Application of Simulation in Hospital Bed Development

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Abstract

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Until recent development, simulation techniques have had only targeted application within the hospital bed and accessory market. With requirements for these products becoming more sensitive to weight and care giver safety, this application must be significantly expanded. Additionally, driving the use of simulation is a more competitive market place. New products must realize commercialization sooner than ever before. Simulation not only provides benefits from an engineering and performance perspective, but reduces development costs and time to market. As an extension to simulation, automation can greatly increase efficiency. This presentation describes simulation usage in this environment and the return on investment which may be possible.

Introduction

Hill-Rom helps healthcare professionals around the world create safer, more efficient and clinically-effective patient care environments and processes that improve the overall quality and cost of care delivered to patients in acute, long term and home care environments. One facet of this is through the design and manufacture of medical devices which include hospital beds and other patient care systems. A focus of research and development has been on improving care giver safety. This is realized in more simple care giver interfaces, decreased actuation forces, and significantly lighter products.

Like other industries, Hill-Rom is sensitive to market pressures. It is critical that we provide the market with useful products in accelerated development cycle times.

Problem Definition

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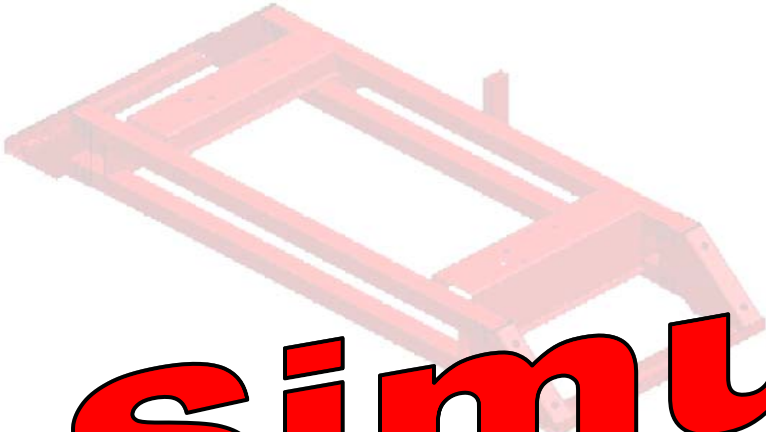
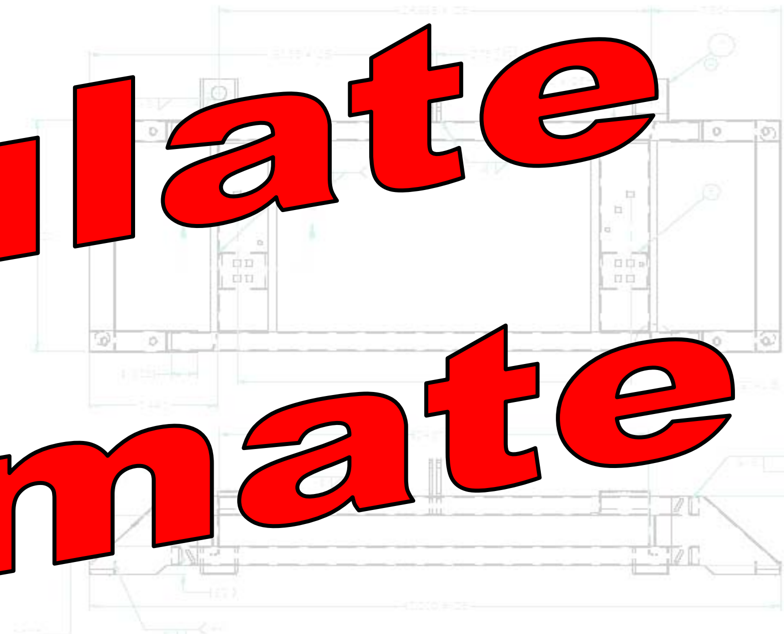
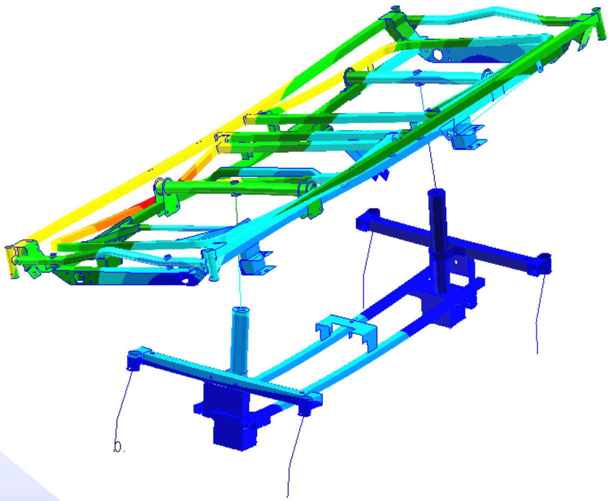




Simulate

Automate

Simulation



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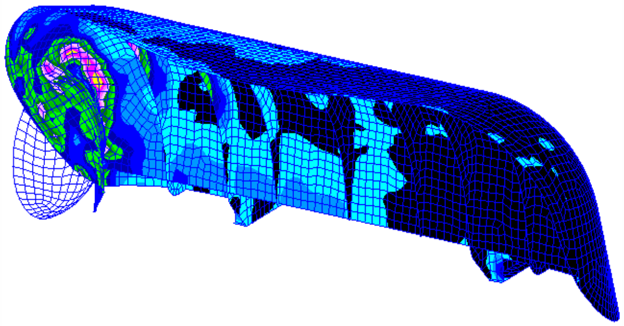
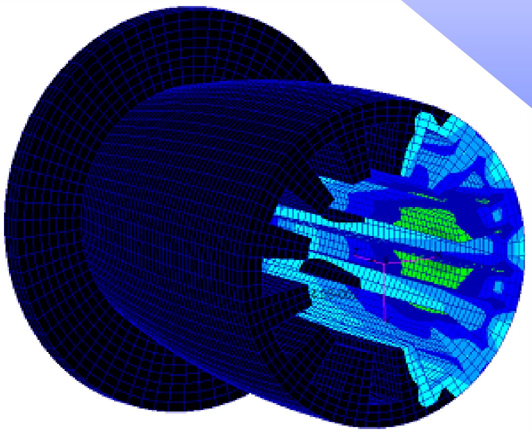
Linear Modeling

Nonlinear Modeling





Dynamic Modeling

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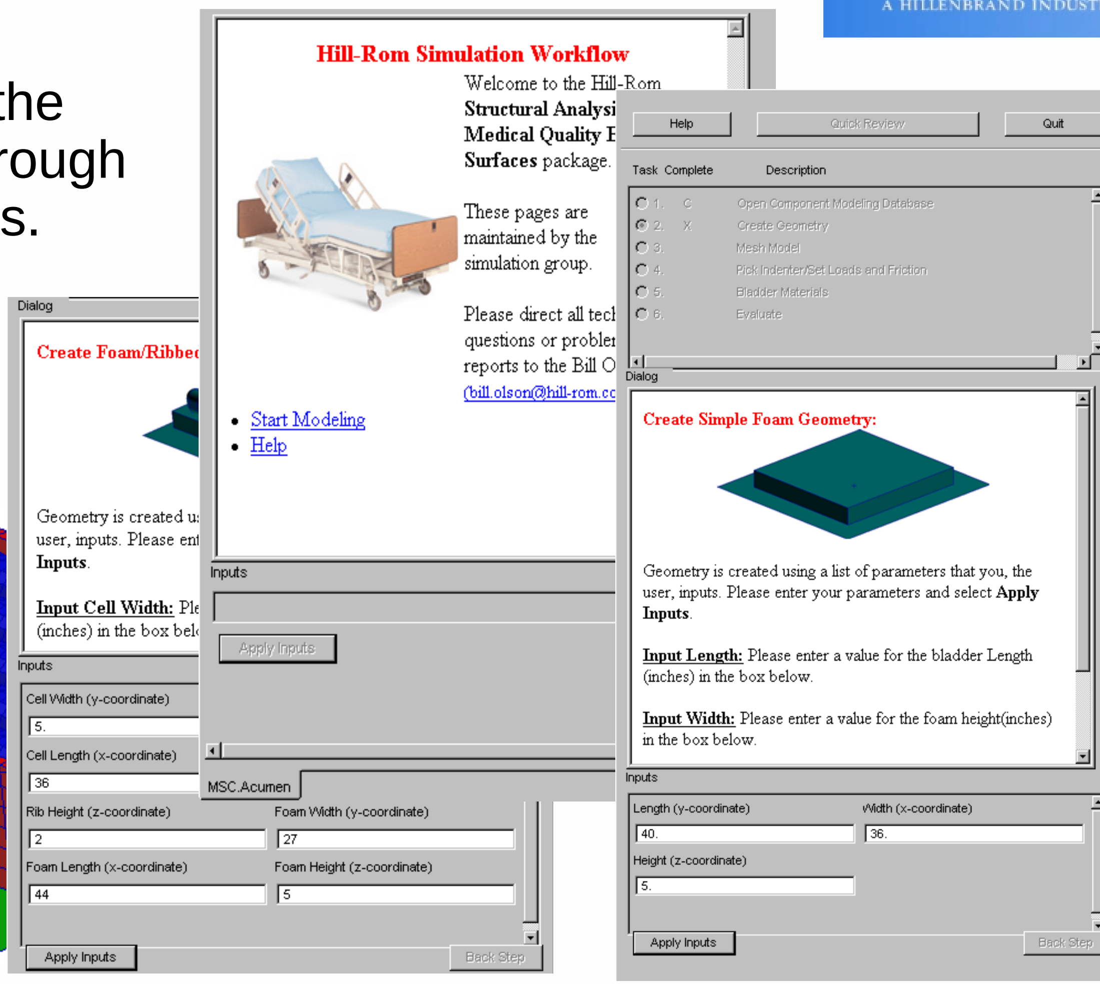
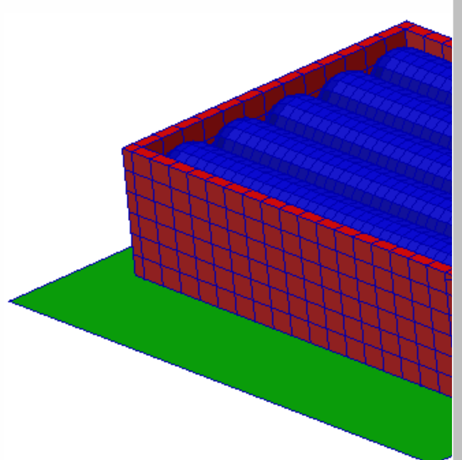
Automation

Automation can extend the benefits of simulation through modeling efficiency gains. Automation can be accomplished through a custom developed environment





Return on Investment

This ROI example is based on a recent effort to develop a simulation process for a major subsystem and automate it within an easy-to-use tool. After a basic process cost comparison is completed, four ROI models are evaluated

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Break Even
- Intangibles

ROI-Baseline Process Cost Evaluation

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A Design Structure Matrix (DSM) approach is utilized to determine both the baseline cost and the improved process cost.

<u>Baseline Process</u>

		1	2	3	4	5	6	7	8			
Identify Requirements	1		0	0	0	0	0	0	0			
Design Concept Model	2	1		0	0.8	0	0	0	0			
Build Physical Concept Prototype	3	0	0.8		0	0	0	0	0	0	0	0
Perform Physical Testing - Concept Model	4	0	0	1		0	0	0	0	0	0	0
Incorporate Design Changes	5	0	0	0	0.75		0	0.75	0.75	0.75	0	0.75
Build Physical Engineering Prototype	6	0	0	0	0	0.8		0	0	0	0	0
Perform Physical Testing - Engineering Model	7	0	0	0	0	0	1		0	0	0	0
Perform Full Body Physical Testing	8	0	0	0	0	0	0	1		0	0	0
Verification of Engineering Model	9	1	0	0	0	0	0	0	1		0	0
Build Physical DVM Prototype	10	0	0	0	0	0	0	0	0	0.8		1
Perform Physical Test - DVM Prototype	11	0	0	0	0	0	0	0	0	0	1	

2) Assign rework dependencies

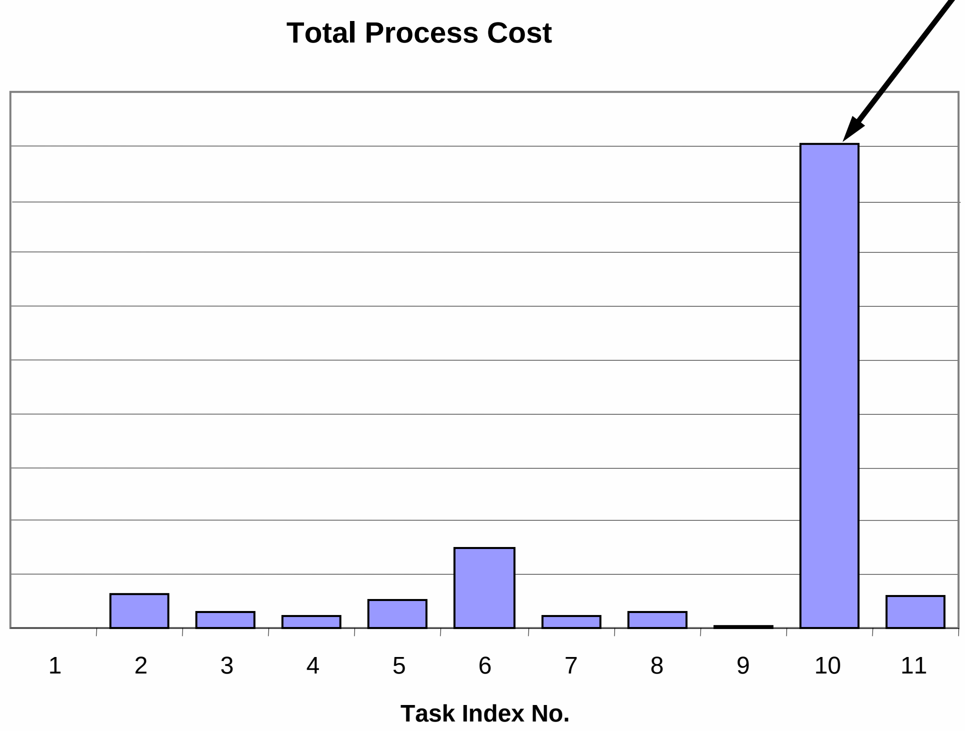
1) Define Process Tasks

3) Assign total number of cycles through process

4) Assign $ values to get total costs

ROI-Baseline Process Cost Evaluation

<u>*Per Task Cost Evaluation</u>



"Build Physical DVM Prototype" represents the majority of the cost of development

*Includes all iterations

ROI-Improved Process Cost Evaluation

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Improved Process

		1	2	3	4	5	6	7	8	9	10
Identify Requirements	1		0	0	0	0	0	0	0	0	0
Design Virtual Concept Model	2	1		1	0	0	0.75	0	0	0	0
Analyze Virtual Concept Model	3	0	0.8		0	0	0	0	0	0	0
Incorporate Design Changes	4	0	0	0.75		0	0.75	0.75	0.75	0	0.75
Build Physical Engineering Prototype	5	0	0	0	0.1		0	0	0	0	0
Perform Physical Testing - Engineering Model	6	0	0	0	0	0.1		0	0	0	0
Perform Full Body Physical Testing	7	0	0	0	0	0	0.1		0	0	0
Verification of Engineering Model	8	1	0	0	0	0	0	0.1		0	0
Build Physical DVM Prototype	9	0	0	0	0	0	0	0	0.1		1
Perform Physical Test - DVM Prototype	10	0	0	0	0	0	0	0	0	0.1	

Perform same type of assessment for the improved process

ROI-Improved Process Cost Evaluation

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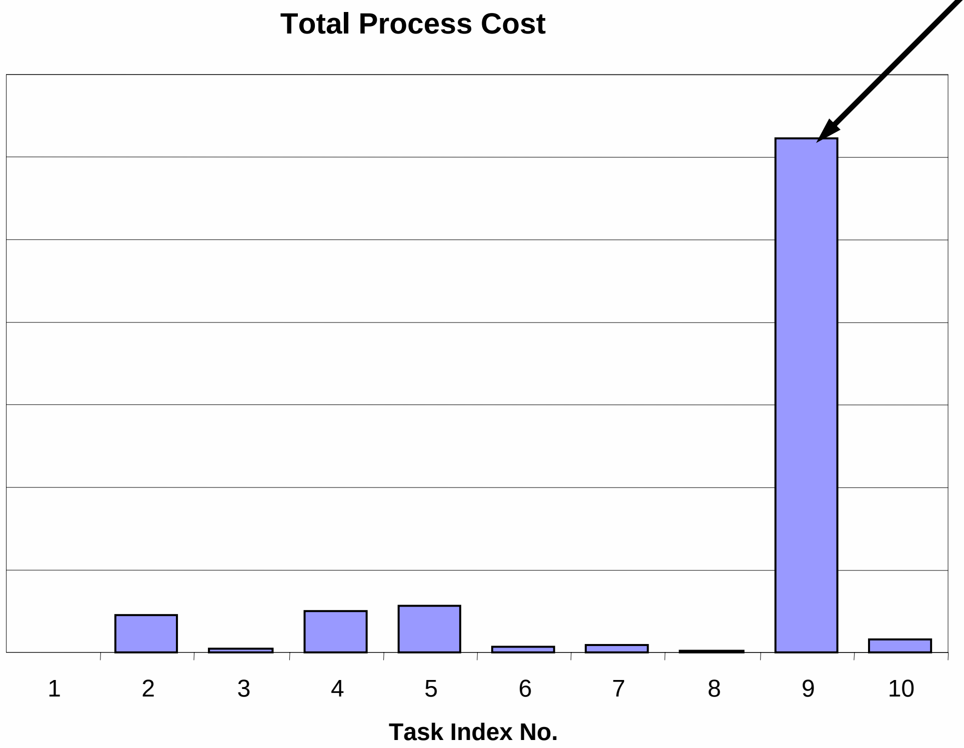
*Per Task Cost Evaluation



"Build Physical DVM Prototype" represents the majority of the cost of development. However, it is significantly (32%) smaller than the baseline process

*Includes all iterations

ROI-Process Cost Comparison

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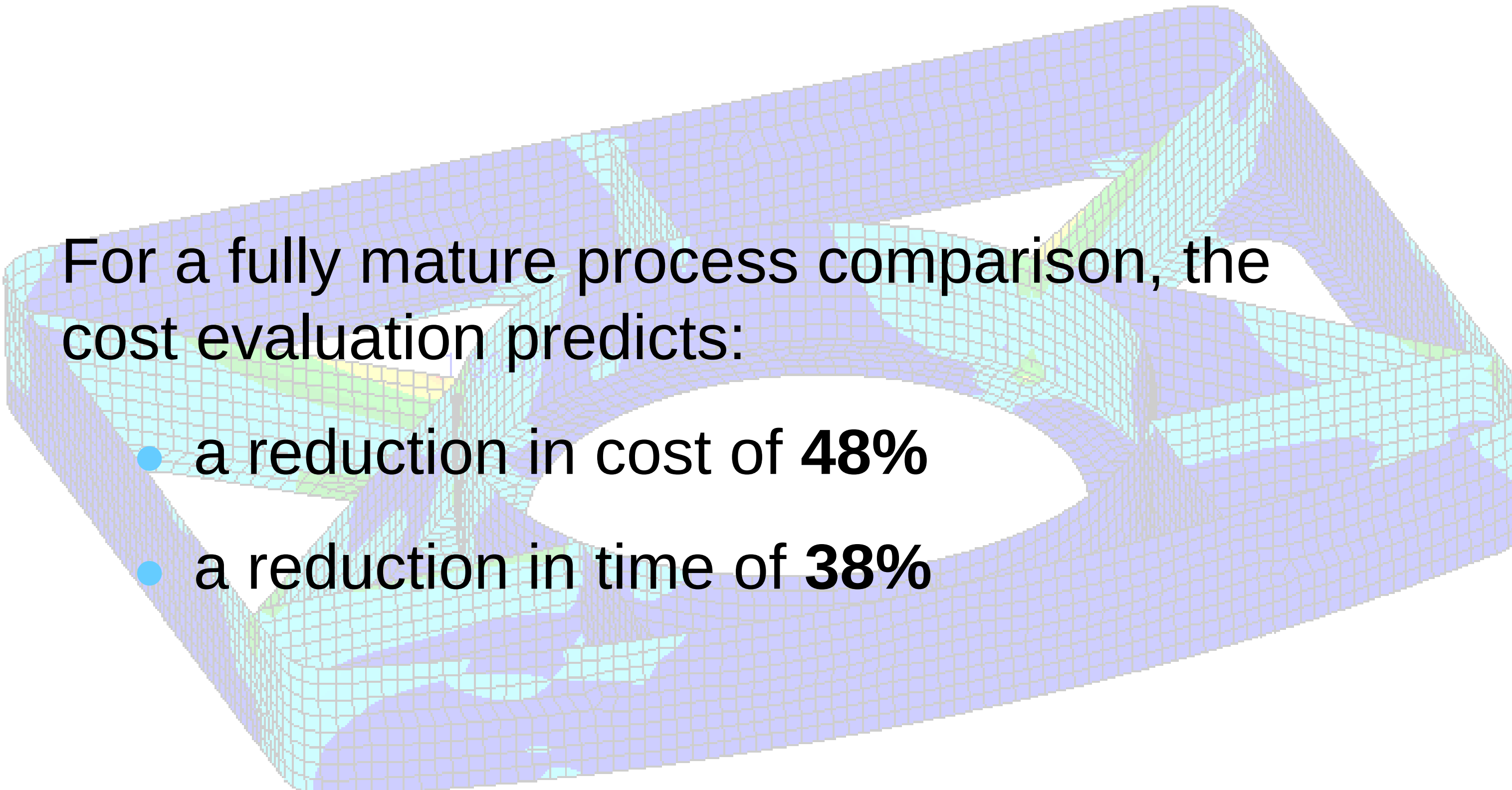

For a fully mature process comparison, the cost evaluation predicts:

- a reduction in cost of **48%**
- a reduction in time of **38%**

ROI-Tangible Evaluations

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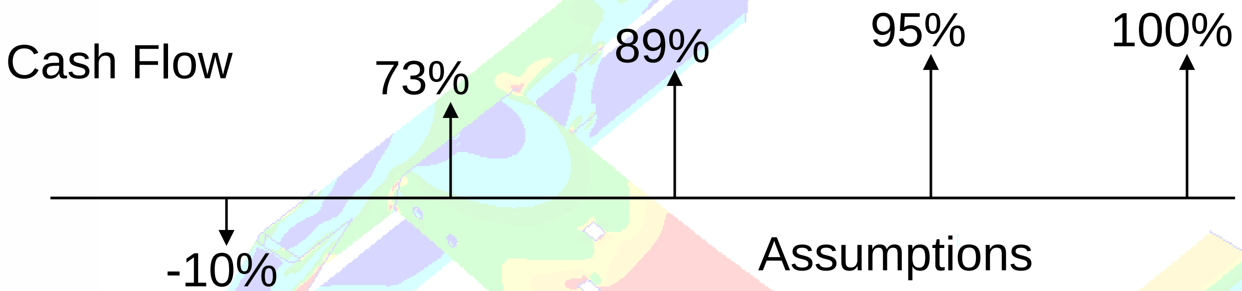

Assumptions
- Graduated Implementation
- 2 design projects/year
- 20% maintenance/year
- Percentage of Entitlement

- NPV-$403K Improved Process (15% hurdle)
- IRR-731% return over 5 year implementation timeframe
- Break Even-14 months

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ROI-Intangible Benefits

- Increased development opportunity.
- Intimate knowledge of full field behavior, not just point wise information.
- Repeatable evaluation (boundary condition normalization). Some systems are subject to variation of boundary conditions which, from a test environment, are not known. This variation, while necessary to understand, complicates a nominal design assessment.
- Some new performance measures, while not verifiable are realized, and may be used for alternative comparisons.

Conclusions

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- Simulation techniques can make vast improvements in the process for developing hospital beds and accessories.
- Automation of this process can further increase productivity and allow for increased cycles of learning.
- Application of this tool has the potential to greatly improve product performance through a more thorough understanding of the product.

Acknowledgements

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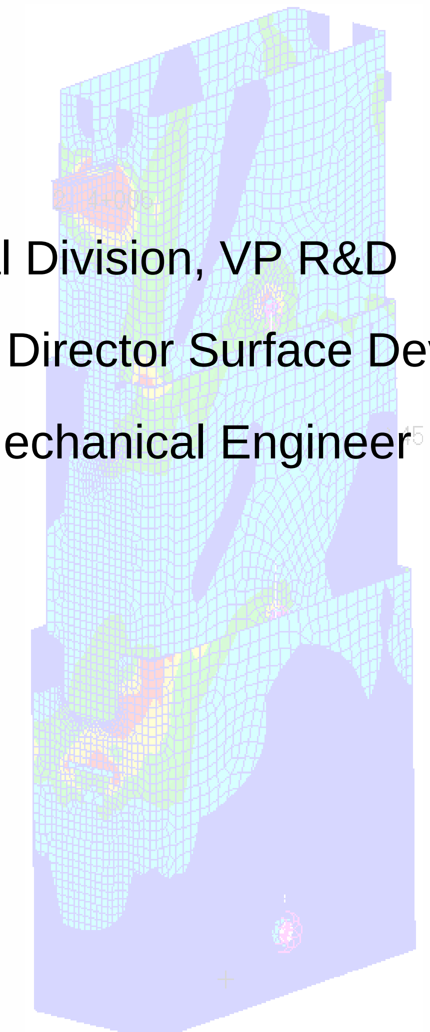

References

Design Structure Matrix (DSM) method, Steward 1981; Smith and Eppinger 1997; Cronemyr, Ronnback and Eppinger 2001 (ref. http://www.dsmweb.org).