Effect of

Model Based Simulation **&**

Quality Function Deployment and Environmentally Conscious Design

In manufacturing Organizations.

PROBLEMS IN MANUFACTURING INDUSTRIAL SYSTEMS

- **Major**
  - Inefficient engineering management → decline in performance of manufacturing organizations.

- **Minor**
  - Disjointed activities
  - Decline in the market shares
  - Absence of methodology governing the integrated use of tools and available resources
  - PFS project failures → Loss of productivity

PURPOSE

Investigate the effects of MBS, QFD, and ECD on Manufacturing Industries.

NIMA GROUP LLC RESEARCH DESIGN

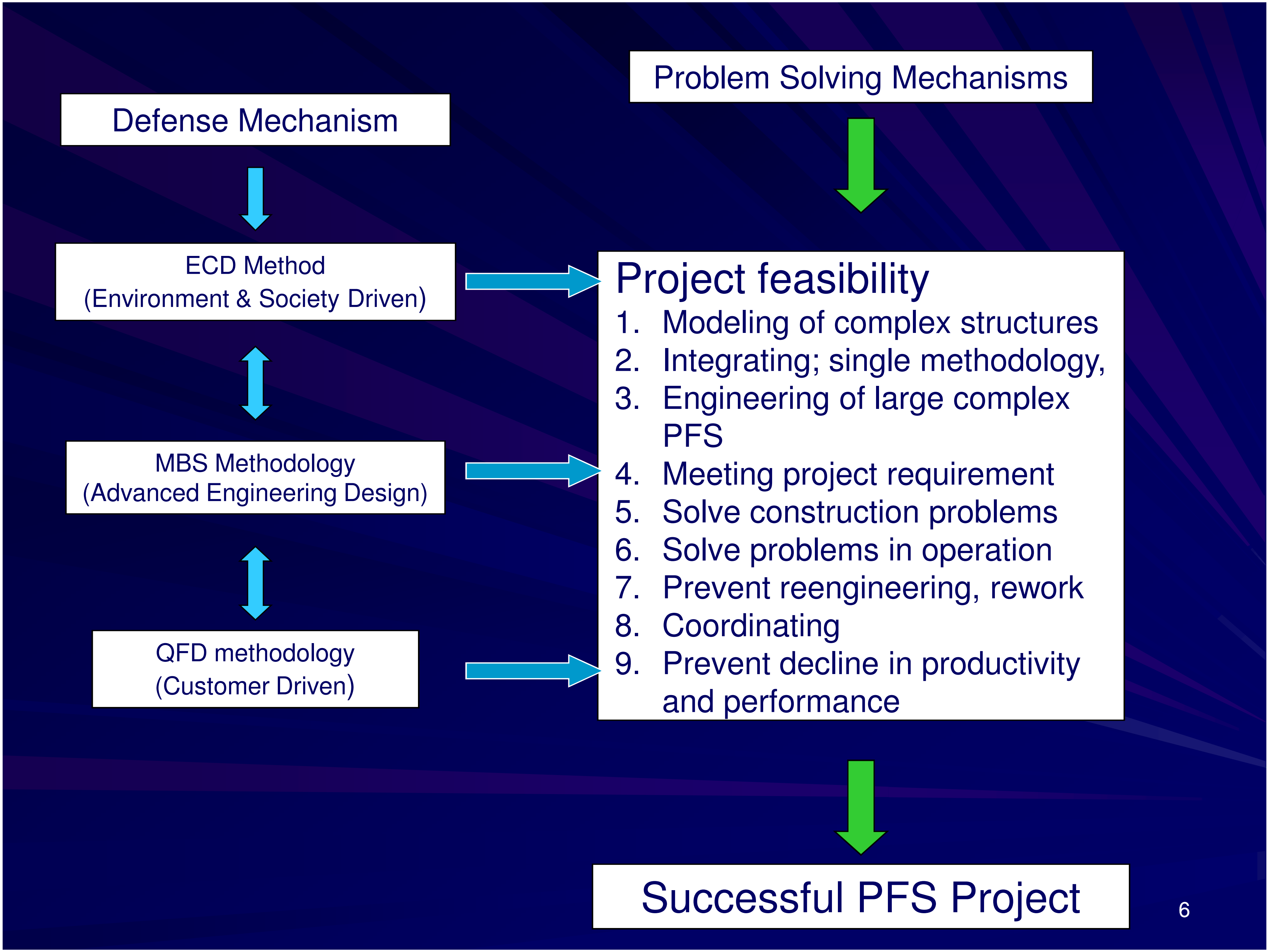
1. Explain the phenomenon
2. Establish relationship between variables
3. Compare between
   - variables,
   - prediction, and
   - analysis.
4. Outline the major design, approaches, and methodologies to demonstrate -
   - How the conceptual integration of MBS and QFD methodologies can improve the PFS processes in the auto industry.
   - Ways to resolve inefficiency, lack of coordination, and poor engineering management.
5. Evaluate, compare and contrast among variables case by case in an attempt to establish a relationship from financial performances of the case study company.

Experiments and Data Collection

- **CASE STUDY COMPANY** – *Eisenmann Corporation, Crystal Lake, IL, USA*

  Results of 12 PFS projects from various locations in the U.S. and Canada for various OEM and Tier-1 suppliers were evaluated.

- **MBS Experiments Conducted**
  - Tank Model-1, in Eisenmann Corp. Shop -
    - To solve problems of deflection, scrap, production loss and accidents (Tower Belleview)
  - Tank model-2, in Eisenmann shop.
    - To solve cracking, corrosion, passivation, safety, contamination and ECD problems (Freight liner).
  - Vibration problem on cantilever – in MBUSI plant -
    - To solve production loss, scrap, noise reduction, and safety (MBUSI)
  - Integrated Structural Model on EMS-
    - To optimize Cost, fabrication, erection, space etc. (HMMA).
  - Integrated structural model with handrails -
    - For quality and strength problems - 11,000 pull tests on 1,480 modules - in plant.
  - 7 MBS experiments in shop to verify field MBS – by measuring stress and deflection (MBUSI-Comu Pico).
  - Hydraulic Model Study –
    - Field experiment to solve paint sludge discharge and backwater- Ford St. Thomas.
  - 4- Complete MBS, QFD, and ECD studies at Eisenmann shop
    - To solve combined installation, performance, commissioning and operation problem for MBUSI, Freightliner, Mobis, and Plastic Omnium PFS projects


Problem Solving Mechanisms
Defense Mechanism
ECD Method
(Environment & Society Driven)
MBS Methodology
(Advanced Engineering Design)
QFD methodology
(Customer Driven)
Project feasibility
1. Modeling of complex structures
2. Integrating; single methodology,
3. Engineering of large complex PFS
4. Meeting project requirement
5. Solve construction problems
6. Solve problems in operation
7. Prevent reengineering, rework
8. Coordinating
9. Prevent decline in productivity and performance
Successful PFS Project

Typical Cases

Housing, Tank, Vario Shuttle (VS)

Crack on Tank Floor

Paint Sludge discharge in sludge basin

Detecting Project Failures

Financial failure

1. Poor project feasibility study.
2. MBS,QFD, ECD not incorporated.
3. Poor sales
4. Low profit margins
5. Excessive project development cost
6. Project development took longer time than expected.
7. Marketing activities poor.
8. Competitors price lower than the project
9. Risk analysis- on new project.
10. Federal/ state legislation changes.
11. Personal experiences.
12. Lack of planning
13. Changing requirements or scope
14. Lack of resources
15. Undefined project schedule, end date, unclear deliverables

Technical failure

1. Influencing factors of financial failures.
2. Incompetent suppliers.
3. MBS+QFD not incorporated.
4. Poor quality of products.
5. Unable to meet the design criteria.
6. Technical difficulties with the product.
7. No marketing need for this product.
8. Maintenance cost is too high due to wear and tear.
9. No field verification.
10. Poor engineering and design criteria
11. Lack of communication
12. Trial and error method of engineering

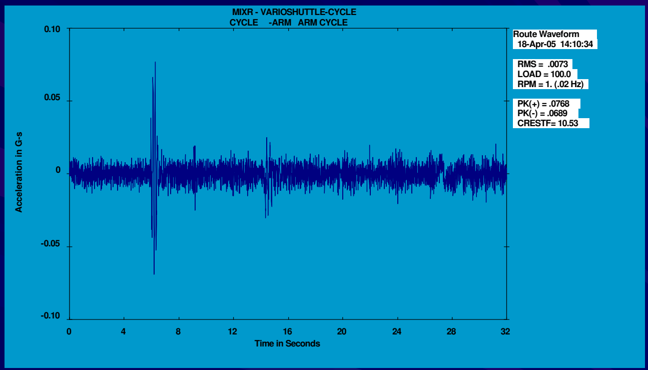
Results

Case Study - 1

- **Lack of full coordination**
- **Lack of complete MBS, QFD, and ECD integration**

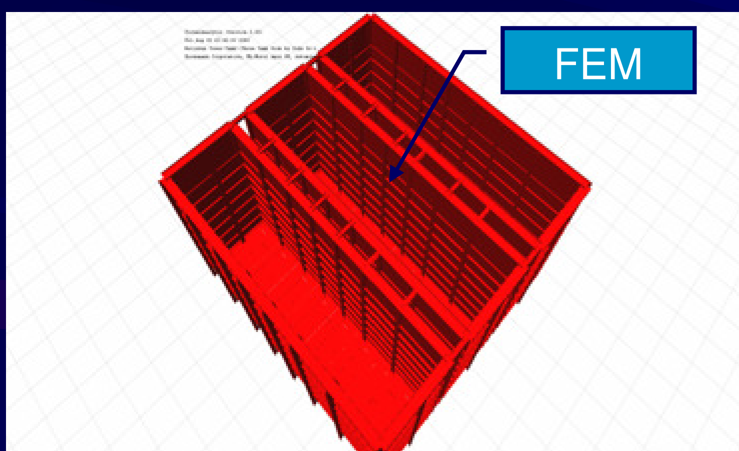
Problem in completing the project on time and within budget.

Case study - 2



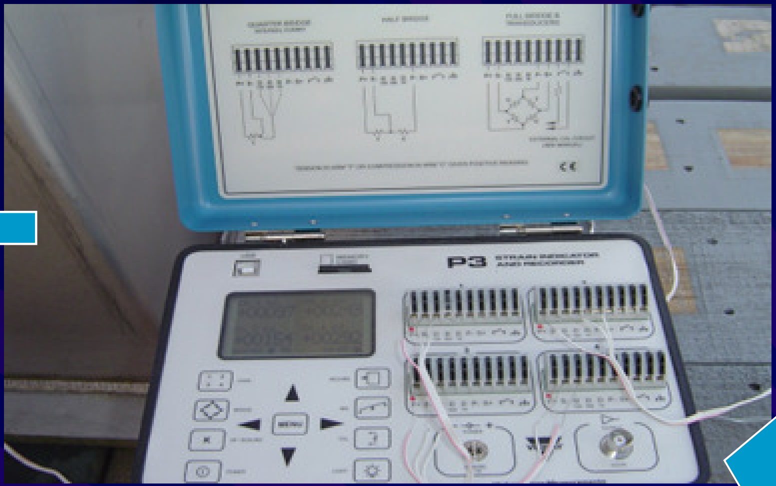
Innovative VS cause only 0.2% scrap compared to 0.3 % for P&F conveyor ~ US$5million/year saving, saving of 3.5 million from building shortening.

Case Study - 3
(MBS Experiment on Tank)

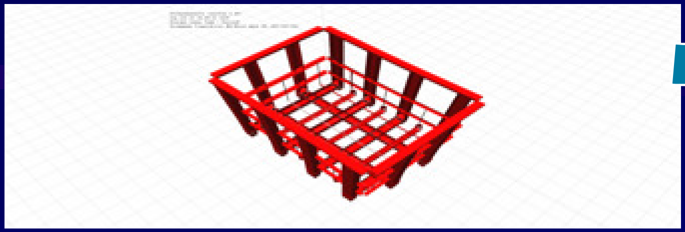


The hoist structures had problems of excessive lateral deflections and vibrations resulting in damage to tanks, parts, interruption of the process and severe damage to hoist wheels moving over the crane beams.

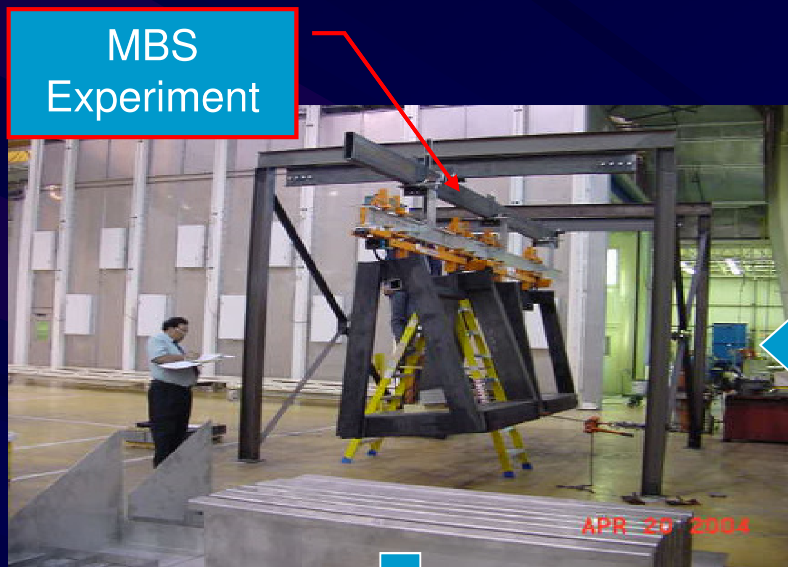
Case Study - 4

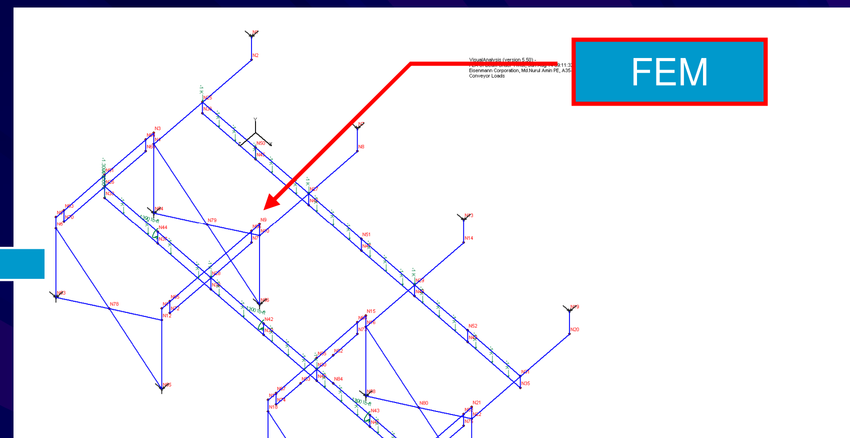


Vishay Instrument set up for Measuring the Strains of Tank Plates, reduced cracks



Case Studies 5 & 6





- More than 5 miles of conveyors with different loading.
- About 95% of them are suspended from two existing buildings area= 400,000 square feet.
- The combined weight of the total PFS project was about 15% of the total cost of the project.
- Non building structural steel for conveyor supports more than 5,000 tons.

Findings

The research findings for the 12 case studies of PFS projects with regard to the case study company's performances are summarized as follows:

- Positive performance of the company depended on how efficiently MBS, QFD, and ECD were integrated.
- Innovative design of the VS had a positive effect on performance.
- Extra field costs of 12.5% of the total sales cost were the result of inefficient management of some engineering projects in PFS.
- Lack of integration and interfacing in MBS, QFD, and ECD methodologies in PFS projects had a negative impact on the company.
- Inefficiency in project coordination, led to projects not meeting schedule, time and budget.

- The one-factor-at-a-time design paradigm, and trial and error methods instead of advanced tools and techniques, caused substantial delays and eroded profits in some PFS projects.

- Poor sales of PFS projects by sales engineers resulted in negative performance in some of the projects even though advanced engineering MBS and partial QFD and ECD were adopted.

- Integration of MBS, QFD and ECD methodologies in the manufacturing company shop on prototype testing in some PFS projects resulted in high performing PFS projects.

- Price wrangling for large PFS projects wasted time that would have been better used for proper engineering, project reviews and fixing layout on complicated PFS projects.

- Excessive pressure on PFS project suppliers for some projects compelled the case study company/suppliers to take unnecessary risks in winning the projects.

- Inadequate information for the PFS projects, inaccurate customer specifications and improperly developed project layouts resulted in an inaccurate estimation of project cost by the PFS supplier.

- In addition, a significant amount of time was consumed in correcting building problems; thus, completion of a PFS project took an excessive amount of time.
- Positive performance in the case study company resulted in more resources being allocated for R&D and MBS study for innovative design of products.

- The integrated MBS, QFD, and ECD paradigm cannot ignore any part of the combined model.

- Integrated MBS, QFD, and ECD for PFS projects guaranteed positive performance by avoiding design flaws and saved more than 12.5% extra field costs.
- The 12 PFS projects in the case study company were a representative sample of the auto industry and enabled to draw conclusions.
- A defective project affected the respective automakers several times more than the case study company.
- The cost of conducting the MBS study was found to be less than 1% of the total project cost.

Conclusions

- The integration of MBS, QFD, and ECD methodologies was found to be an effective, efficient, and economically sound means.
- The educational and practical experiences of MBS, QFD, and ECD team members should be integrated to strengthen management skill.
- Experienced professional engineers should work in the MBS, QFD, and ECD teams to model complex systems of PFS.

- The integration of MBS, QFD, and ECD methodology was found to be the dominant mode of manufacturing.
- MBS, QFD, and ECD integrated methodology study enabled accurate examination of non-building process-sensitive PFS project
- Examining MBS on prototype structures in the shop generated and communicated important structural information to QFD and ECD team members.
- To establish positive, sustainable overall performance, changes in the PFS process must be coordinated with a set of changes in management structures.
- The integrated MBS, QFD, and ECD methodology created a defensive mechanism against project failure.

- Without proper design criteria, reviewed by MBS, QFD, and ECD teams, suppliers will not be able to detect and amend the defects.
- The cost of conducting the MBS, QFD, and ECD integration was less than 1% of the total PFS project sales cost.
- Automakers should collaborate with the PFS project suppliers in the integrated MBS, QFD, and ECD teams.
- Only by having a FEM of the typical structure verified by MBS experiments the behavior of a non-building structure can be predicted.
- The model can be used on other PFS projects that have the same design criteria and environmental conditions.

- Poor performances on some PFS projects resulted in wastes of resources
- The cost of reengineering reworks caused substantial loss of positive performance.
- A defective project affected the respective automakers because of the production loss.

Social Impact

- Integrated MBS, QFD, and ECD teams can prepare an environmental impact statement (EIS) for proposed PFS projects that significantly affect the quality of the human environment.

- By providing high quality products and reducing the amount of landfill waste, the auto industry reduces the cost to society.

- Success for the PFS supplier will lead to success for the entire auto industry if other PFS suppliers adopt this integrated methodology.

- The economy and loss of jobs will improve, which, in turn, will contribute to the country’s prosperity and will also have a positive social impact.

- The efficacy of the integrated methodology can be examined for PFS project implementation experiences to foster social change both at the national and international levels.

- Through this integrated technique complex problems of the auto industry can be solved and that will alleviate the surrounding human problems and social change, will start.

Recommendations

- Eliminate trial-and-error methods of engineering problem solution.
- Avoid disjointed activities.
- Integrate MBS, QFD, and ECD methodology. Inefficiency and poor engineering management could be eliminated.
- Increase coordination and communication among teams.
- Involve engineering professionals from different disciplines.
- U.S automakers should award PFS projects to prospective bidders based on their ability to incorporate integrated MBS, QFD, and ECD methodology.
- Improve efficiency in executing PFS projects.

- Integrated MBS, QFD, and ECD methodology on PFS projects will have on auto industry management decisions in selecting suitable PFS turnkey supplier companies.
- Future research could include other innovative designs rather than Vario Shuttle of the case study company in the integrated MBS, QFD, and ECD methodology.
- More research should include additional work with FEM and the design tools that support the structural modeling process.
- Engineering management and organizational issues can be addressed by future research that might include additional research parameters for multidisciplinary team.

Concluding Remarks

- The complex task of PFS design and implementation requires in- depth application knowledge.
- The results of this complex experimental research study indicated that integrated MBS, QFD and ECD methodology improves the performance of the manufacturing organizations.
- It is this writer’s hope that integration of these methodologies, which is technically feasible and economically viable, will in time gain wider acceptance under a new engineering management development program, where it will play an important and relevant role in the automotive and other industries.