

Engineering Research Center for

Reconfigurable Manufacturing Systems



Fault Diagnosis Through Automatic Model Generation for Large-Scale Manufacturing Systems

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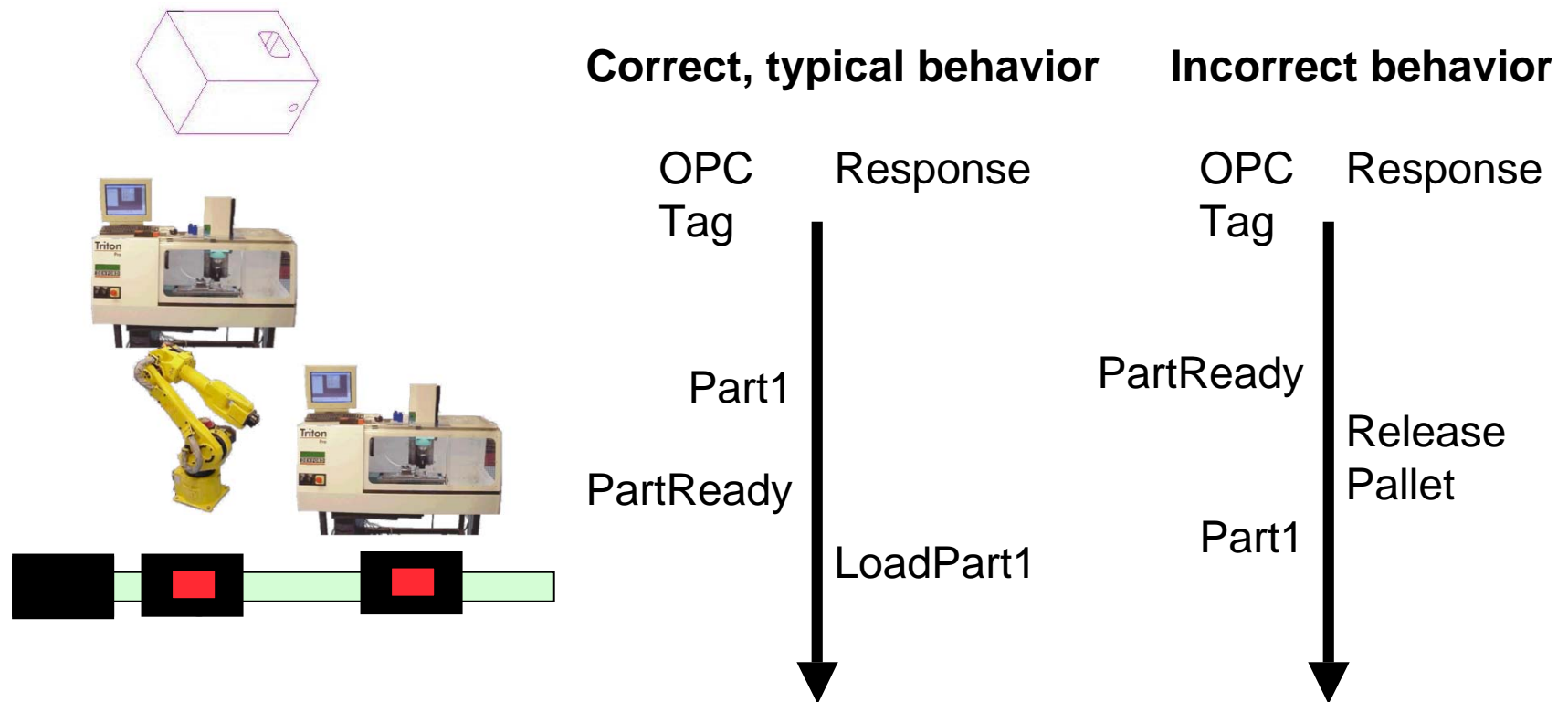
The University of Michigan, Ann Arbor

Outline

- Fault Diagnosis Motivation
- Solution Concept
- Leveraging Factory Health Monitor (FHM)
- Solution Goals and Deliverables
- Benefits to Industry
- Milestones and Future Plans



Motivating RFT Example



- No model of entire system's correct behavior
- Manual inspection – laborious, offline
- Fault diagnosis using estimated model – automated, online

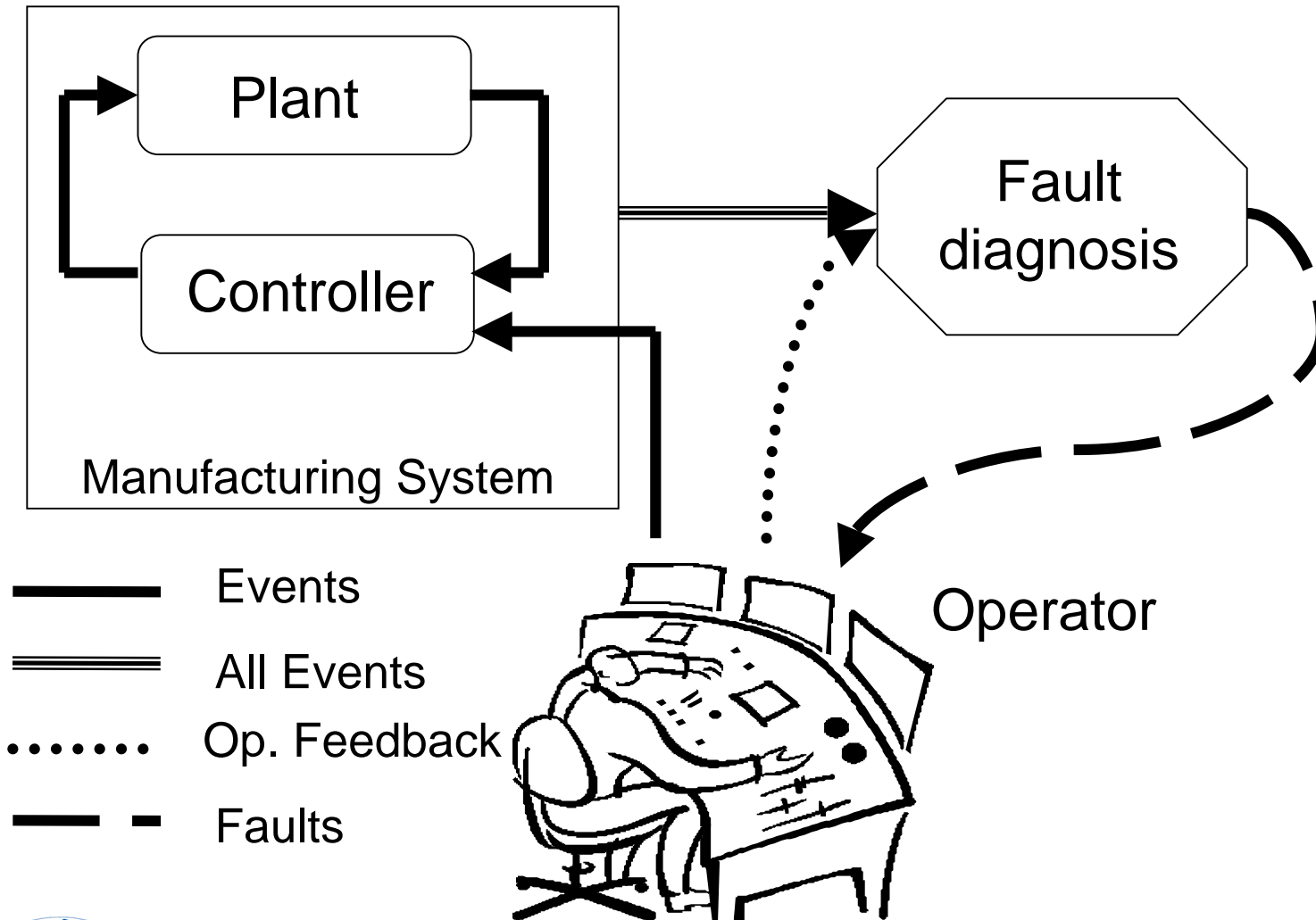


Terminology

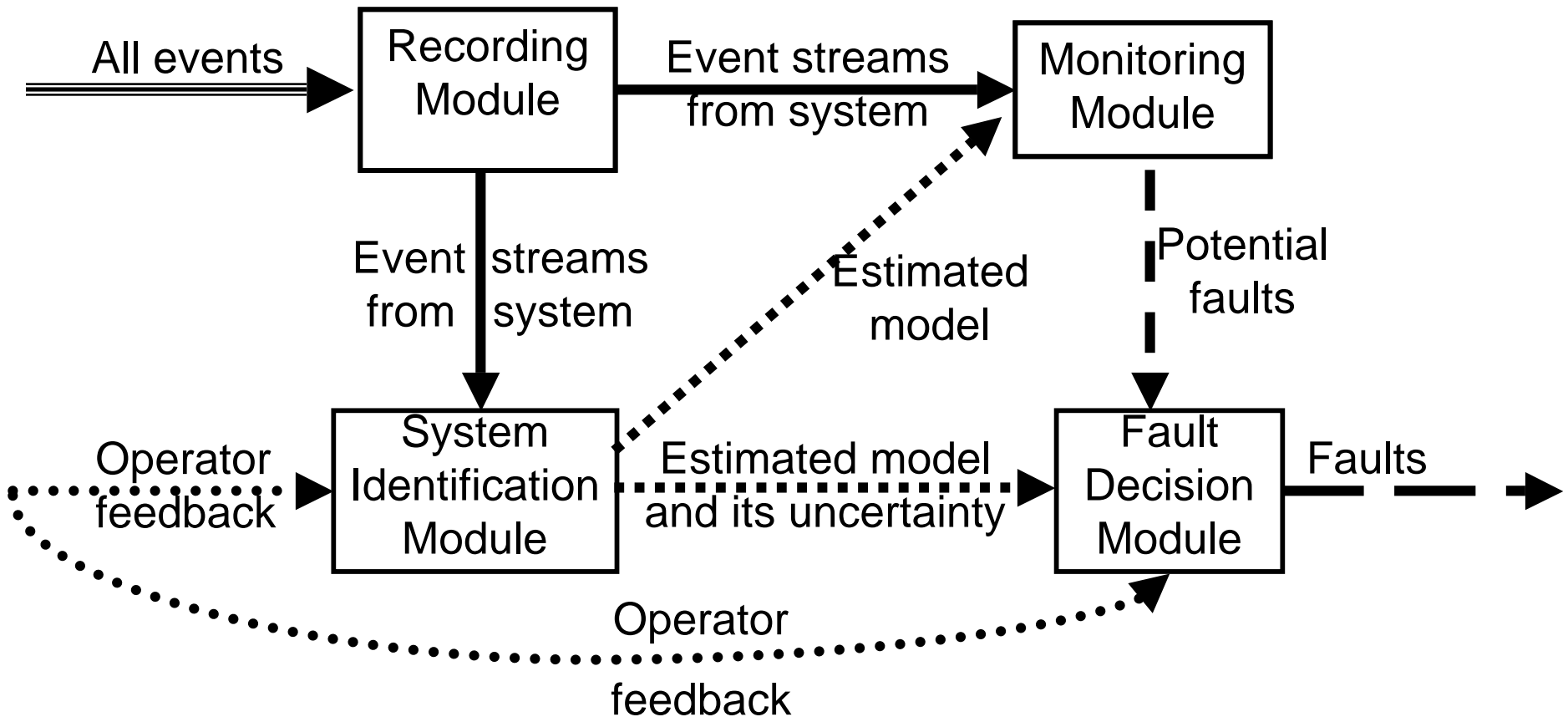
- Detection – determining that a fault has occurred
- Diagnosis – identifying which fault has occurred
- Within this work, “diagnosis” refers to detection and diagnosis



Solution Concept: Interaction



Solution Concept: Fault Diagnosis



Leveraging Factory Health Monitor

- Goal: to integrate an event-based observer with a diagnostic scheme based on system identification to create a multilevel factory health monitor
- Provides preliminary version Recording Module

Factory Health Monitor

Display is paused

pause

The FHM has not been loaded.

Based on past performance 0.0 % of the time this sequence led to a unhealthy state
Based on past performance 0 % of the time this sequence led to a unhealthy state : Cell2 context filter.
Based on past performance 0.0 % of the time this sequence led to a unhealthy state : Cell1 context filter.

Rule Fired	Trigger	Response	Context	Firing Error
33	Cell1.Clamp1_OPC (0)	Cell1.Start1 (1)	all	true
34	Cell1.Clamp1_OPC (0)	Cell1.Start1 (1)	Cell1	false
5	Cell1.Start1 (1)	Cell1.Done1 (0)	all	false
6	Cell1.Start1 (1)	Cell1.Done1 (0)	Cell1	false
7	Cell1.Done1 (0)	Cell1.Clamp1_OPC (1)	all	false
8	Cell1.Done1 (0)	Cell1.Clamp1_OPC (1)	Cell1	false
9	Cell1.Clamp1_OPC (1)	Cell1.Robot_P1M1 (1)	all	false
10	Cell1.Clamp1_OPC (1)	Cell1.Robot_P1M1 (1)	Cell1	false
9	Cell1.Clamp1_OPC (1)	Cell1.Robot_P1M1 (1)	all	false
10	Cell1.Clamp1_OPC (1)	Cell1.Robot_P1M1 (1)	Cell1	false
11	Cell1.Robot_P1M1 (1)	Cell1.Robot_away_out (1)	all	false
12	Cell1.Robot_P1M1 (1)	Cell1.Robot_away_out (1)	Cell1	false

Load FHM Start Recorder Stop Recorder Reset



Solution Goals and Deliverables

- Goal: Create fault diagnosis approach for mfg systems without a pre-existing model
- Deliverables
 - Methodology and algorithms
 - Prototype software modules
 - Record OPC events
 - System identification to build estimated model
 - Monitor current execution vs. expected by model
 - Fault diagnosis based on estimated model
 - Application of methodology, software to RFT
 - Industrial plant pilot study (?)



Benefits to Industry

- Event-based fault diagnosis is possible for manufacturing systems
 - That are lacking pre-existing formal model
 - Whose formal model may be incorrect or incomplete
 - That have formal models but ones that cannot be used dynamically for fault diagnosis
- Algorithms to compare system identification techniques so that the best technique for a particular scenario can be discovered



Milestones and Future Plans

