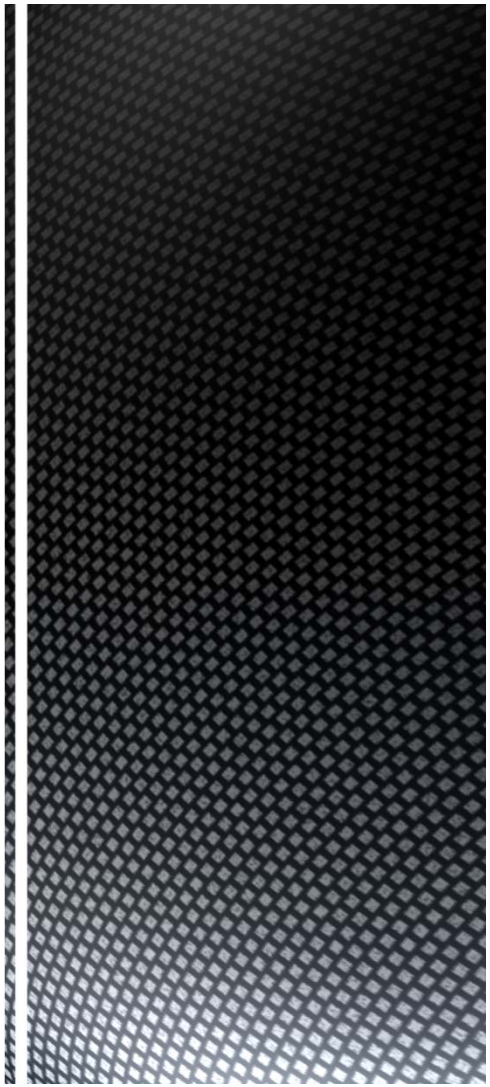
# *CIM (21-548)*

*Advanced Manufacturing Laboratory*
*Department of Industrial Engineering*
*Sharif University of Technology*

*Session # 9*



# *Course Description*

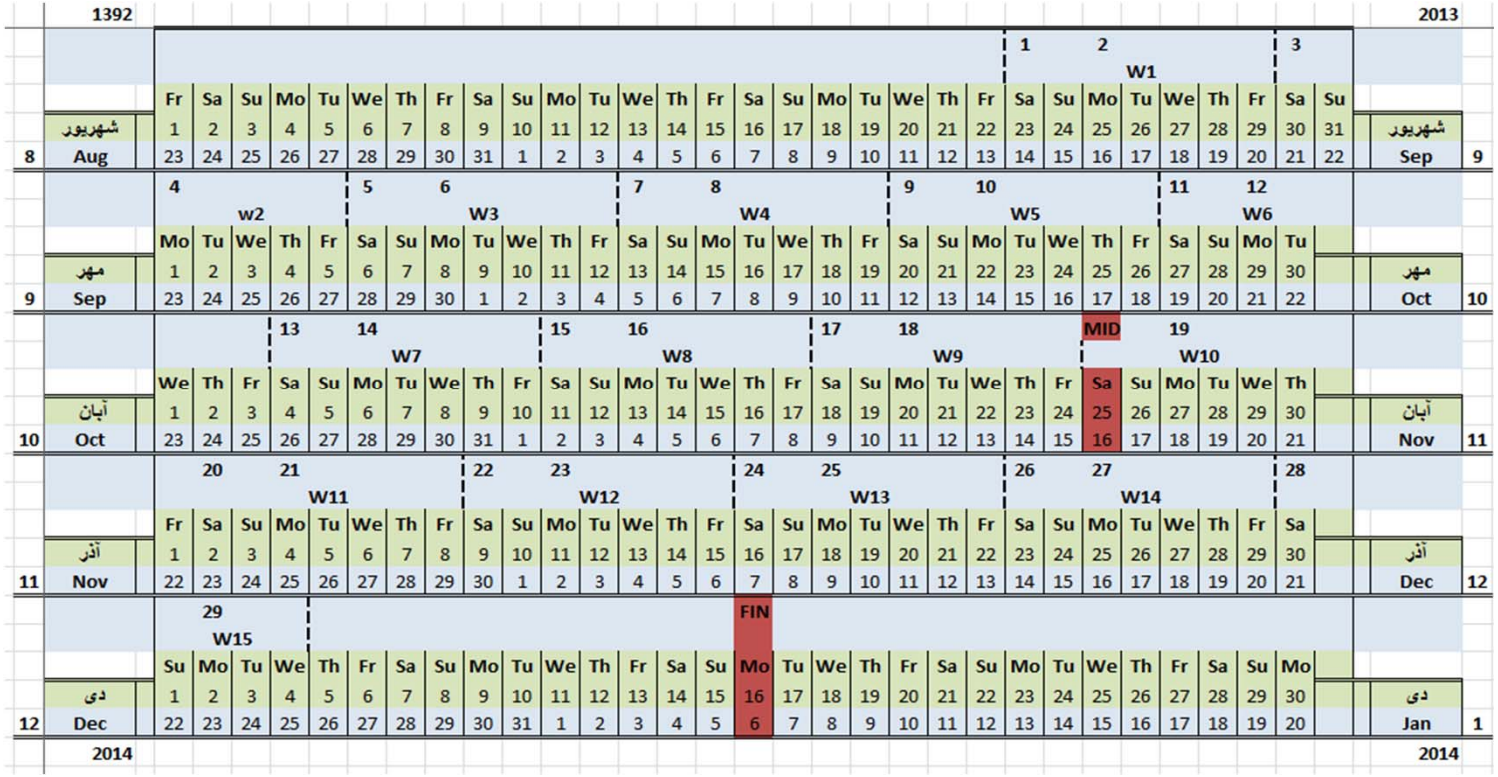
- *Instructor*
  - *Omid Fatahi Valilai, Ph.D. Industrial Engineering Department, Sharif University of Technology*
  - *Email: FValilai@sharif.edu , Tel: 6616-5706*
  - *Website: Sharif.edu/~fvalilai*
- *Class time*
  - *Sunday-Tuesday* *09:00-10:30*
- *Course evaluation*
  - *Mid-term* *(30%)*
  - *Final exam* *(50%)*
  - *Quiz* *(5%)*
  - *Exercise* *(15%)*

# *Course Description* *(Continued ...)*

- *Mid-term session:*
  - *Sunday: 16th Azar 1393, 09:00 ~ 10:30*
- *Final Exam:*
  - *Tuesday: 30th Dey 1393, 15:00 ~ 17:30*
- *Reference:*
  - *Schaefer, D., Cloud-based Design and Manufacturing (CBDM): A Service-Oriented Product Development Paradigm for the 21st Century, . London: Springer, 2014*
  - *Koren, Y., "The Global Manufacturing Revolution", Wiley, 2010*
  - *Nasr, A., "Computer-Based Design and Manufacturing An Information-Based Approach",Springer, 2007*
  - *Mitchell, F.H., "CIM Systems: An Introduction to Computer-Integrated Manufacturing", Prentice Hall College Div; 1St Edition edition (January 1991), ISBN: 978-0131332997*

# *Course Description* *(Continued..)*

- *Course Calendar:*



| 1392 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2013 | |
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| | | | W15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2014 | |

# *Course Description* *(Continued..)*

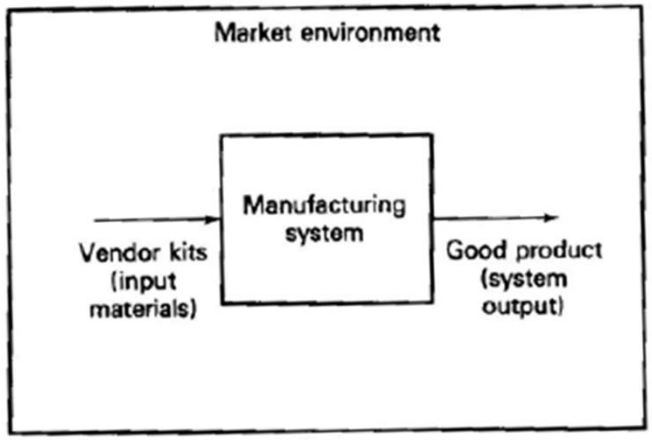
- *Contents:*
  - *Globalization and Manufacturing Paradigms* *(8 sessions)*
  - *System Concepts* *(3 sessions)*
  - *Evolution of Manufacturing systems* *(2 sessions)*
  - *Manufacturing System Design* *(4 sessions)*
  - *Manufacturing Equipment Design* *(3 sessions)*
  - *Information flow in Manufacturing Systems* *(4 sessions)*
  - *Product design and Manufacturing System* *(3 sessions)*
  - *Manufacturing System Implementation* *(5 sessions)*

# *Course Description* *(Continued..)*

- *Contents:*
  - *Manufacturing System Design* *(4 sessions)*
    - *Problem definition*
    - *Computer Integrated Manufacturing*
    - *Design principles*
    - *A multi-layer model for study of design principles*
    - *Implementing system design concept*

# *Manufacturing System Design*

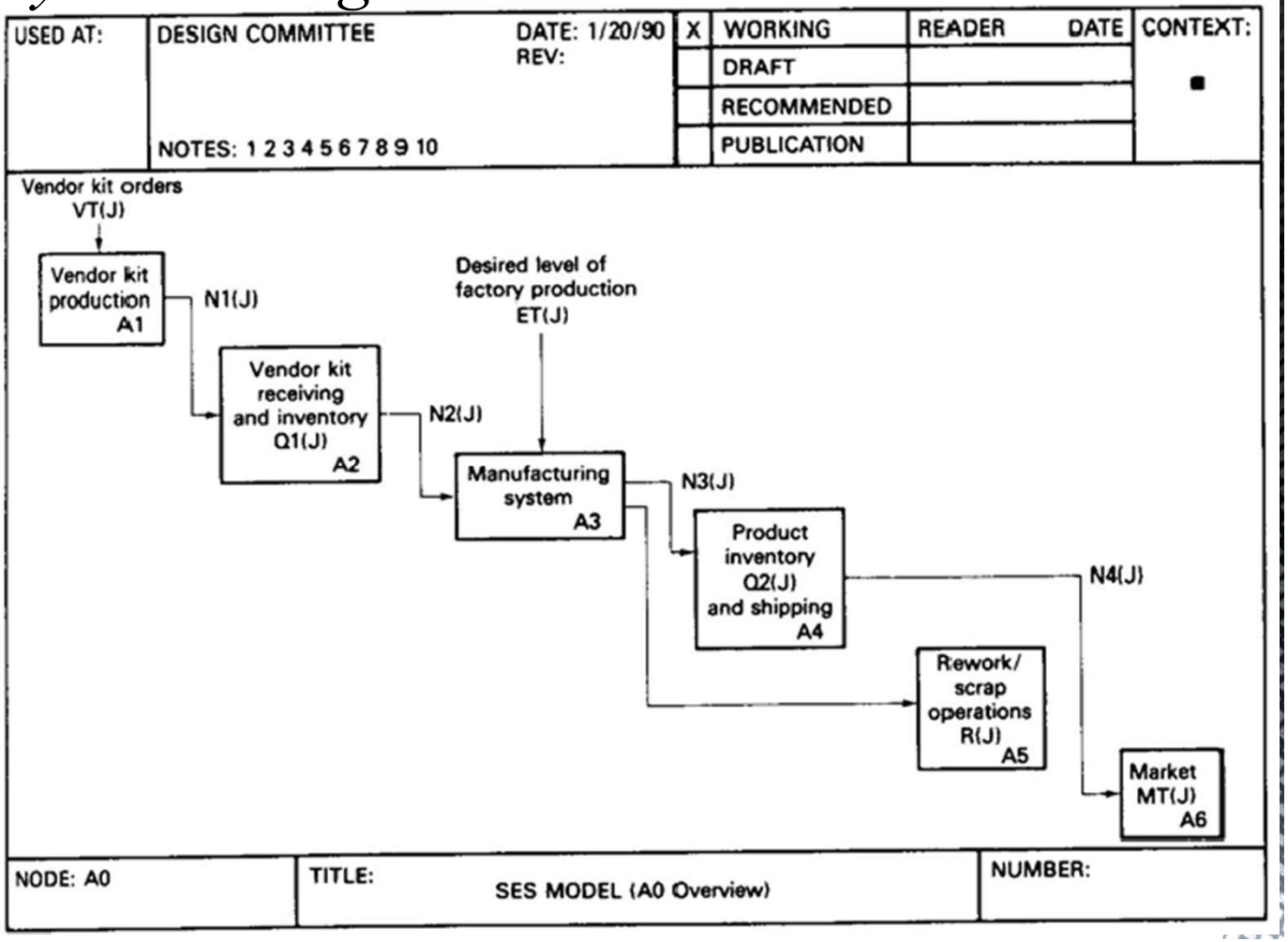
- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *The effects of various design choices on manufacturing system performance can be summarized by means of a system-environment simulation (SES) model.*
  - *The SES model is a simple planning and evaluation tool. This model provides a rough-cut , approximate method for use in considering some of the performance aspects of a manufacturing system within its environment.*



# *Manufacturing System Design*

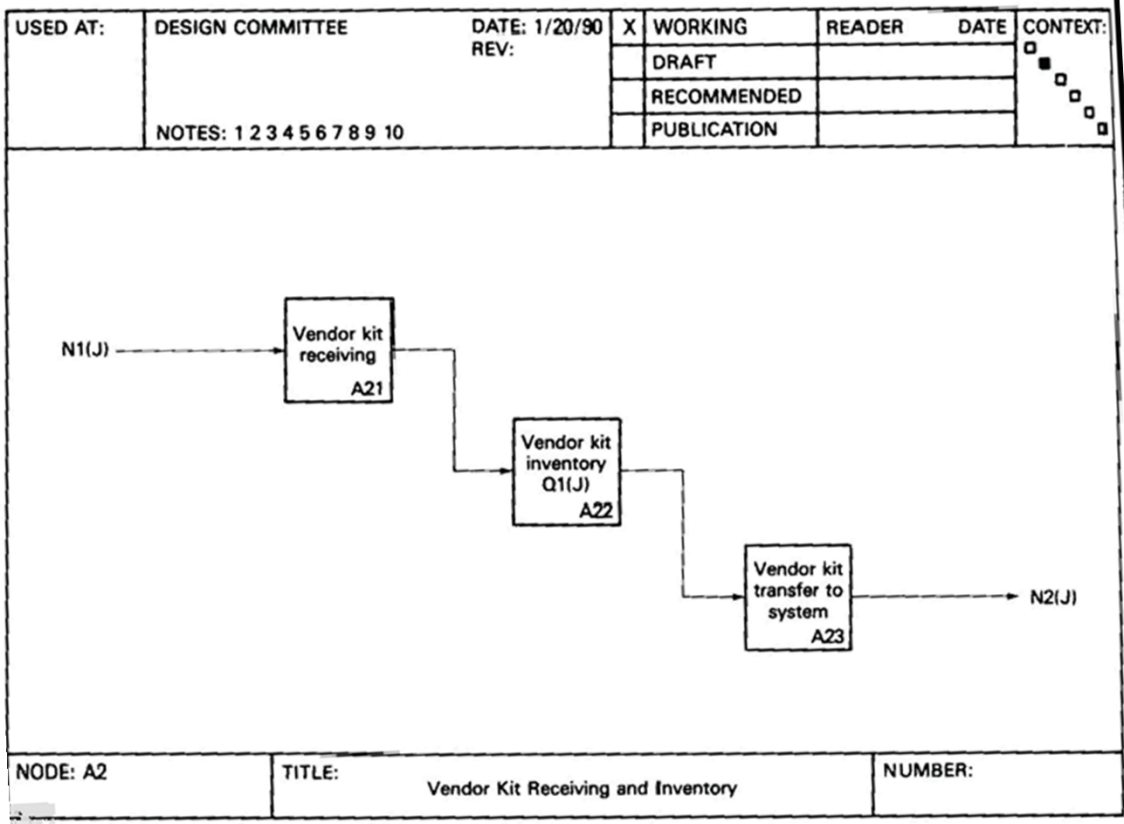
- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *The vendor kit orders VT(J)*
  - *The desired level of factory production ET(J)*

  *Both control the manufacturing system and the vendor.*



# *Manufacturing System Design*

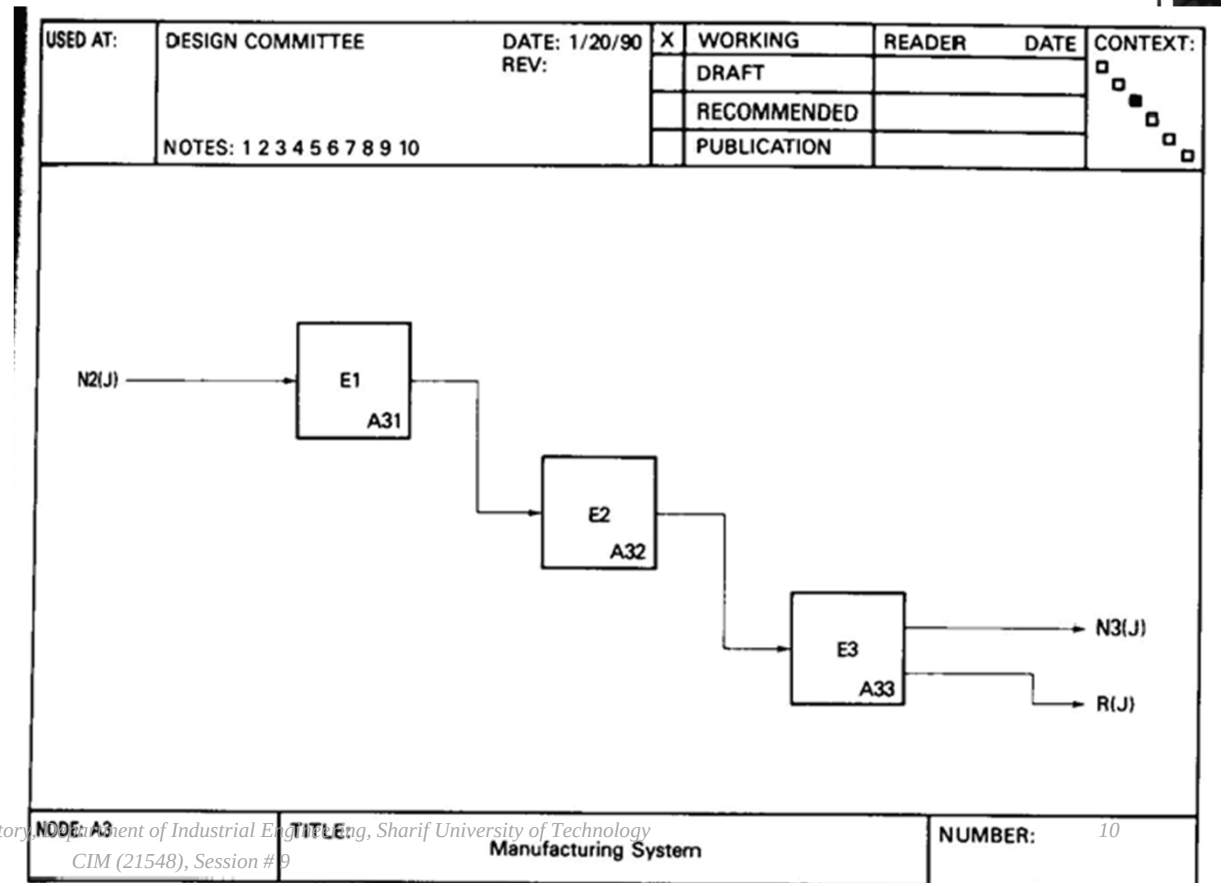
- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *Once vendor kit orders are received, a number of steps may take place, producing a delay before vendor kits are shipped to the manufacturing system, represented by NI(J)*
  - *A receiving function, inventory function, and transfer-to-system function, thus further subdividing the system: NI(J), QI(J), and N2(J)*




(c)

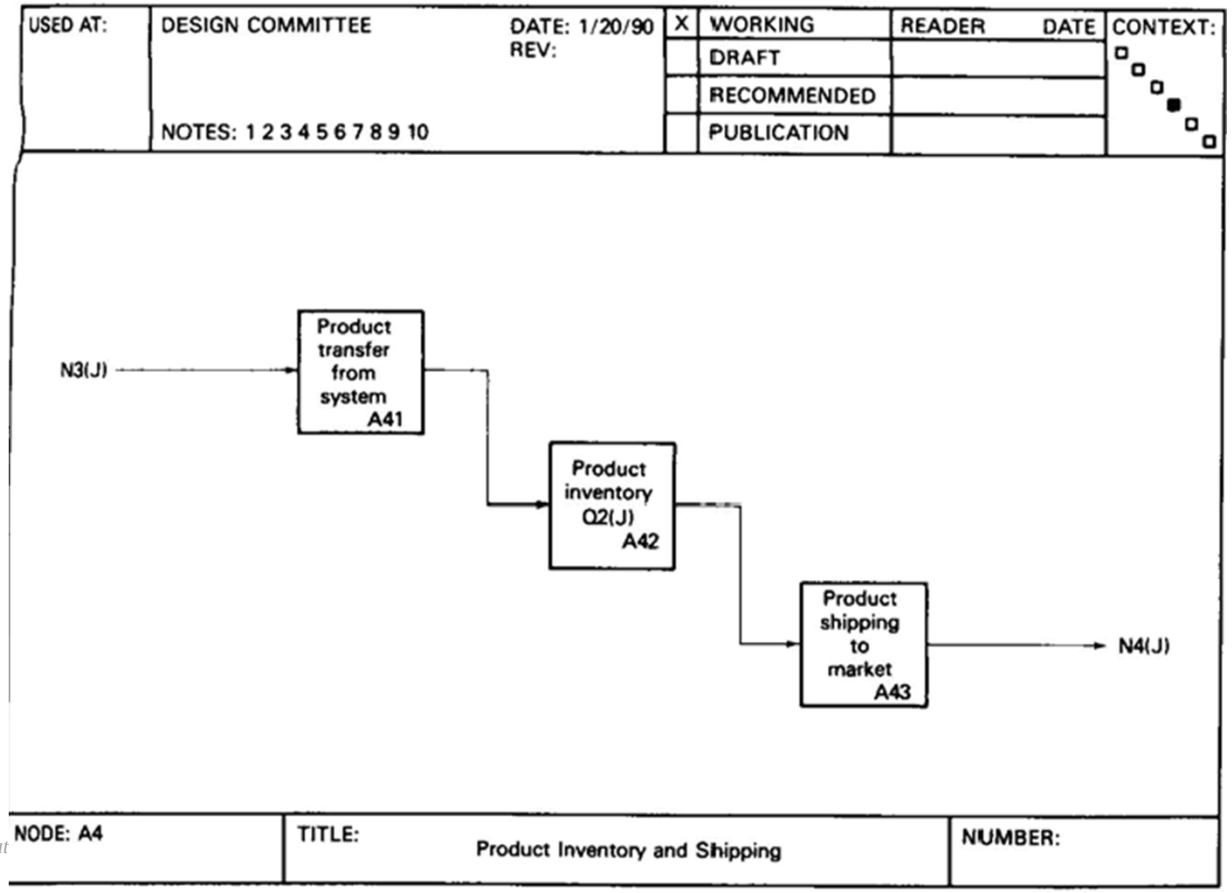
# *Manufacturing System Design*

- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *The arrival of the vendor kits N2(J)*
  - *The shipment of good product N3(J),*
  - *The shipment of product to rework or scrap R(J).*



# *Manufacturing System Design*

- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *The arrival of the finished work in shipping is represented by N3,*
  - *N4 represents the actual sales to the market from shipping.*
  - *If, in any time increment, the volume of sales to the market is less than the volume of goods arriving in shipping, then the excess factory production will go into product inventory Q2.*



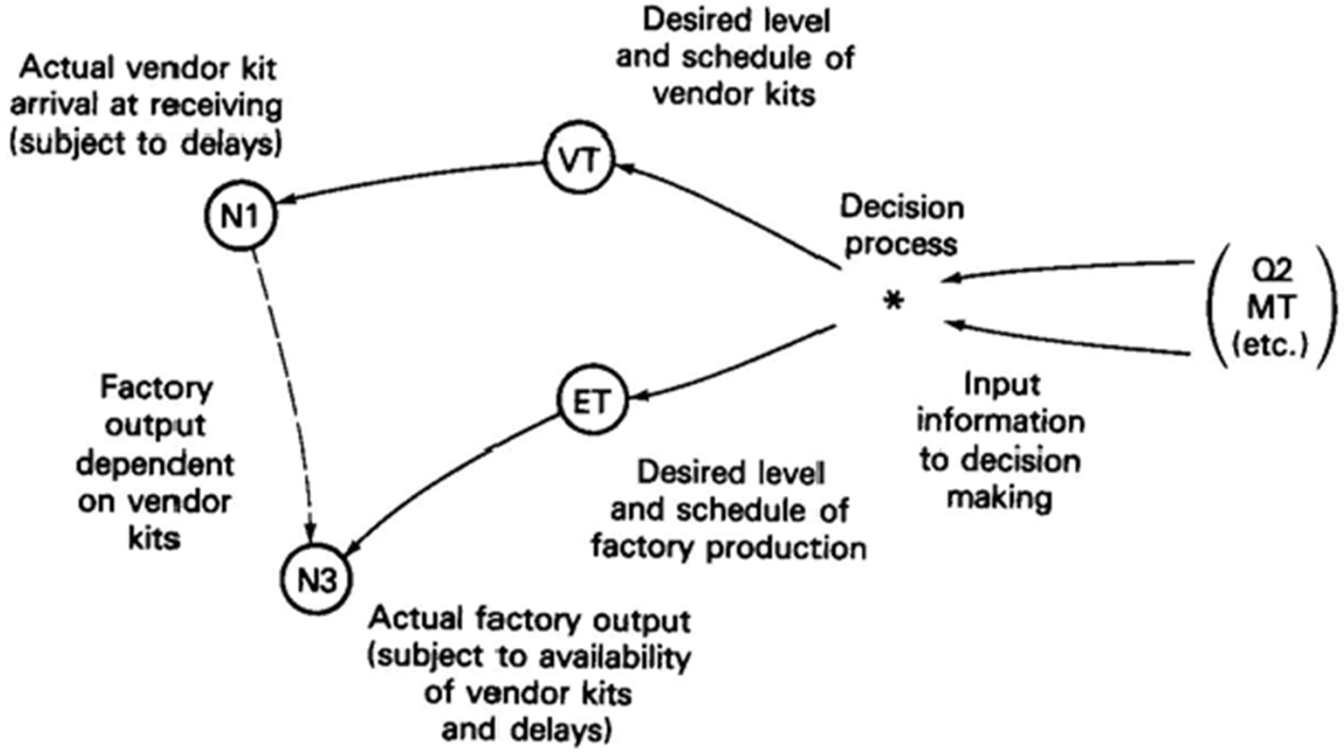
# *Manufacturing System Design*

- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *A decision-making loop determines the level of*
    - *Purchasing from vendors (VT) and*
    - *The desired level of production in the factory (ET).*
    - *The feedback loop uses information on the product inventory (Q2) and*
    - *The market (MT) as basis for placing*
    - *Vendor orders (VT) and for*
    - *Determining the desired level of factory production (ET).*

    - *The variable MT determines the market sales that are possible.*

# *Manufacturing System Design*

- *A Simple Introductory Model for Studying System-Environment Interactions*



# *Manufacturing System Design*

- *A Simple Introductory Model for Studying System-Environment Interactions*

| | |
|---|---|
| MT(J) | Maximum number of finished products that can be sold by the factory to the market at the time defined by J |
| VT(J) | Number of vendor kits ordered at the time defined by J |
| NI(J) | Number of vendor kits delivered to the receiving unit of the factory at the time defined by J |
| N2(J) | Number of vendor kits delivered to the factory from receiving at the time defined by J |
| Q1(J) | Number of vendor kits stored in receiving inventory at the time defined by J |
| ET(J) | Level of desired factory production that is set by the decision-making loop (actual production may be less than ET if an insufficient number of vendor kits, N2, is available) |
| EMAX | Maximum number of products that can be produced by the factory at the time defined by J |
| U | Efficiency rate of the factory equipment |
| R(J) | Number of vendor kits lost to rework or scrap at the time defined by J |
| N3(J) | Number of (good) products transferred from the factory to shipping at the time defined by J |
| N4(J) | Number of products sold to the market at the time defined by J |
| Q2(J) | Number of products in inventory at the time defined by J |

# *Manufacturing System Design*

- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *Relationships among suppliers, factory operations, and the market can be specifically illustrated.*
  - *The impact of decision making on kit inventory and product inventory can also be specifically studied.*
  - *The effects of different types of decision-making feedback loops in the system can be demonstrated directly.*
  - *Delays associated with the provision of vendor kits and with factory production can also be illustrated.*
  - *It is also important to be able to describe the financial performance of such a system; the ultimate measure of system performance is often related to financial parameters.*

# *Manufacturing System Design*

- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *The cost per unit sold $C depends on*
    - *The fixed daily costs ($FC),*
    - *The variable costs per unit ($VC),*
    - *The vendor kit daily storage costs ($VD), and*
    - *The output product daily storage cost per unit ($ST).*

# *Manufacturing System Design*

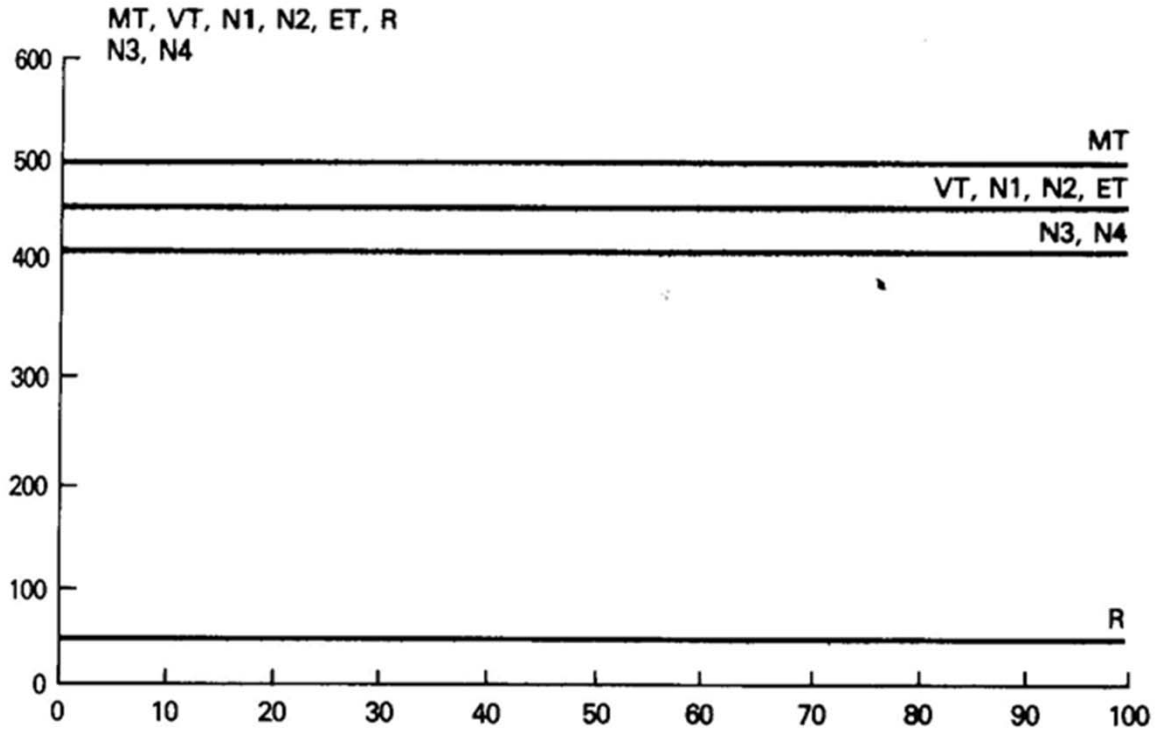
- *A Simple Introductory Model for Studying System-Environment Interactions*
  - *The cost per unit sold $C*

$$\$C(J) = \frac{\$FC + \$VC * (N3 + R) + \$VD * Q1 + \$ST * Q2}{N4}$$

$$(\$C)_{AV} = \frac{\sum_{J\,min}^{J\,max} \$C(J)}{\sum_{J\,min}^{J\,max} N4(J)}$$

# *Manufacturing System Design*

- *A Simple Introductory Model for Studying System-Environment Interactions*



# *Exercise: CM:I:07*

- *Developing Models of Manufacturing Systems*

ELSEVIER

Journal of Manufacturing Systems

Volume 32, Issue 4, October 2013, Pages 543–549


Technical paper

## A conceptual model for assisting sustainable manufacturing through system dynamics

Hao Zhang, Javier Calvo-Amodio, Karl R. Haapala

DOI: 10.1016/j.jmsy.2013.05.007