Inspection
	TA3-3: In-Line Inspection of Engine Valve Seats
	TA3-4: Camshaft / Crankshaft Polishing Testing
	TA3-5: Thread profile measurement in small diameter holes
	TA3-6: Reconfigurable Inspection Machine
	TA3-6: Reconfigurable System for Turbine Blade Finishing

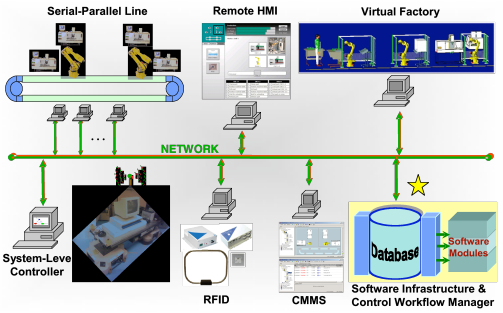
Reconfigurable control for manufacturing systems

- **Control challenges**
  - Coordination of multiple machines—> complex systems
  - Vendor neutral, open architecture environments
  - Reconfiguration in response to market demands
- **Research approach**:
  - Core research areas
    - Formal methods for verification/validation of logic control
    - Testing and characterization of networks for control
    - Resource-based control methods
    - Simulation models for control evaluation
  - Reconfigurable Factory Testbed for testing and implementation
  - Industry relationships
    - Joint research projects, USCAR participation
    - Student internships
    - Analysis of plant floor data
    - Network performance workshops (annually in May)

Reconfigurable Factory Testbed

- *Ongoing ('03); Core Infrastructure; 2 Students; Significant ERC Membership Involvement*

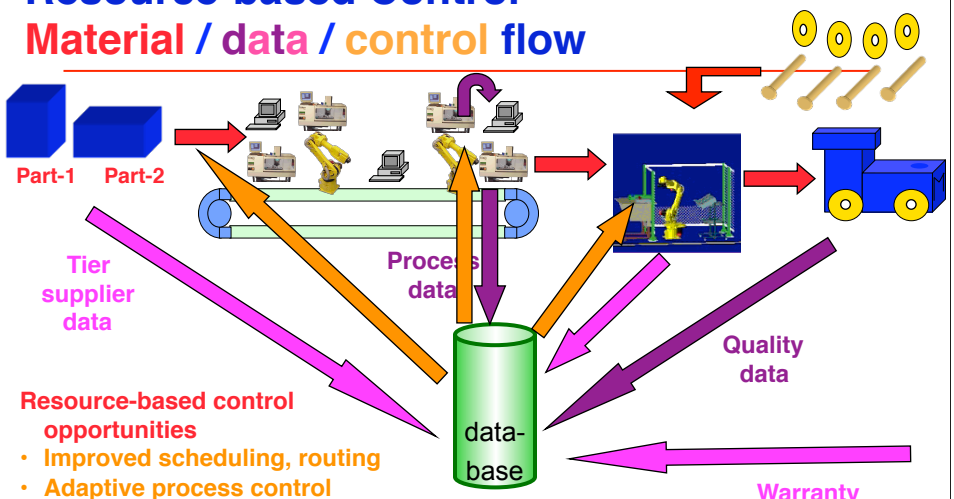
- ***Objectives***
  - ***Consolidate, demonstrate and transfer*** **research**
  - **Testbed support for *ALL* TA2 Industry projects**
- ***Key Deliverables***
  - ***Networks for Control, Diagnostics and Safety***
  - ***Consolidated reconfigurable control and I***
  - ***Virtual + Real Manufacturing Environment***



- ***Benefits to Industry***
  - **Project *facilitator* and *accelerator***
  - **Demonstrates the *vision* that ties all projects together**
  - **Tool to *promote ERC membership* and *self-sufficiency***

Resource-based Control

Material / data / control flow



Resource-based control opportunities

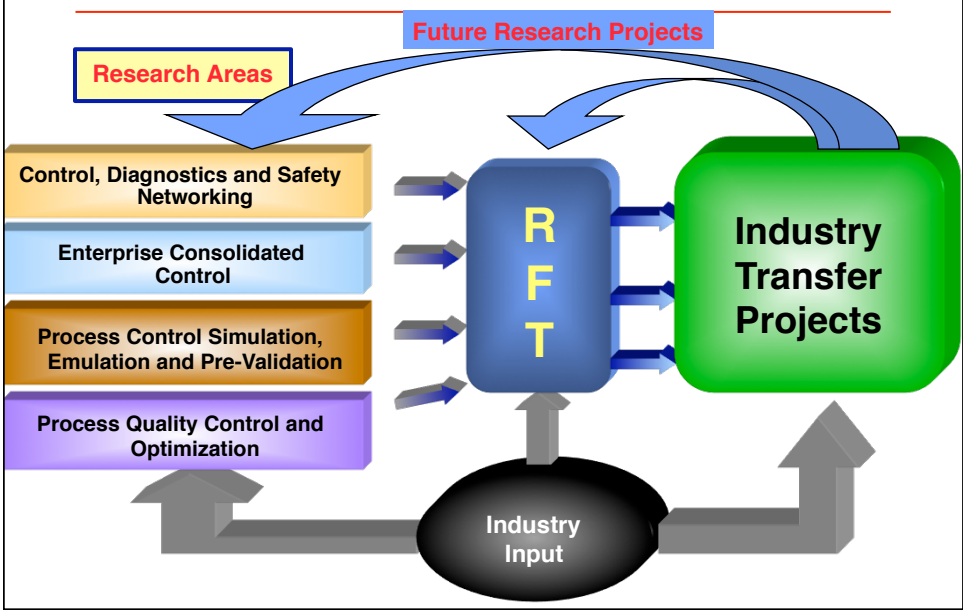
- **Improved scheduling, routing**
- **Adaptive process control**
- **Maintenance management and maintenance scheduling**
- **… many others**

RFT enabled research and technology transfer opportunities

Resource-based Control
Benefits

- ***Data Collection***
  - *Process / Product / People for complete manufacturing visibility*
  - Data consolidation for automated/consolidated analysis
- ***Data Analysis***
  - Diagnostics
  - Dynamic scheduling
  - Process optimization
  - Maintenance scheduling and optimization
  - Early Warning Systems for Warranty Cost Reduction
  - *Leverage consolidated control for resource coordination*
- ***Control***
  - Automatically adjust current production scheduling and dispatch, maintenance scheduling, and machine/tool settings to optimize quality, minimize scrap, and maintain productivity
  - Optimize future production and maintenance scheduling
  - *Leverage consolidated control for resource coordination*

TA2: Technology Transfer Process



ERC/RMS Projects (TA2)

Proj. #	Project Title	Partners
1	Virtual Fusion: Integrating Virtual Systems into Manufacturing	GM Ford Chrysler
2	Manufacturing Network Time Synchronization Best Practices (funded by NIST)	
3	Reducing Unscheduled Downtime Through Automated Event-Based Control	
4	Wireless Network Analysis and Testing	
5	The Reconfigurable Factory Testbed (RFT)	
6	Factory Logic Control Consolidation	
7	Fault Diagnosis using Auto Model Generation	
8	Network ROI Cost Calculator (hold, ready for transfer)	