

Design & Analysis of Manufacturing Systems and Supply Chains

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Research Projects – An Overview

• Design & Analysis of Manufacturing Systems and Supply Chains

- Activities concerned with planning, coordinating and controlling materials, parts and finished goods from supplier to customer
- Issues related to two distinct flows (material and information) through the organization

• Scope of Research Projects at RPI

- P1: Warehouses, Distribution Centers in Supply Chains
- P2: Manufacturing Systems with Product Variety
- P3: Original Equipment Manufacturer and Suppliers
- P4: Information Sharing in Supply Chains
- P5: High Mix/Custom Product Manufacturers

• Collaborators and Sponsors

- Universities, Industry, NSF



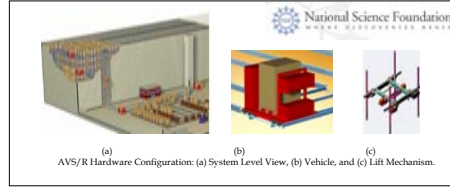
P1: Conceptualization Tools for Warehouse Systems

• Principle Investigators and Collaborators

- Prof. Malmberg (RPI) and Prof. Heragu (University of Louisville)

• Motivation

- AVS/RS: Vehicles for storage and retrieval operations (new technology)
- AS/RS: Cranes for storage and retrievals (old technology)



P1: Conceptualization Tools for Warehouse Systems

• Issues

- Device dwell point rules
- Lift seizure
- Blocking protocols
- Storage policy
- Load batching
- Dispatching rules

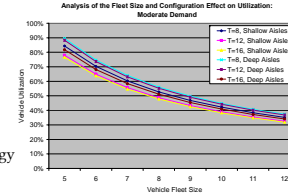
• Approach & Methodology

- New queuing models for unit load S/R systems
- New algorithms for performance evaluation

• Sponsor and Collaborator

- National Science Foundation, Material Handling Institute of America

• Students involved: Po-Hsun Kuo, Li Zhang



P2: Queuing Models for Systems with Product Variety

• Manufacturing environments with product variety

- Analysis of tradeoffs with respect to capacity, inventory and delivery
- Existing queuing models are not scalable to real environments
- Need new modeling methodologies for complex high variety systems

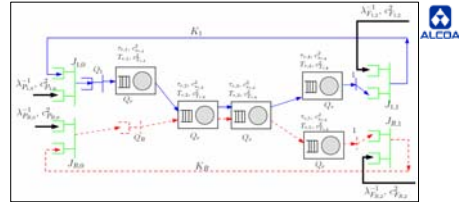
• Sponsor and Collaborator

- ALCOA (Davenport) facility - a mile long (128 acres) of hi-tech equipment
- Customers: Aerospace, Building, Communications, and Automotive



• Student involved: Kumar Satyam

P2: Queuing Models for Systems with Product Variety



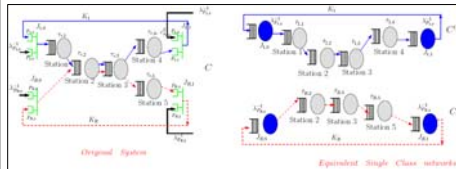
• Research Questions

- Effects of changes in product variety and product mixes
- Fixed versus flexible flow
- Bottlenecks in terms of rates and variability

• Approach and Methodology

- Parametric decomposition approach for open and closed queuing networks

P2: Queuing Models for Systems with Product Variety

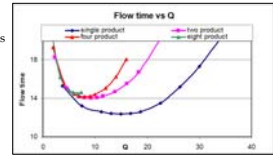


• Research Challenge

- Estimation of waiting times

• Research Insight

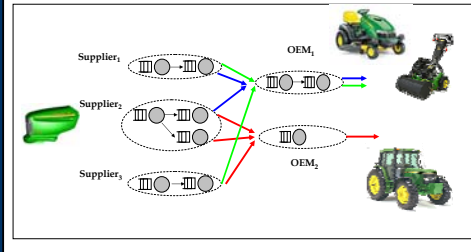
- Tradeoffs w.r.t product variety, batch size, flow times



P3: Design Optimization of Flexible Assembly Systems

• Research Motivation

- Some OEMs outsource 80% of their components and sub assemblies
- Assembly line shut downs could cost as much as \$50,000 per hour



P3: Design Optimization of Flexible Assembly Systems

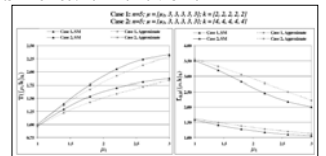
• Research Questions

- Flexible versus dedicated
- Variability: product mix versus process
- Optimize supply base, bill of materials

• Approach and Methodology

- Queuing analysis of kitting operations

• Students involved: Ram Ramakrishnan



P4: Information Sharing in Supply Chains

• Pull Systems with Advanced Demand Information

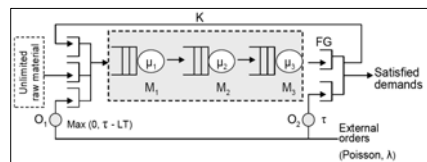
- Increased information sharing across supply chains (EDI, CFRP, ERP, RFID)

• Expectations due to Information Sharing

- When do I get my product? How much price cut do I get?

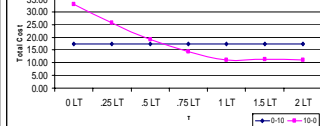
• Research Questions

- What is the benefit of integrating ADI into pull type PICS?
- How are the benefits sensitive to quality of ADI?



P4: Information Sharing in Supply Chains

• Total Cost vs. τ for $\lambda = 0.5$



• Benefits of ADI

- ADI can be used to shift towards MTO
- There are regions where ADI is beneficial

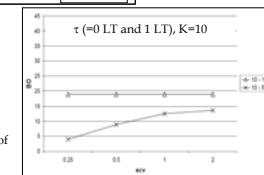
• Impact of Quality of ADI

- Backorders increase with variability of ADI

• Student: David Claudio

• Collaborator

- Prof. Viviana Cesani, Univ. of Puerto Rico, Mayaguez

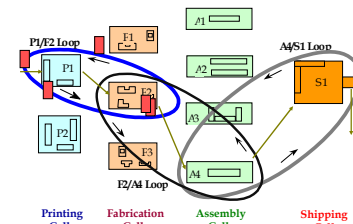


P5: POLCA Production Inventory Control Strategy

• Limitations of pull-kanban systems

- Possible proliferation of inventory in high mix environments
- Inability to operate in ETO/custom environments

Paired-cell Overlapping Loops of Cards with Authorization



- A strategy tailored for high mix, custom environments

P5: POLCA Production Inventory Control Strategy

• Characteristics of POLCA

- POLCA is not a replenishment signal, it is a capacity signal
- POLCA cards are not specific to a part, but a pair of cells
- POLCA cards stay with a job through both cells
- Authorizations prevent allocation of capacity in absence of demand

• Implementation Results

- Rockwell Automation (Cambridge, Ontario)
- Reduced WIP by 30%, increased output by 18%

• Ongoing Research

- Analytical models for performance comparison

• Collaborators

- Center for QRM, Univ. of Wisconsin-Madison
- Center for Economic Growth, NY

