

# Engineering Research Center for Reconfigurable Manufacturing Systems



**Reducing Unscheduled Downtime Through  
Automated Event-based Control  
- Updates for May 2009 -**

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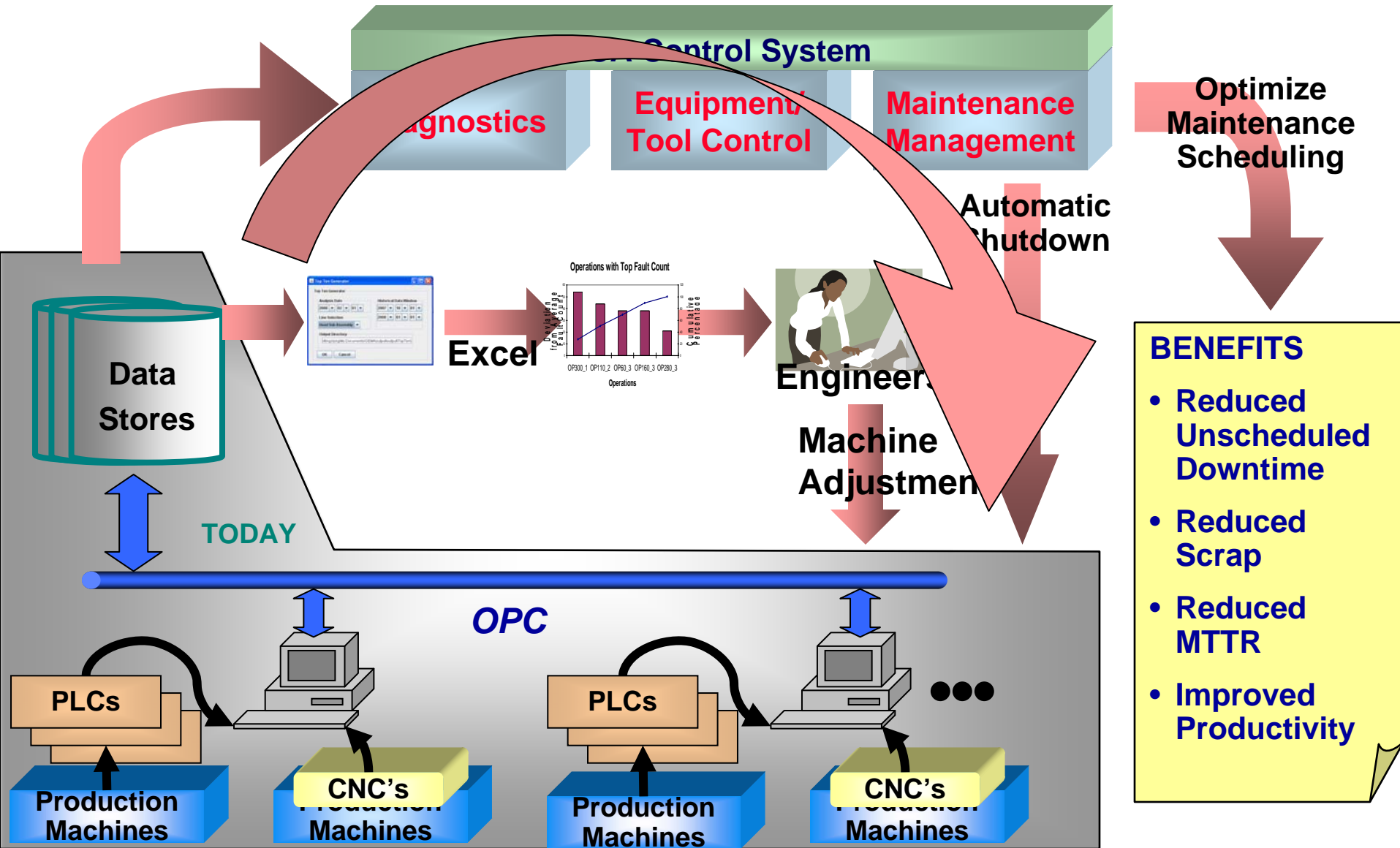
NSF Engineering Research Center for Reconfigurable Manufacturing Systems  
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TA2 TAC 1



# Closing the Loop





# Previous Work and Results

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- **Top Ten Software:** Generate Pareto Chart, of machines experiencing abnormal behavior.
- **Downtime Prediction Software:** Using this software, improvements can be made in dealing with low factory loads and reducing the costs of downtime. Delivered softwares are portable to other plants and manufacturing systems, on going discussions with GM to implement software.
- **Improving Standard Best Practices:** Using this software, improvements can be made in dealing with low factory loads and reducing the costs of downtime.



## Moving Forward: Tools for Improving Control

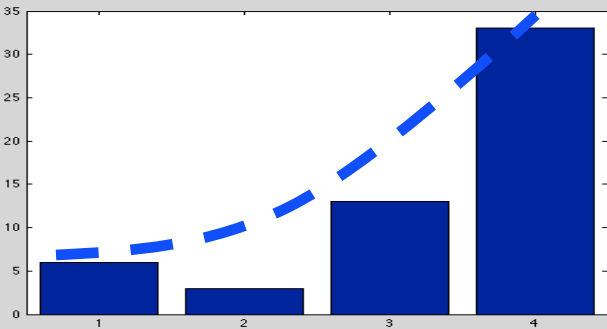
- **Software for Optimized PM scheduling** 
- **Software for Low Load Maintenance Scheduling**
  - Representative of today's economic climate
- **Software for Reducing Redundancy in Maintenance Scheduling**
- **Best Practices for Improving Data Quality** 

**The project will focus on delivering tools that can help a factory improve fault prediction and data quality.**



# Software For Optimizing Maintenance Scheduling

Profiling the rise in faults can be used to optimize the preventive maintenance schedule.



Calculated Lowest Cost for Preventive Maintenance

Predicted Unsch. Downtime

Planned Preventive Maintenance

Predicted Rise in Faults

Observed Rise in Faults before Downtime

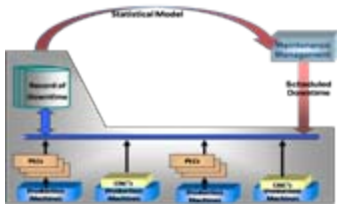


Tool will compare the cost of rescheduling a preventive maintenance relative to the cost generated to the rise in faults and the costs of the expected unscheduled downtime.



# Evolution of Software Tools as Data Quality Improves

Scenario 1



**Stage 1:** Only data involving maintenances and unscheduled downtime is available.

Low Data Quality

**Software Tools: statistical methods**

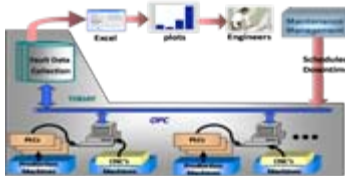
Scenario 3



**Stage 2:** Fault and event data are available to the managers, no discernable relationship can be established between the two.

**Software Tools: Anomaly Detection**

Scenario 2



**Stage 3:** Enough data exists to establish a straightforward linear trend in the event data and machine failures.

**Software Tools: normalized regression**

Scenario 4



**Stage 4:** Enough knowledge exists to filter out bad data and enough data exists to train and use a pattern recognition algorithm.

High Data Quality

**Software Tools: Pattern Recognition**

The process by which factory data quality can be improved will be outlined in the next deliverable.

Deliverable is a best practices document that references software solutions developed for analysis.



# Milestones and Future Plans

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July 2008

- **Audit for data quality at GEMA**

September 2008

- **Construction of UML Data plan**

March 2009

- **Improved regression analysis with normalized signal**
- **Investigated means to improve best practices at GEMA**

April 2009

- **Visited GM to discuss technology transfer**

May 2009

- **Developed Software along with user manuals**
- **Outline for Data Quality improvement techniques**
- **Report on suggested best practices for maintenance scheduling.**

