

ADAMS/Insight and Rapid Simulation

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Mechanical Dynamics, Inc.**

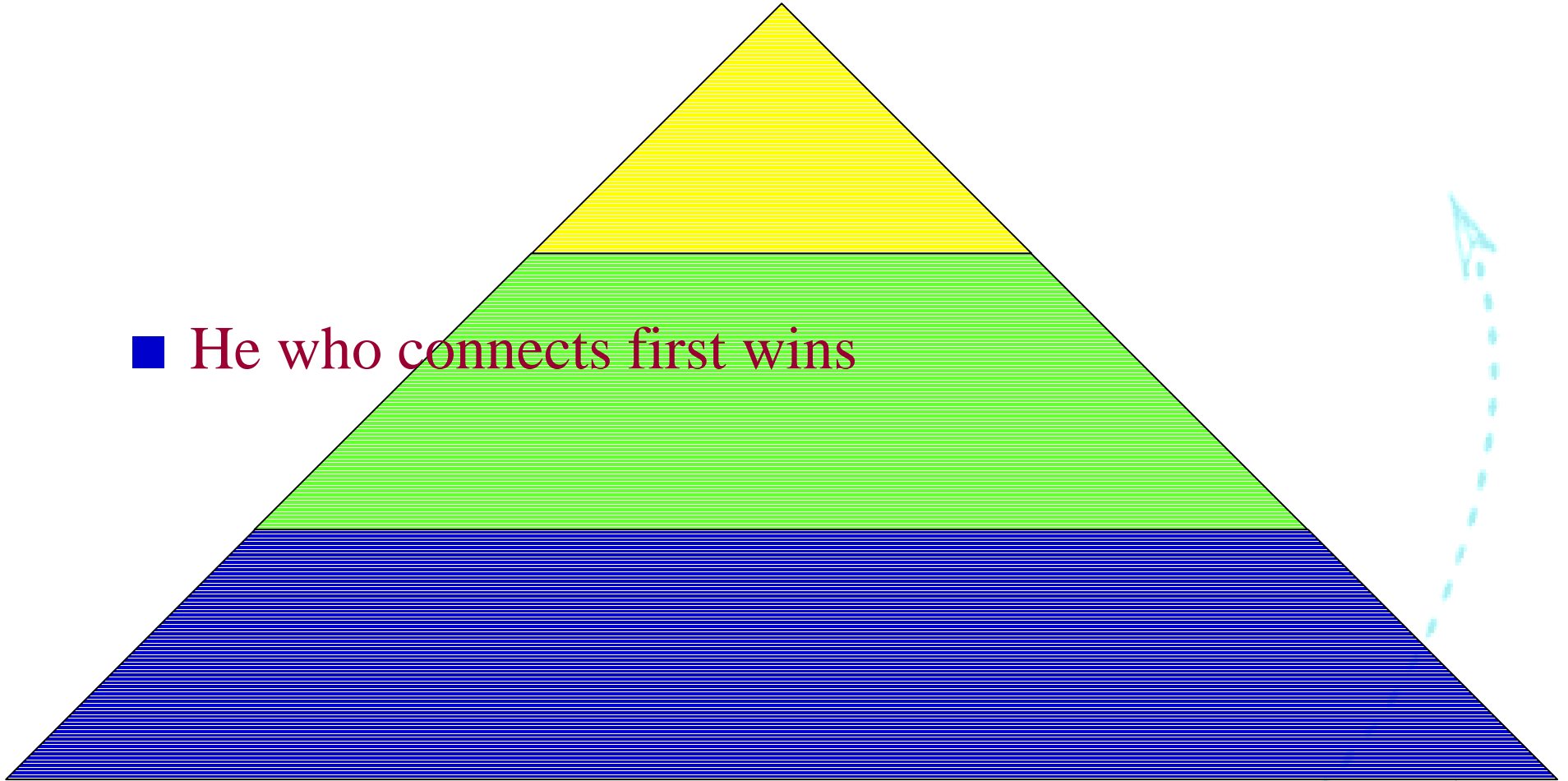
2000 International ADAMS User Conference



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The Power of Virtual Prototyping

- He who connects first wins





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Dynamic DNA

“Instead of being 20% there when we start driving prototypes, with (computer-aided engineering) we are 80% there” - Ford Motor Company 1998



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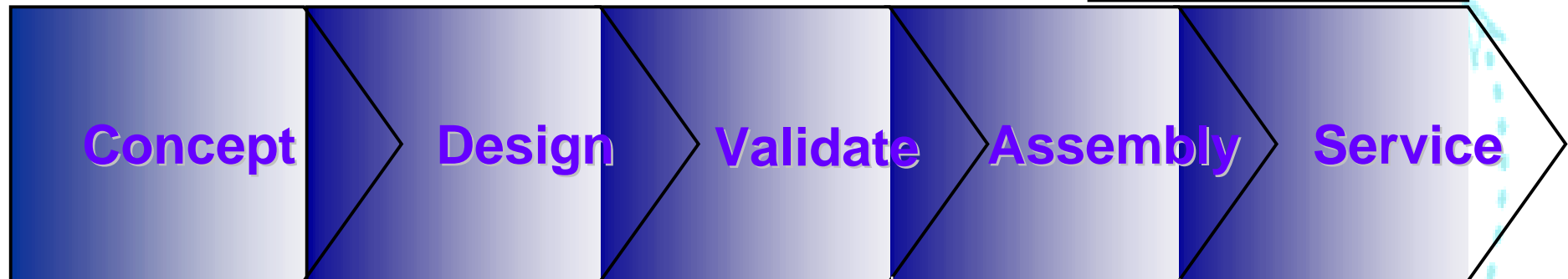
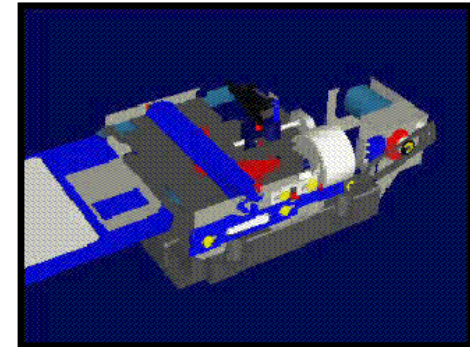
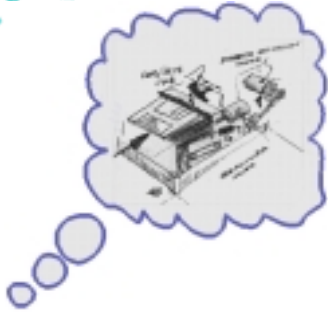
Challenges Facing Corporations Today

- Cut design cycle time
- Predict behavior
- He who connects first to their data wins!



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The Product Lifecycle



Am I sure?

Will it fit?

Can it be made?

What to make?

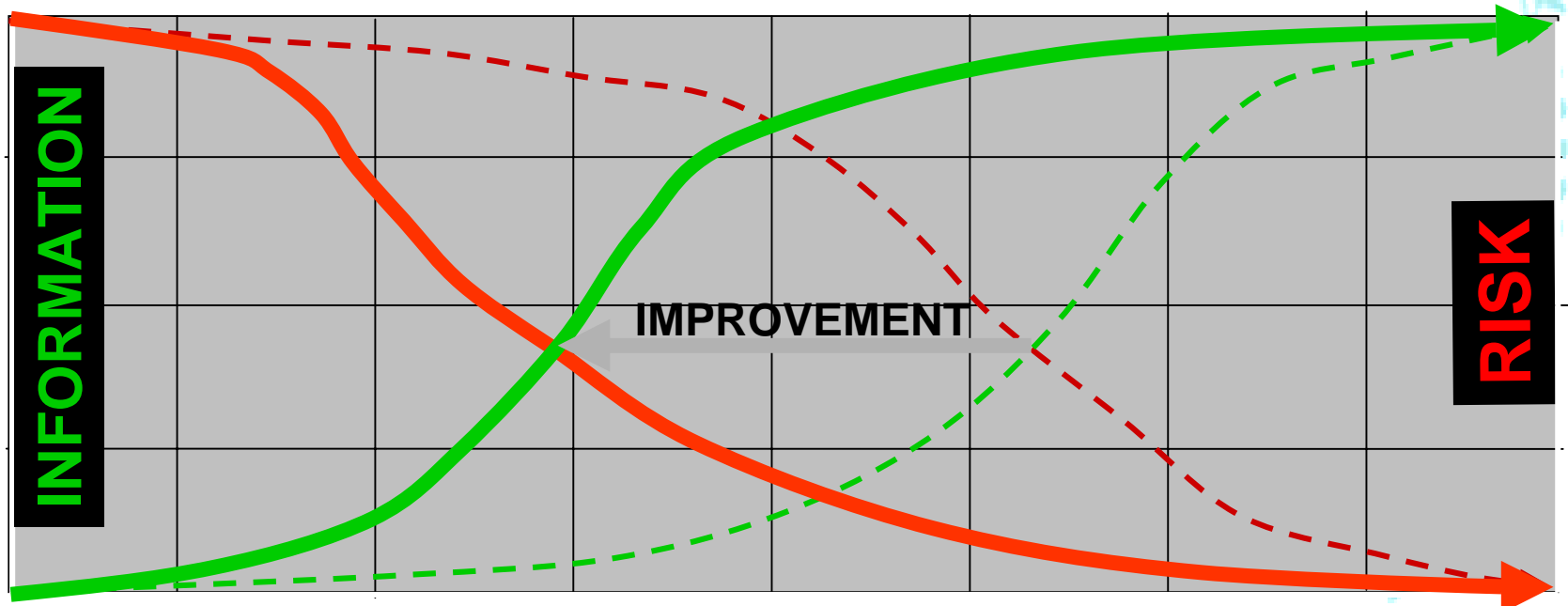
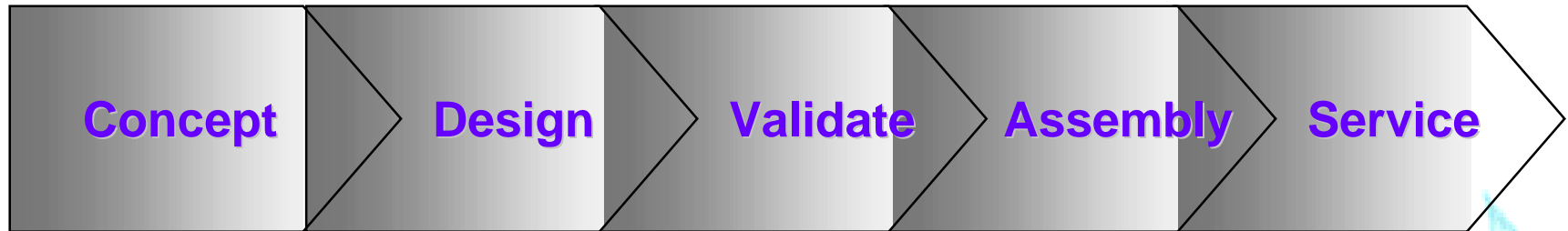
Will it work?

Will it last?



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Managing Risk Through Better Information



Product Development Process



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How?

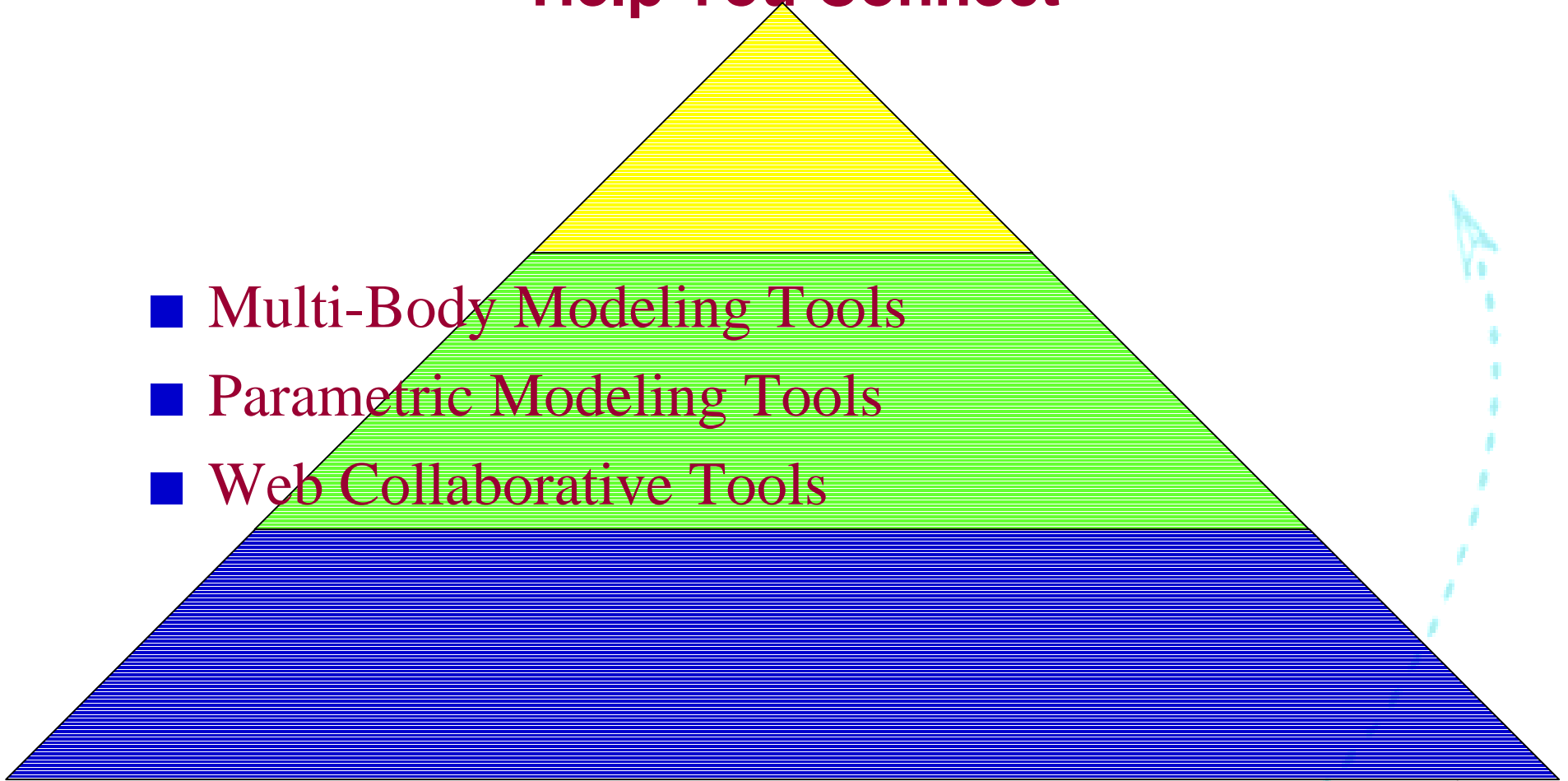
- How do we get more information up-front?
- How do we learn about our design earlier?
- How do we connect with our data?



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Virtual Prototyping Solutions Help You Connect

- Multi-Body Modeling Tools
- Parametric Modeling Tools
- Web Collaborative Tools

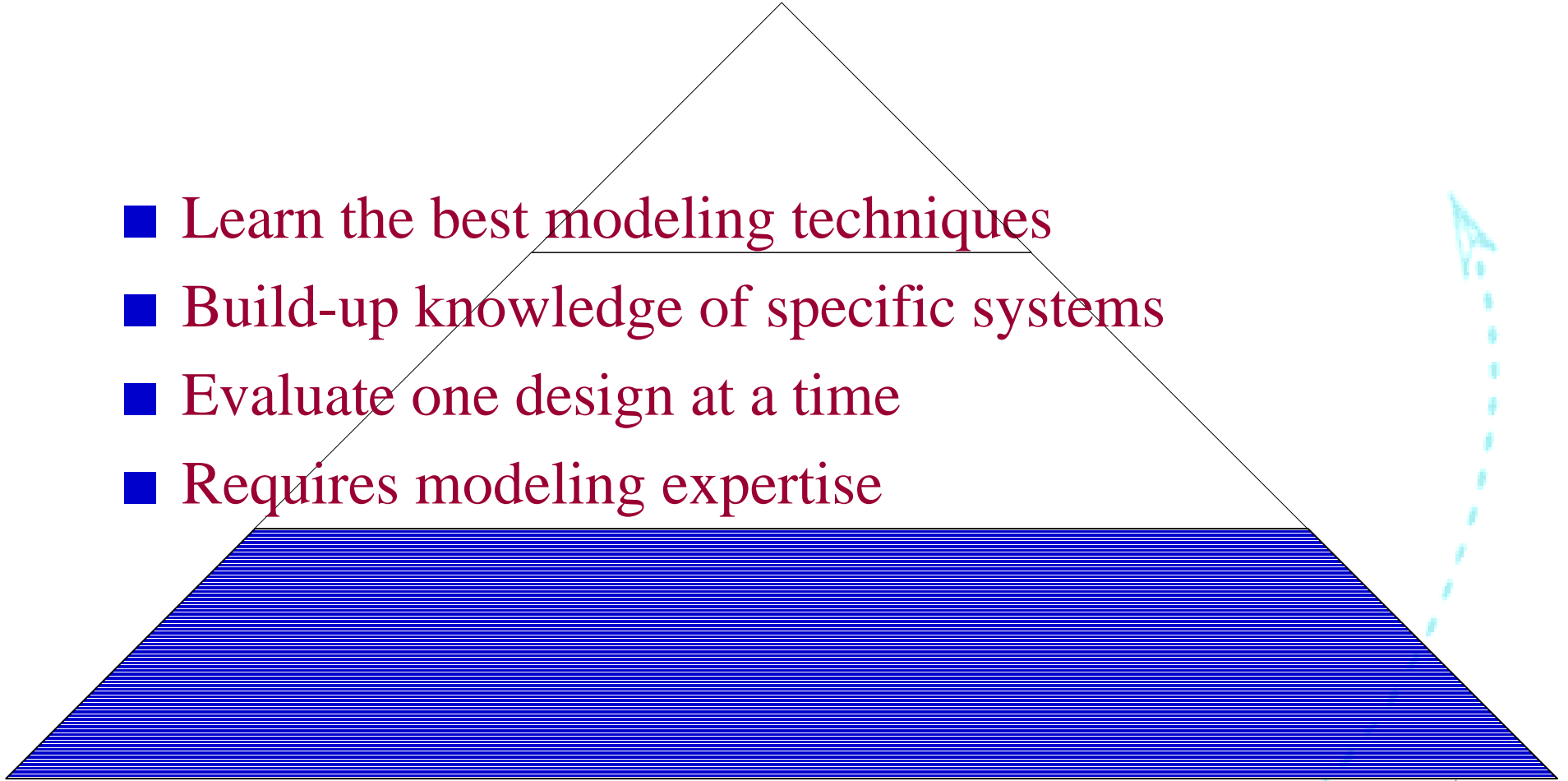




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Multi-Body Modeling Tools

- Learn the best modeling techniques
- Build-up knowledge of specific systems
- Evaluate one design at a time
- Requires modeling expertise

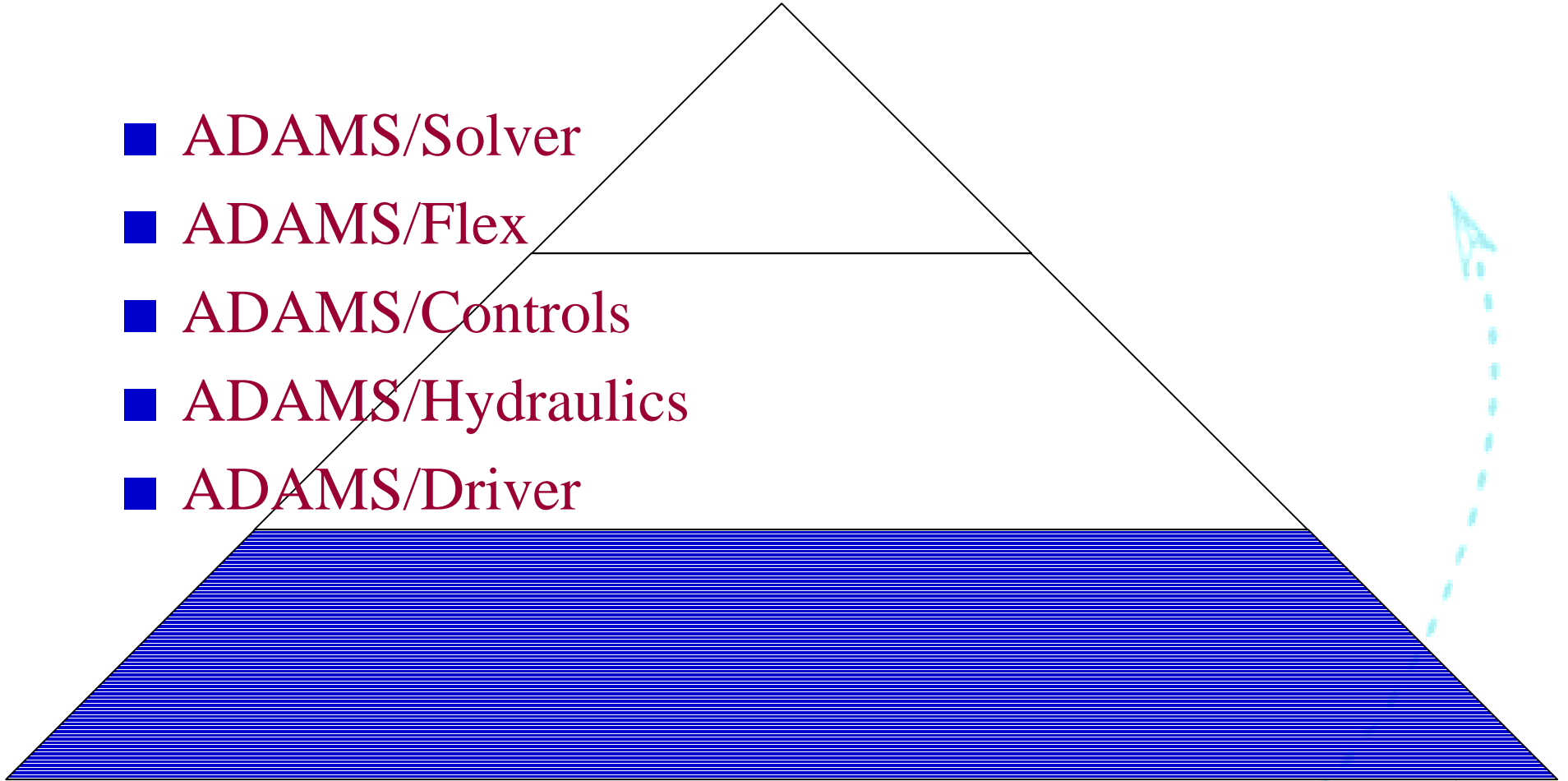




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Multi-Body Modeling Tools

- ADAMS/Solver
- ADAMS/Flex
- ADAMS/Controls
- ADAMS/Hydraulics
- ADAMS/Driver





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Parametric Modeling Tools

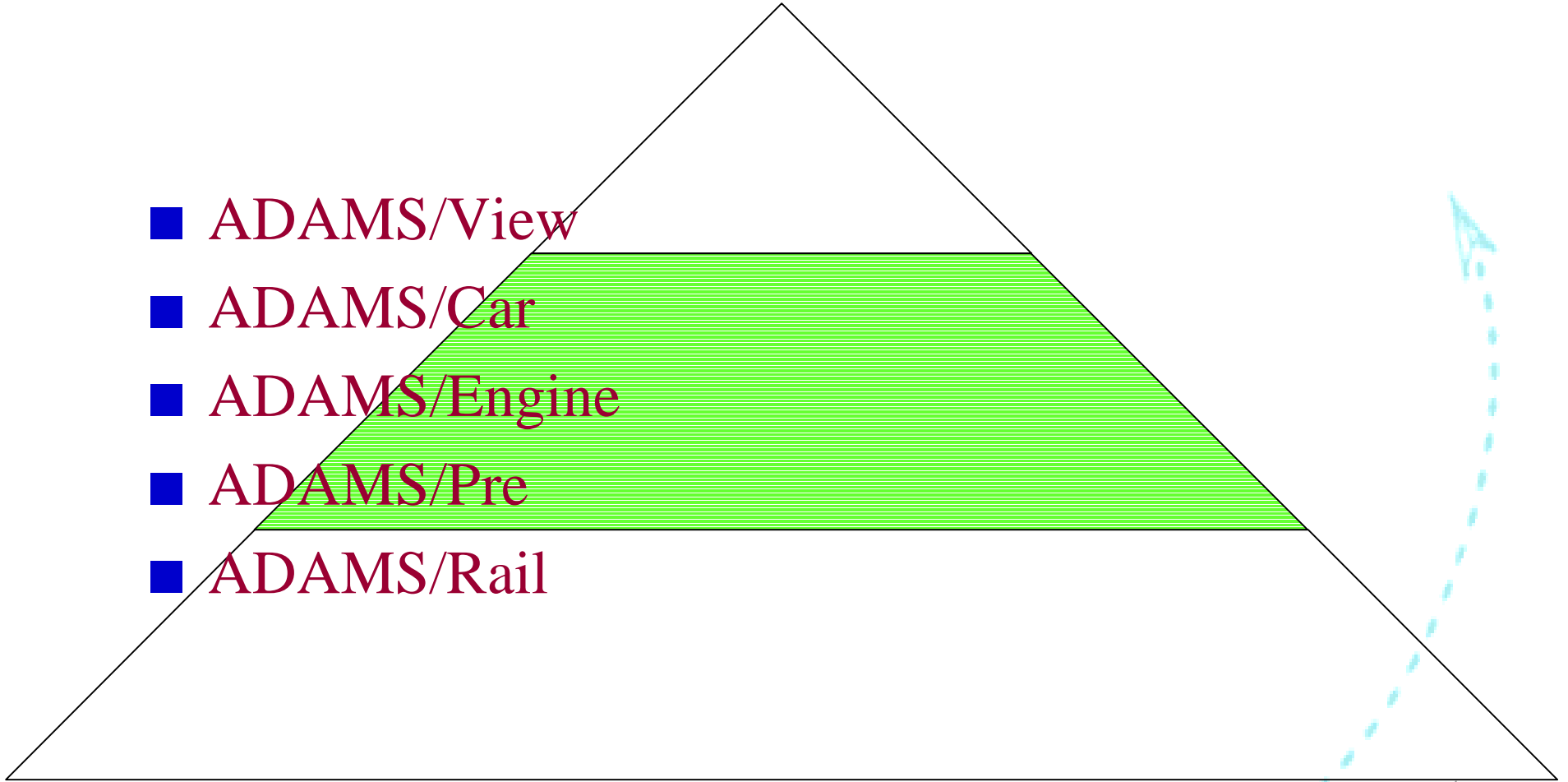
- Build complex multi-body models from base set of parameters
- Bookshelf corporate expertise
- Utilize consistent methods
- A/B comparison is easy, effects of design changes are analyzed quickly
- Users don't have to develop methods



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Parametric Modeling Tools

- ADAMS/View
- ADAMS/Car
- ADAMS/Engine
- ADAMS/Pre
- ADAMS/Rail





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Web Collaborative Tools

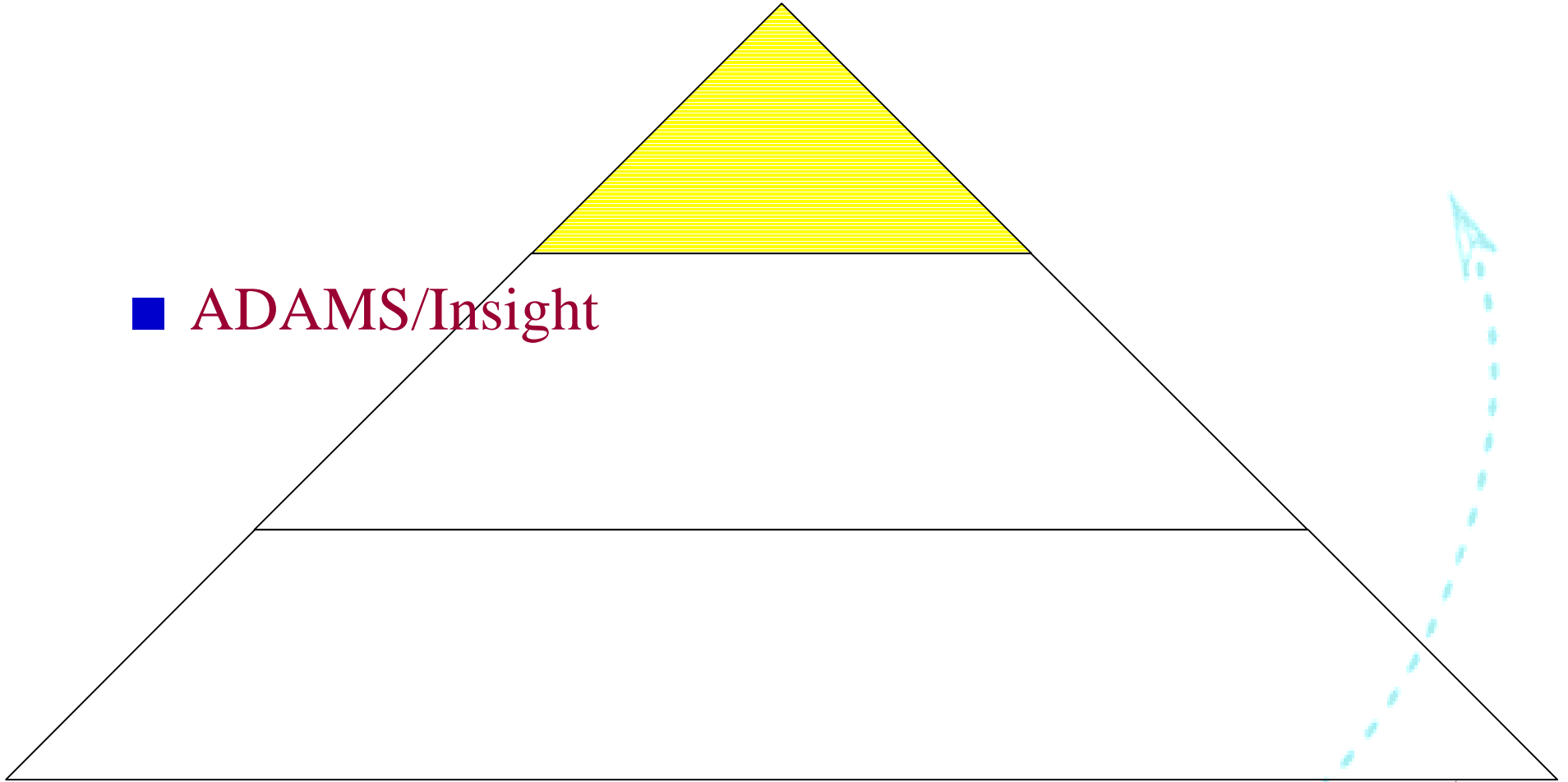
- Control parametric tools to analyze design spaces
- Gain understanding of complex systems
- Publish interactive results



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Web Collaborative Tools

■ ADAMS/Insight





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ADAMS/Insight is the Key

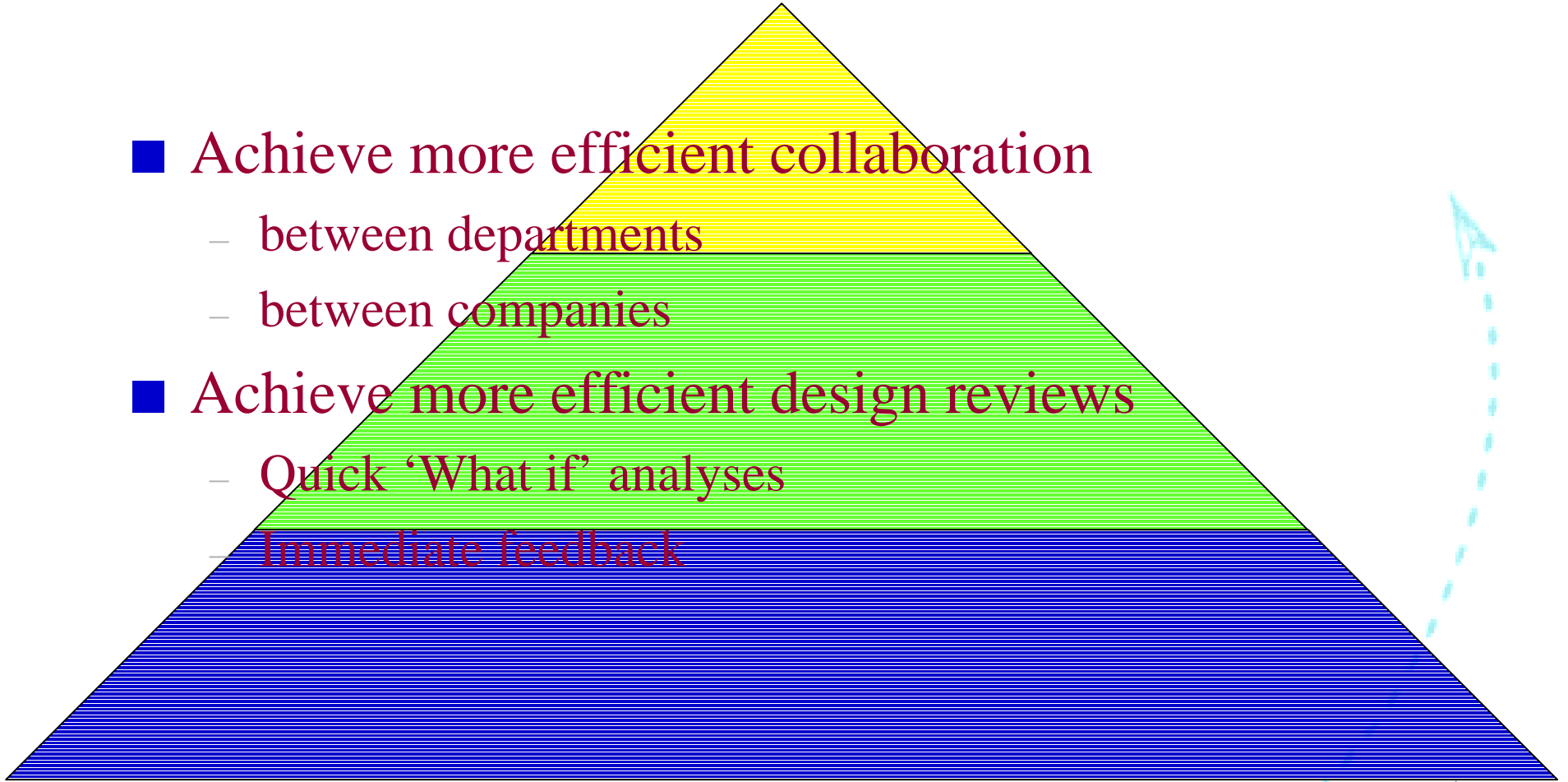
- Greater understanding of system under investigation
 - Identify primary inputs
 - Identify interactions of inputs
 - Simplify system
- Communicate findings in an interactive, easy to use, format
- Reduce time to market



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Together these Virtual Prototyping Solutions help you...

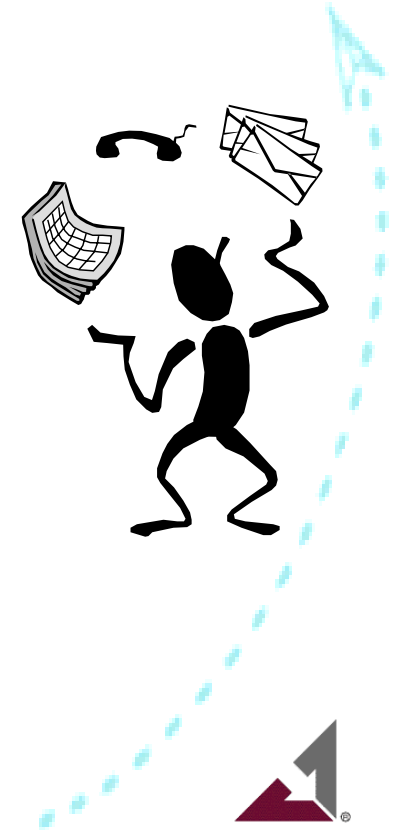
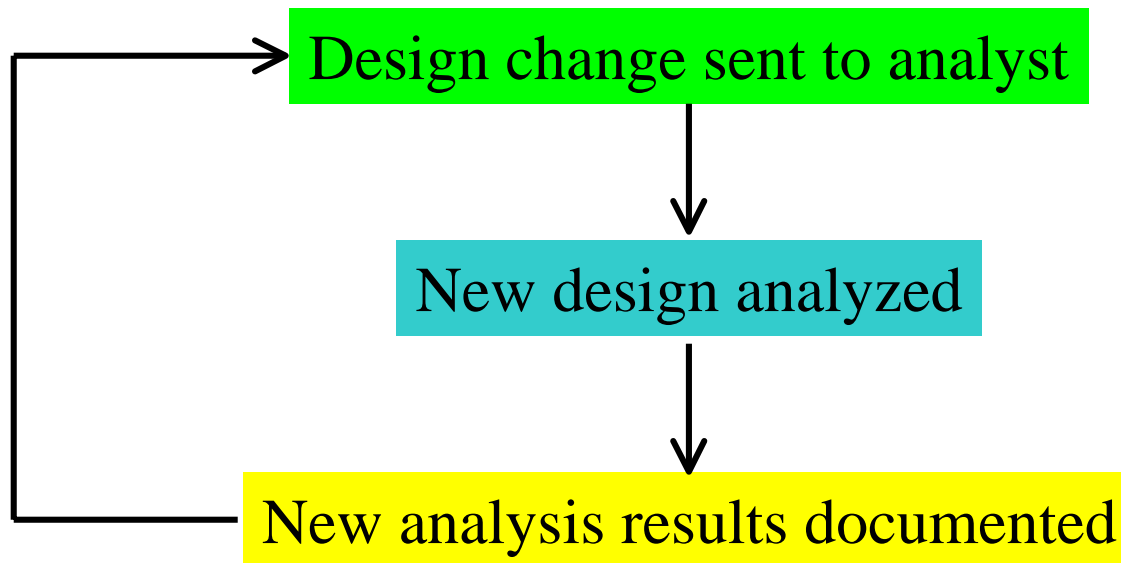
- **Achieve more efficient collaboration**
 - between departments
 - between companies
- **Achieve more efficient design reviews**
 - Quick 'What if' analyses
 - Immediate feedback





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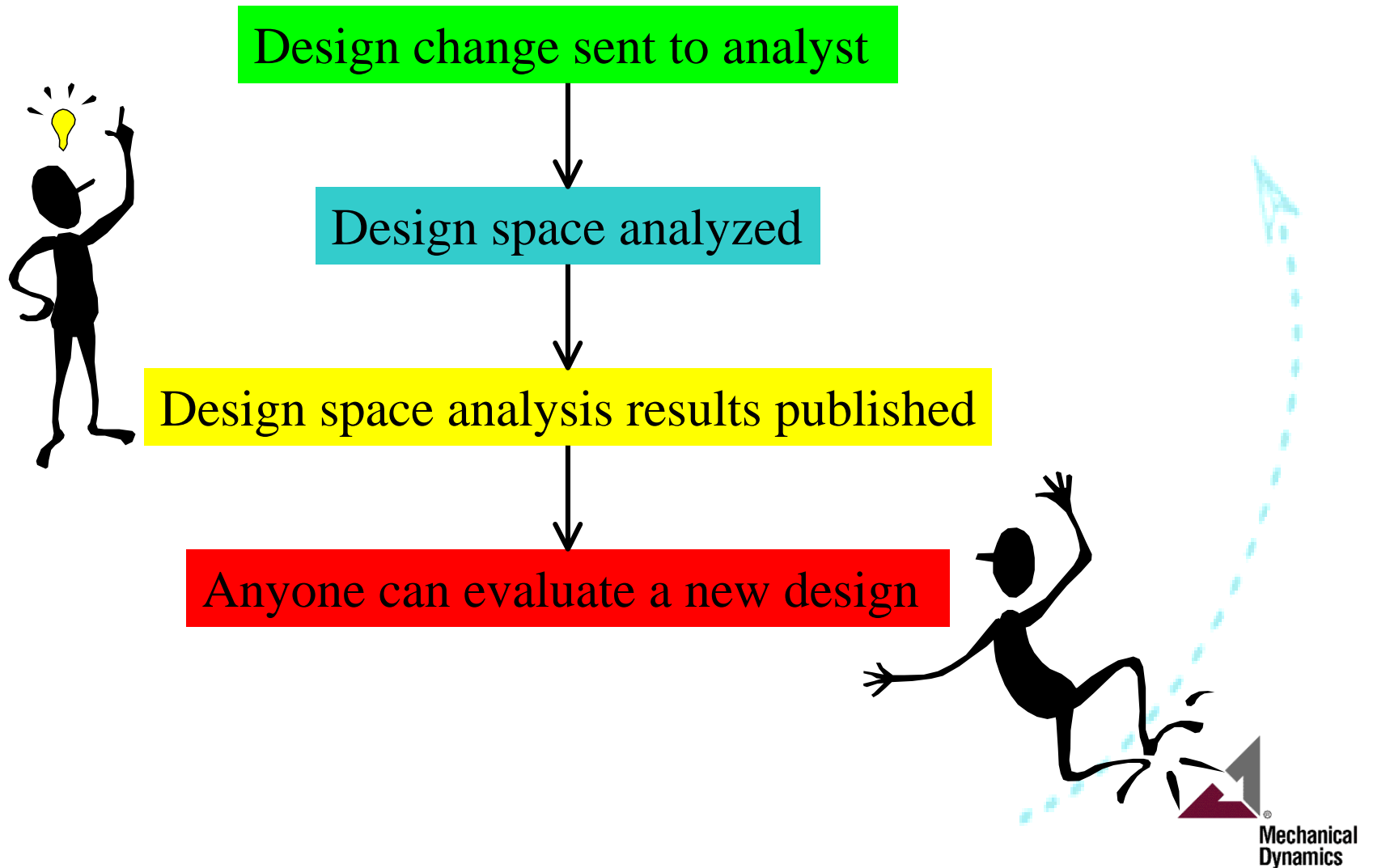
Old Collaboration Model





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New Collaboration Model





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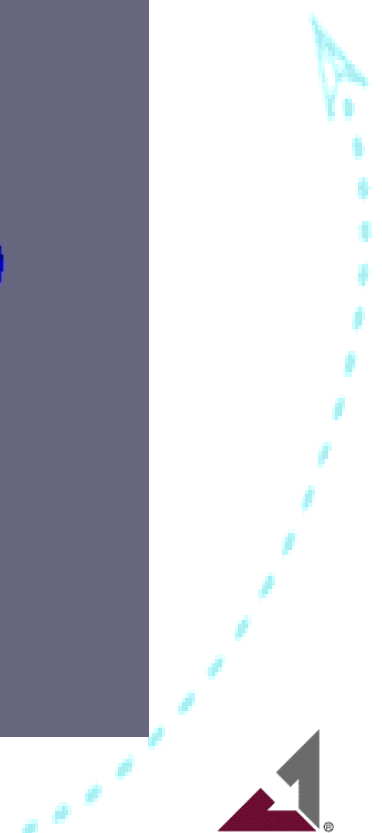
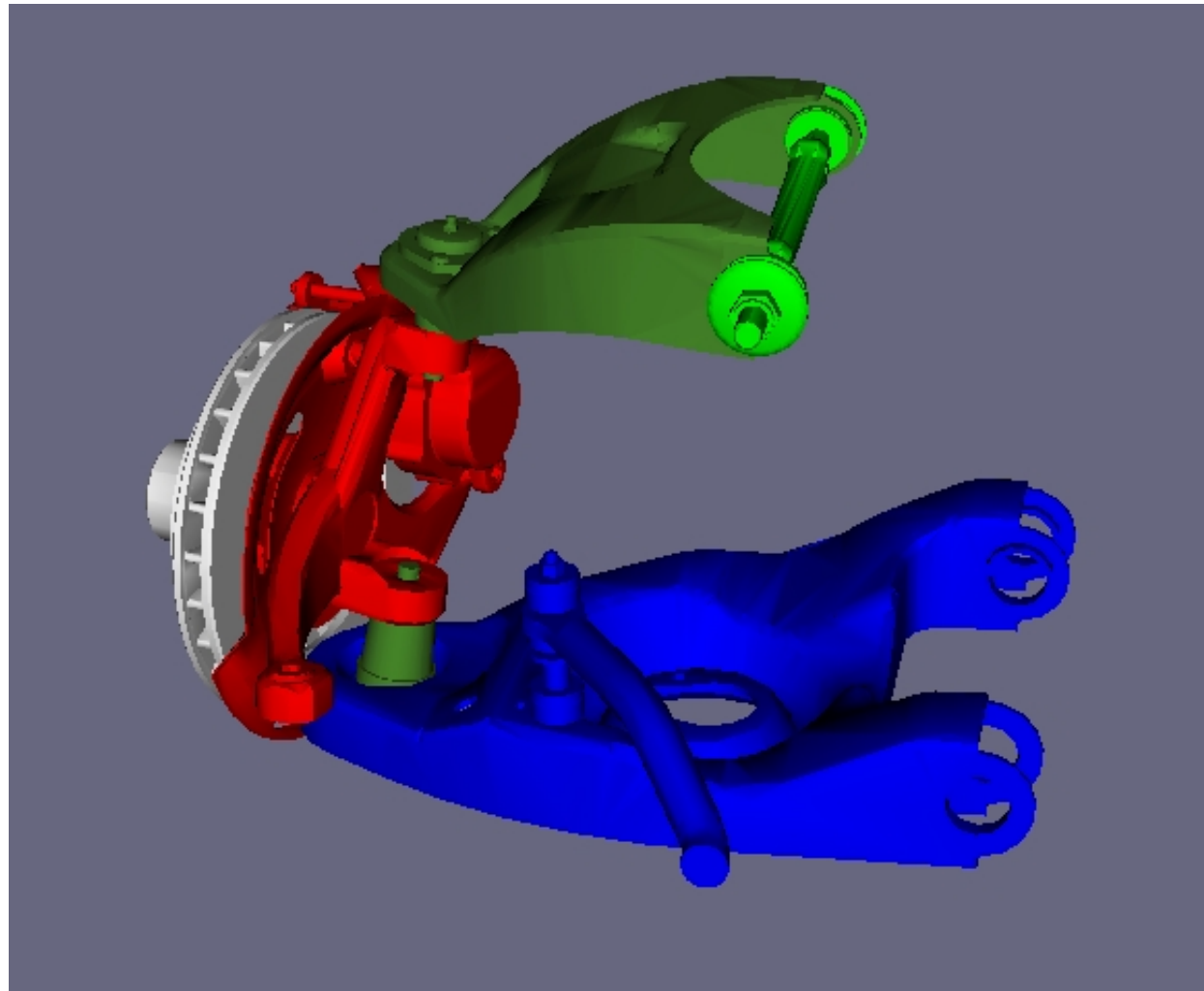
Complete Virtual Prototyping Solution

- How long does it take to evaluate a design space?



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Example System





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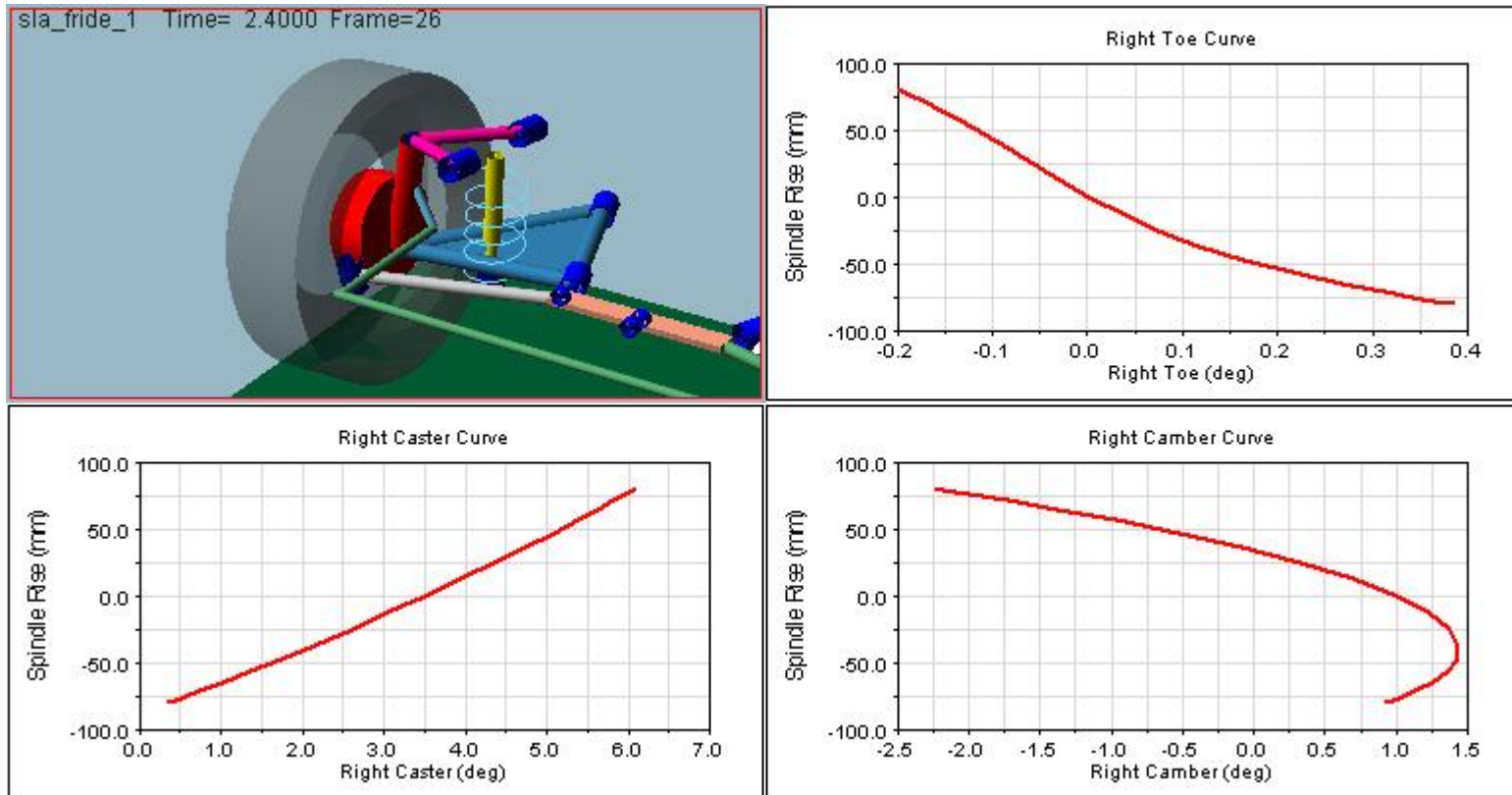
Case Study: Characteristic Curves of Automotive Suspension

- Toe, Caster, Camber curves are essential properties of a suspension
- Curves represent change in angular orientation of wheel under different loading conditions
- Curves must be continually evaluated as design changes



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Ride Motion Analysis

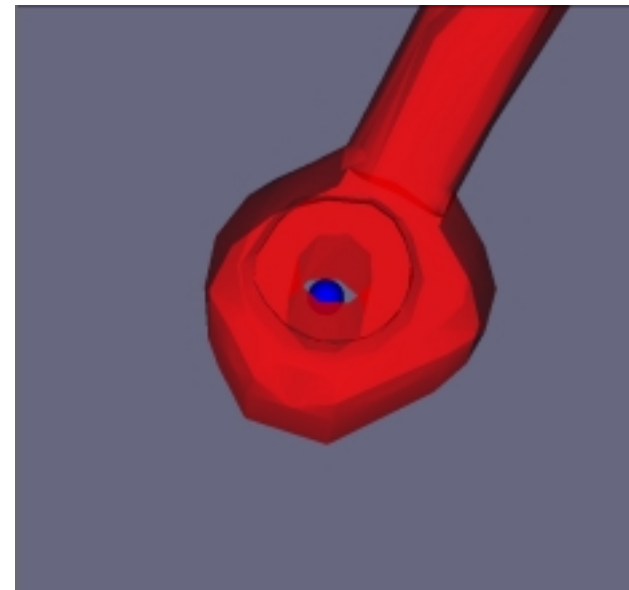




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Problem Statement

- Packaging problems with current design
- Tie-rod spindle connection point must be moved
- Would like to move tie rod:
 - 10 mm outboard
 - 14 mm aft
 - 15 mm up
- **Is this Okay?**

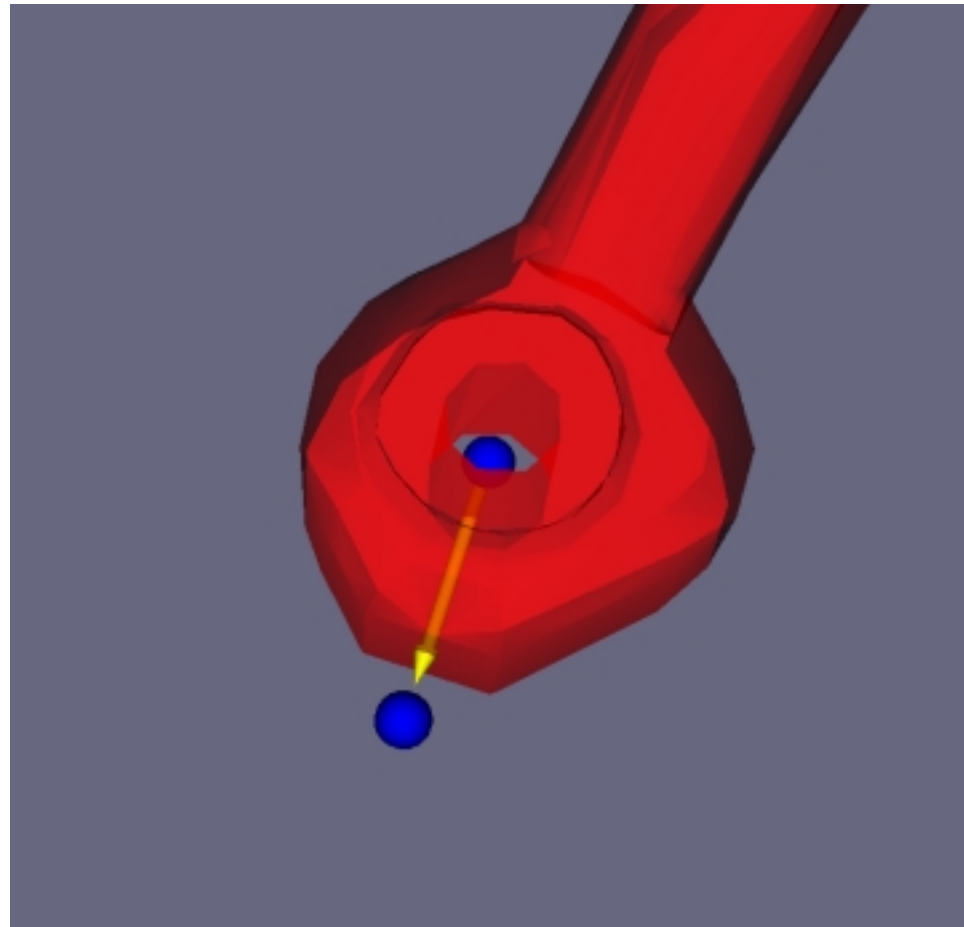




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How could we solve this problem?

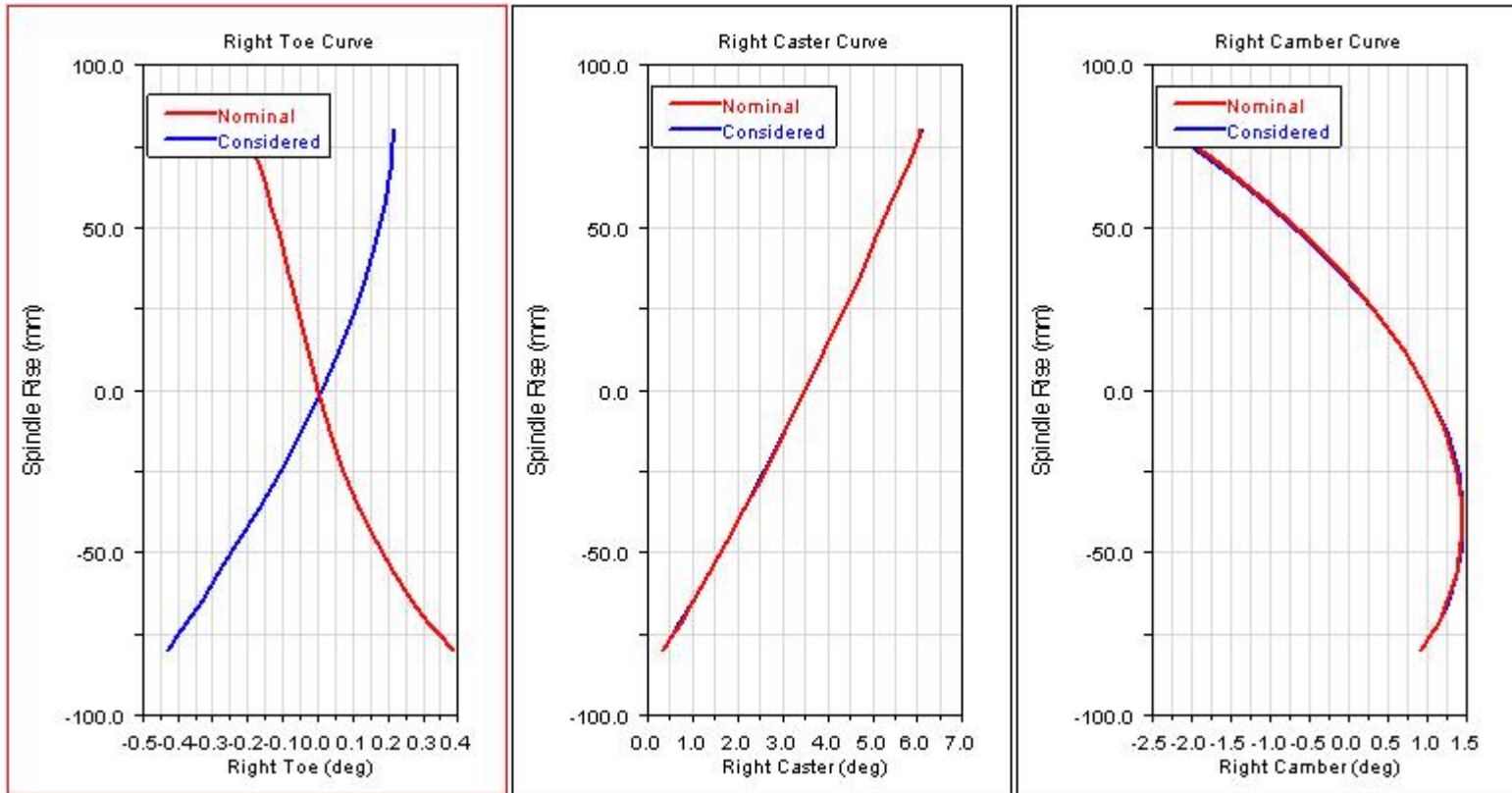
- Run two analyses: nominal, considered
- Publish difference





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Sample Report (old approach)





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Issues with Old Approach

- Results are static
- New analysis requests keep coming

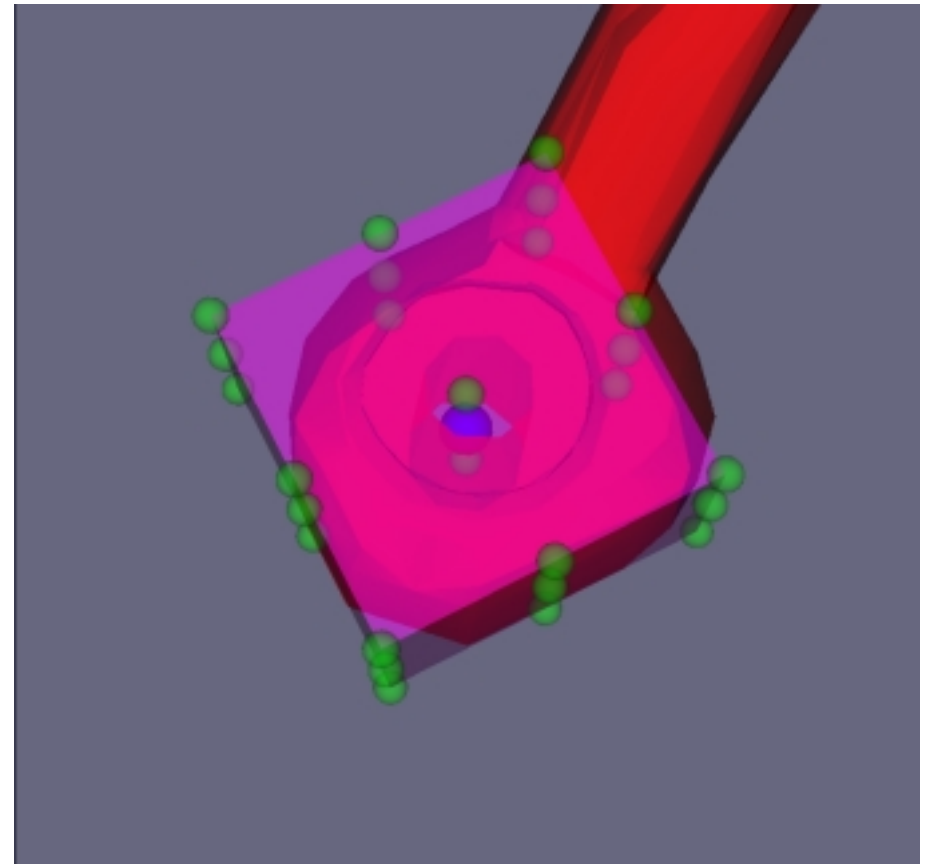




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How do we want to solve this problem?

- Setup experiment with ADAMS/Insight
 - Define design space
 - Define trial runs





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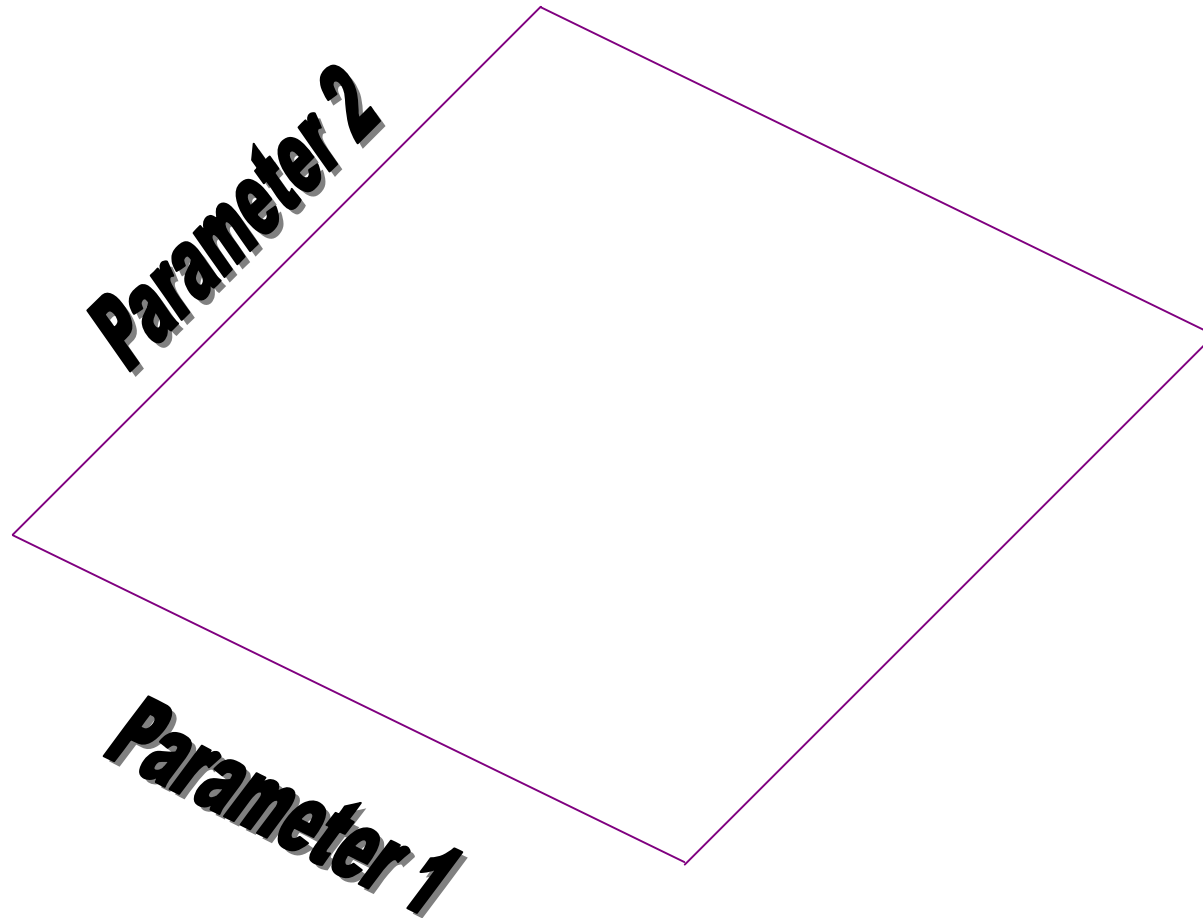
How do we want to solve this problem?

- Utilize parametric modeling tool
 - Analyze set of trials picked by DOE theory
- Use DOE theory and the response surface method
 - Fitted results give continuous information throughout design space



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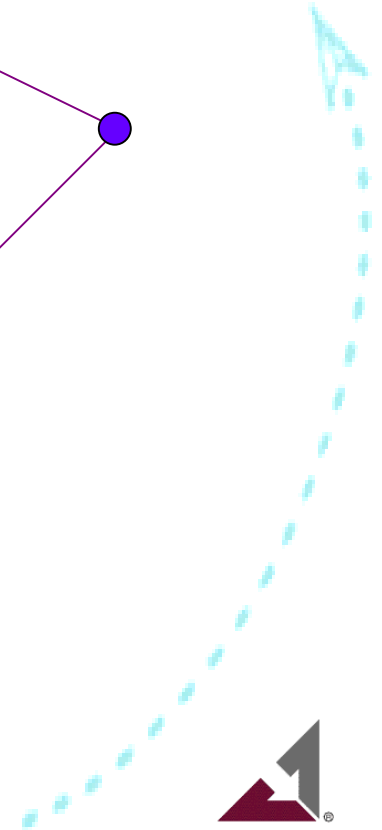
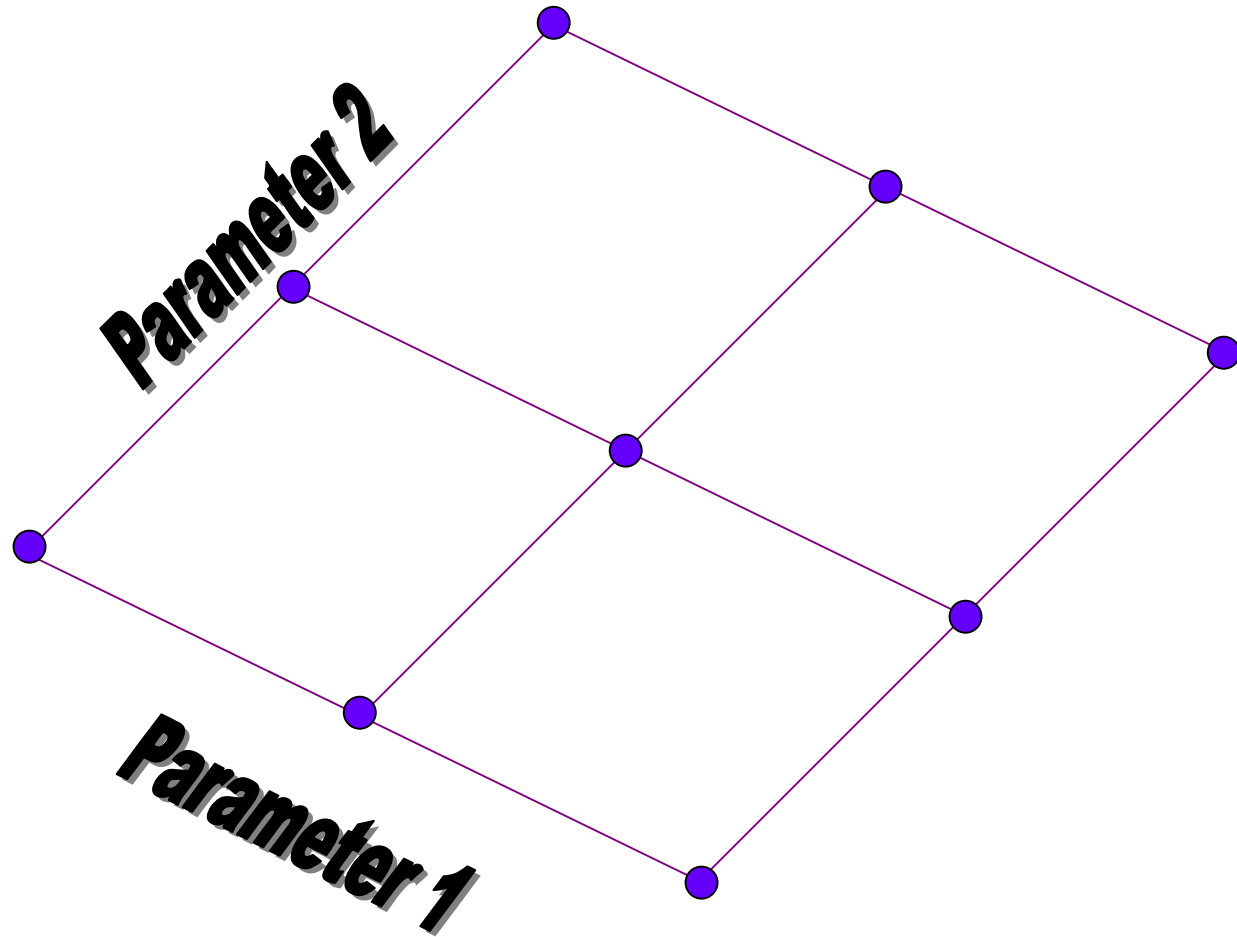
Start with Design Space





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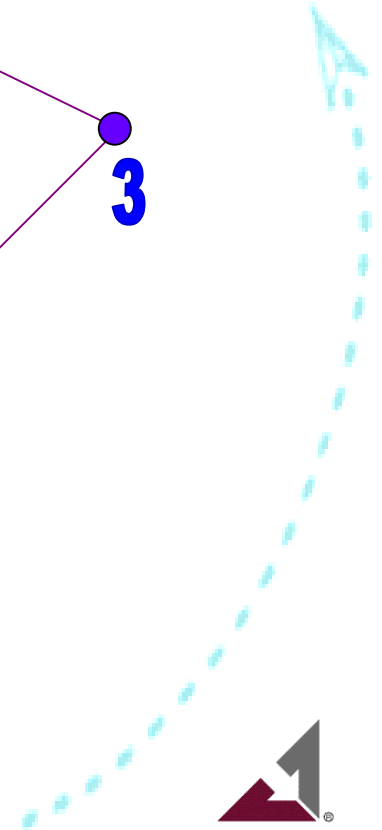
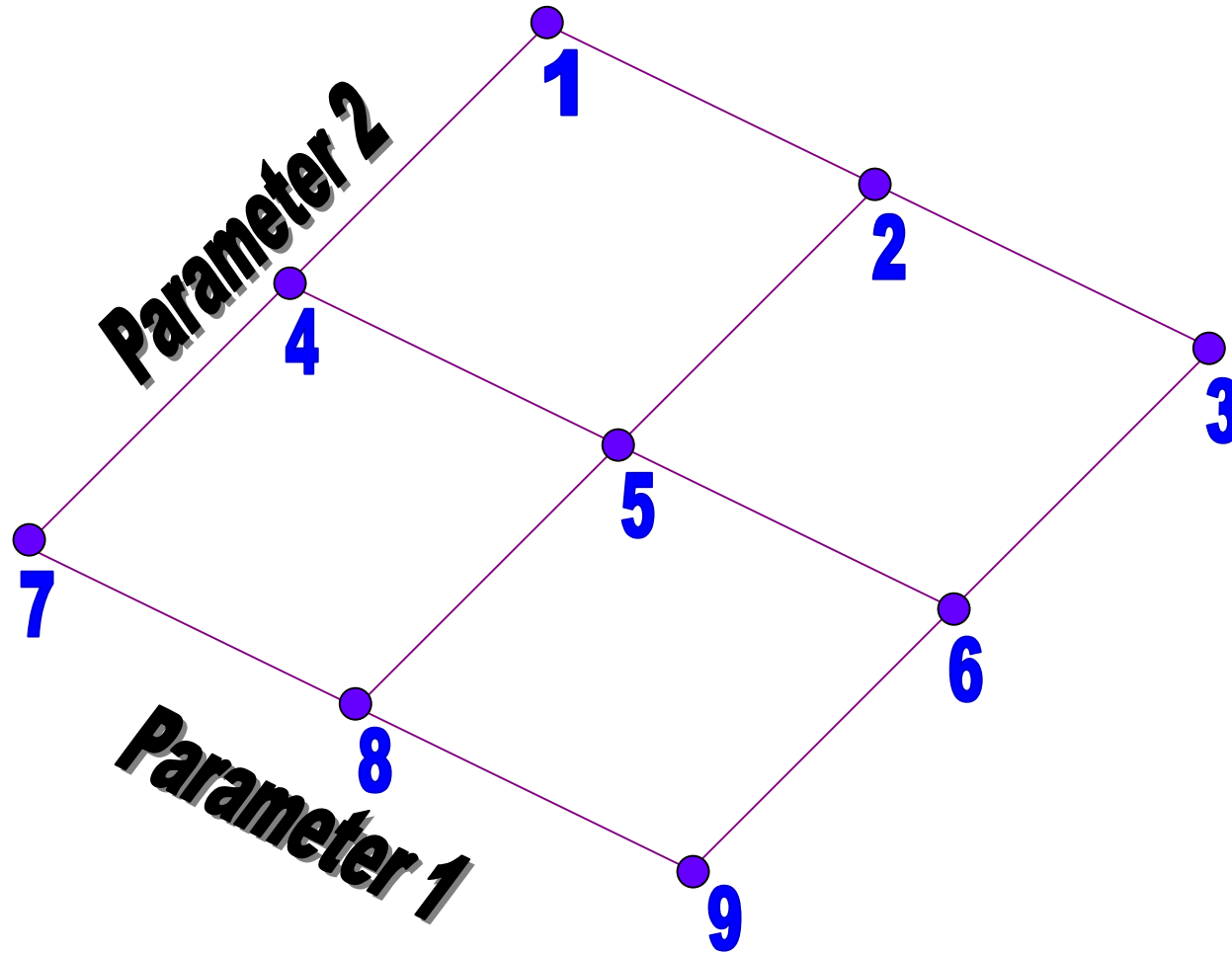
Add DOE Design points





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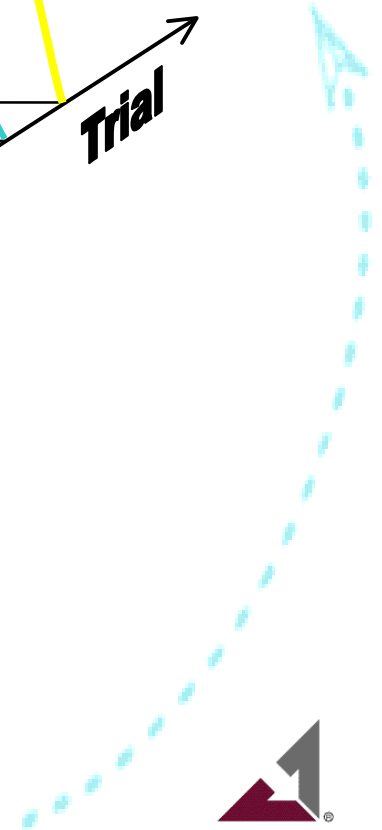
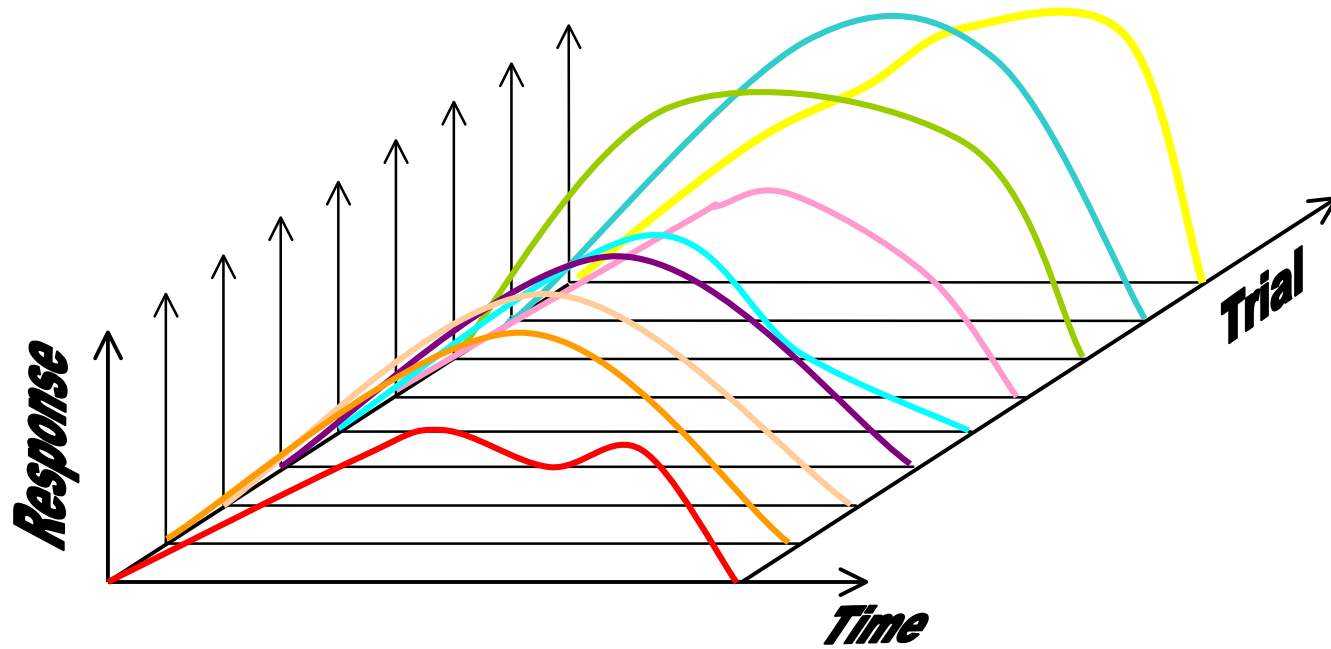
Assign Trial Numbers





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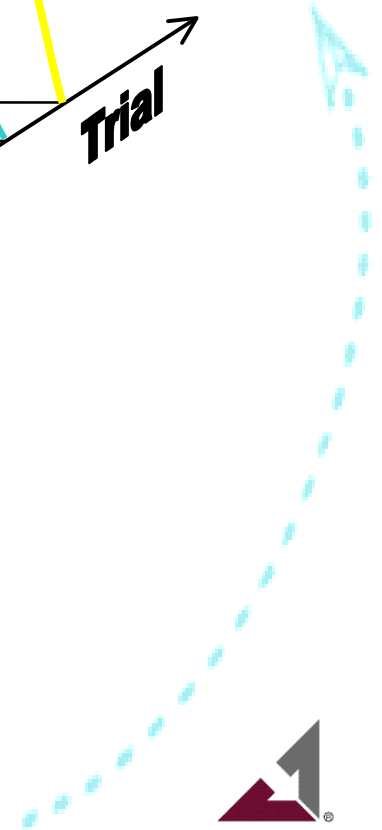
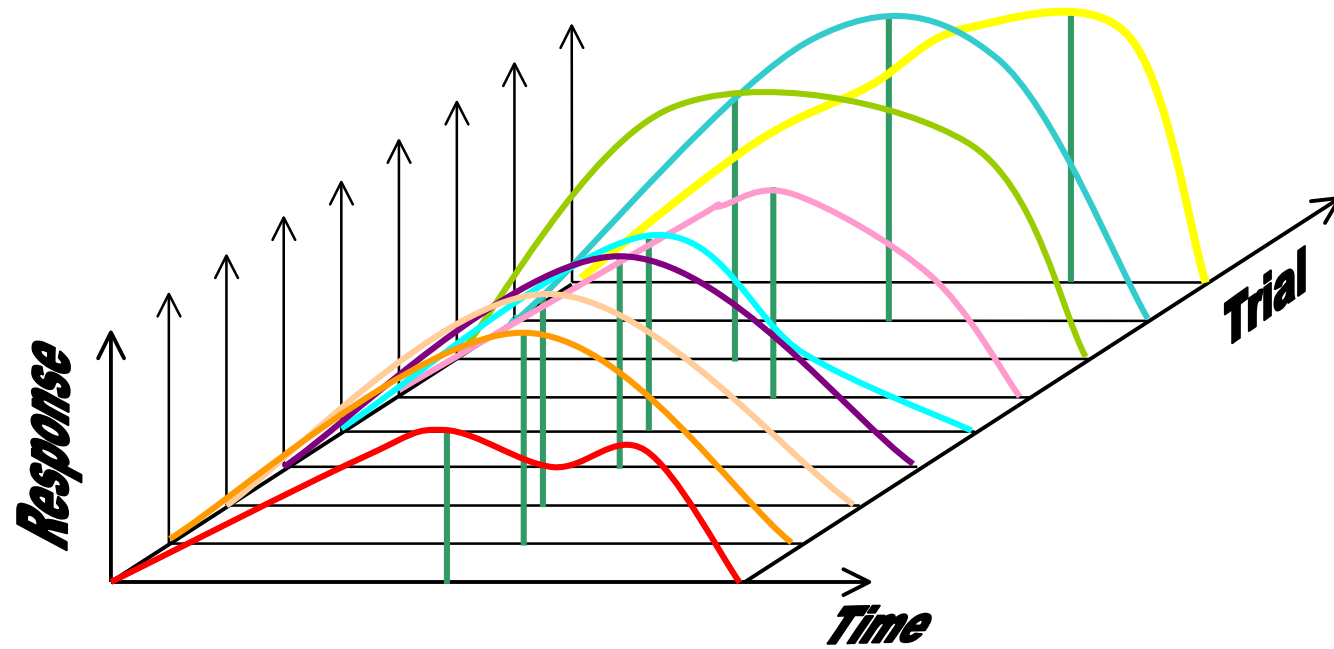
Analyze Model at Each Trial





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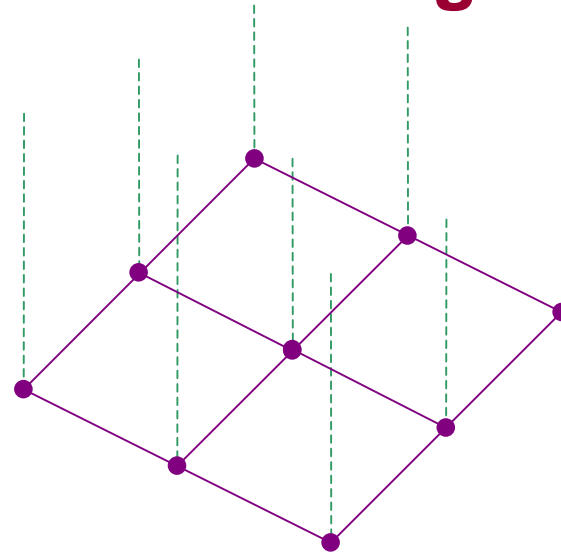
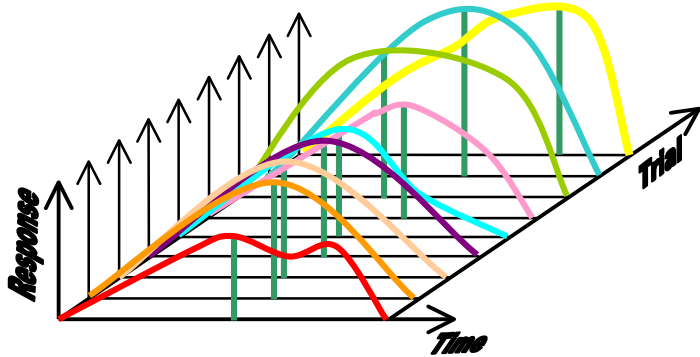
Calculate Objective at each Trial





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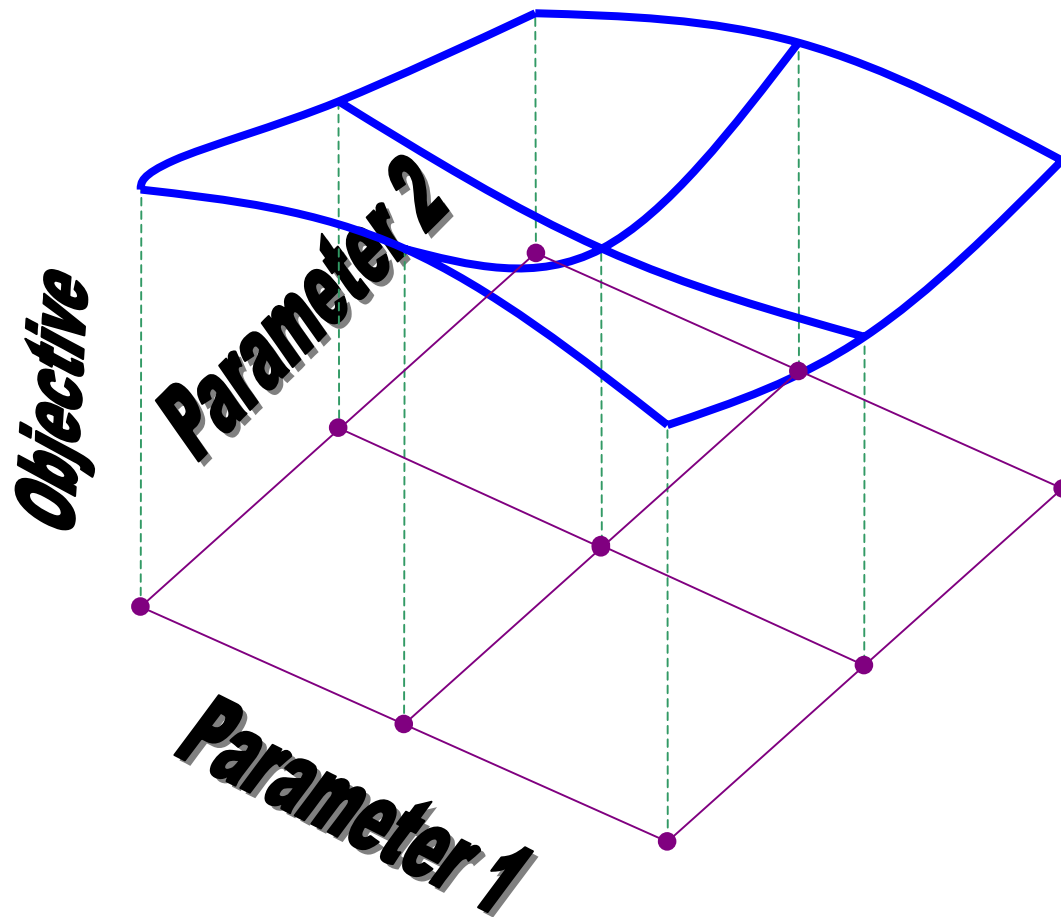
Map Trial Objectives Back to Design Space





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Create Response Surface





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Response Surface Method

- Provides continuous knowledge within design space
- Can be extended (hard to visualize)
 - More than 2 factors
 - More complex response types



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Results of Case Study

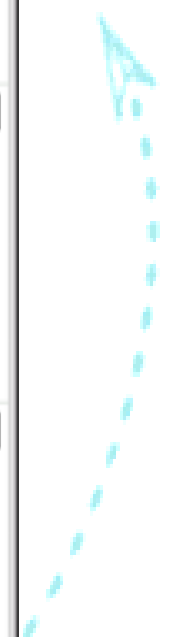
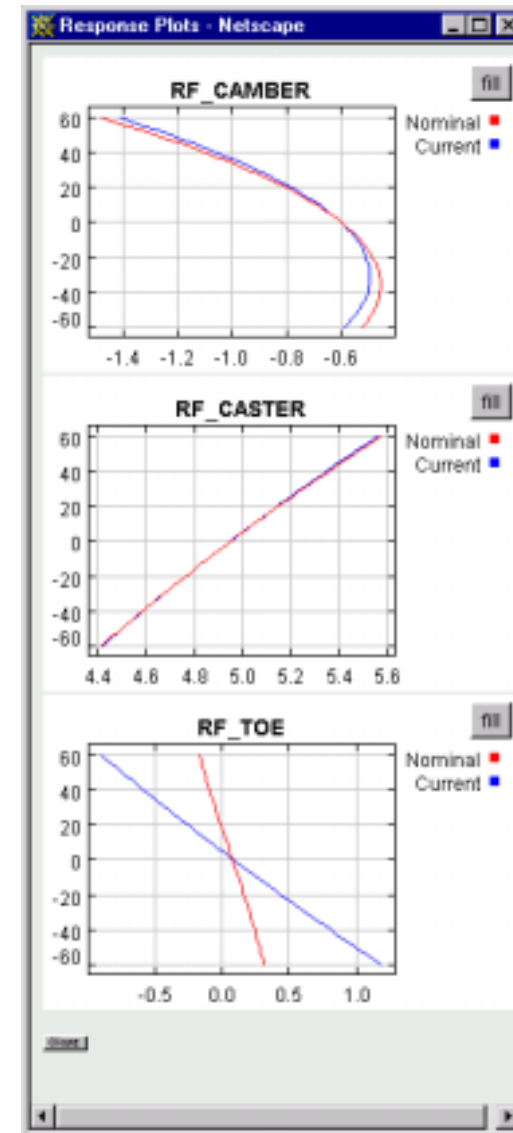
Responses from Experiment "TCC Case Study" - Netscape

Factor	Units	Current	Tolerance	Min	Nominal	Max	Description
front_pt12_x	mm	1.4050e+03	2.0000	1.3950e+03	1.4050e+03	1.4150e+03	Left Outer Tie Rod Ball X
front_pt12_y	mm	-6.6800e+02	2.0000	-6.7000e+02	-6.6800e+02	-6.5800e+02	Left Outer Tie Rod Ball Y
front_pt12_z	mm	5.3300e+02	2.0000	5.3000e+02	5.4300e+02	5.5300e+02	Left Outer Tie Rod Ball Z
front_pt12_x	mm	1.4050e+03	2.0000	1.3950e+03	1.4050e+03	1.4150e+03	Right Outer Tie Rod Ball X
front_pt12_y	mm	6.6800e+02	2.0000	6.5800e+02	6.6800e+02	6.7800e+02	Right Outer Tie Rod Ball Y

Response	Units	Current	Tolerance	Description
MAX_RF_TOE	deg	9.8909e-01	2.3184e-01	Maximum Left Front Toe
MAX_RF_TOE	deg	2.7549e-01	5.6040e-02	Maximum Right Front Toe

Plot	Units	Min X	Max X	Description
RF_CAMBER	deg	-60	60	Left Front Camber as function of spindle rise (2nd order polynomial)
RF_CASTER	deg	-60	60	Left Front Caster as function of spindle rise (2nd order polynomial)
RF_TOE	deg	-60	60	Left Front Toe as function of spindle rise (3rd order polynomial)

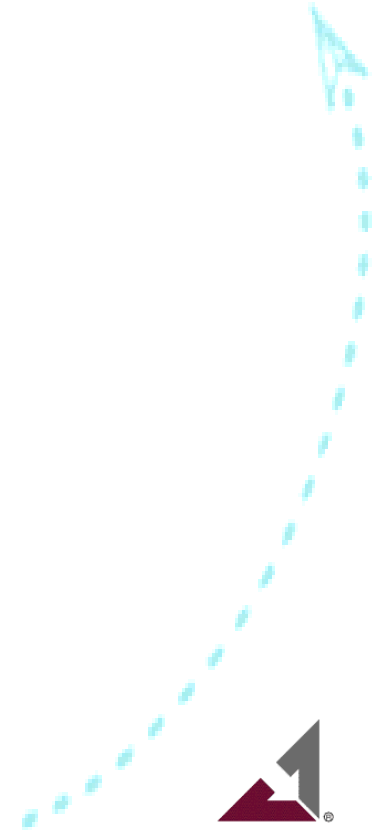
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Brief History of ADAMS Modeling

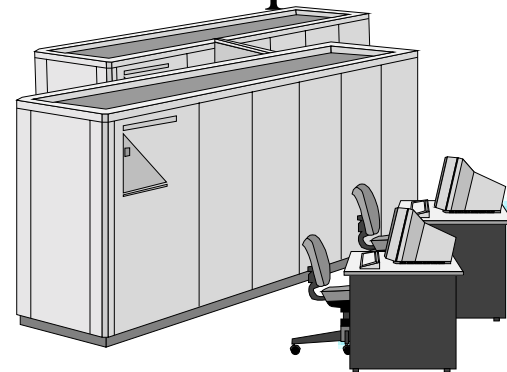




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In the Beginning (70s-80s)

- ADAMS/Solver
- Focus was on developing ONE model of ONE design
- Evaluation of design change required modeling expertise, could be time-consuming
- Evaluation of design change was error-prone





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Parametric Modeling (90s)

- Pre-processors developed for specific systems
- Analysts maintained model parameters
- Standard modeling practices leveraged throughout organization
- Attribute specialists no longer needed to be ADAMS experts to get job done
- A/B comparisons faster





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Today

- Analyst quickly evaluates design *space*
- Analyst quickly communicates results to organization





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The Power of Virtual Prototyping

- He who connects first wins

