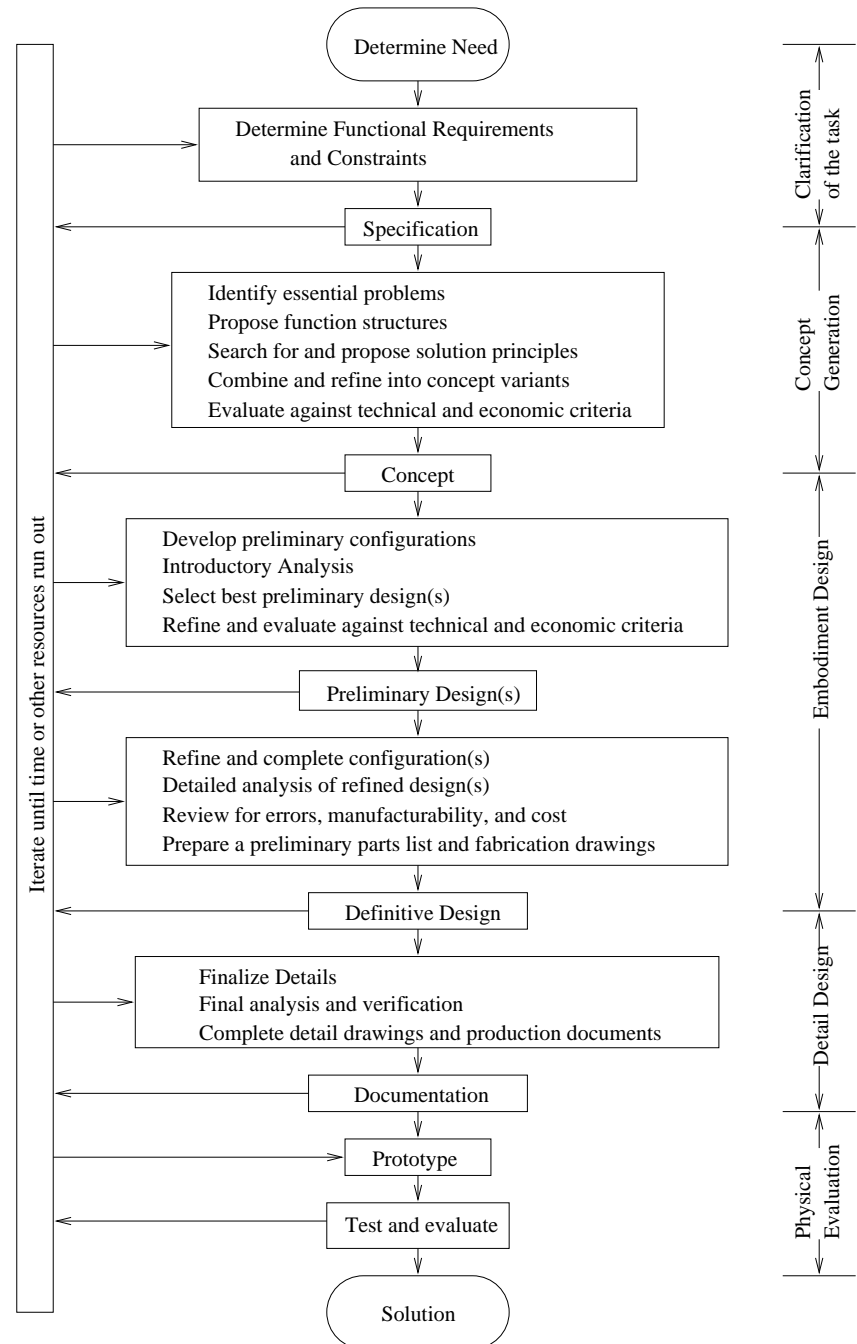
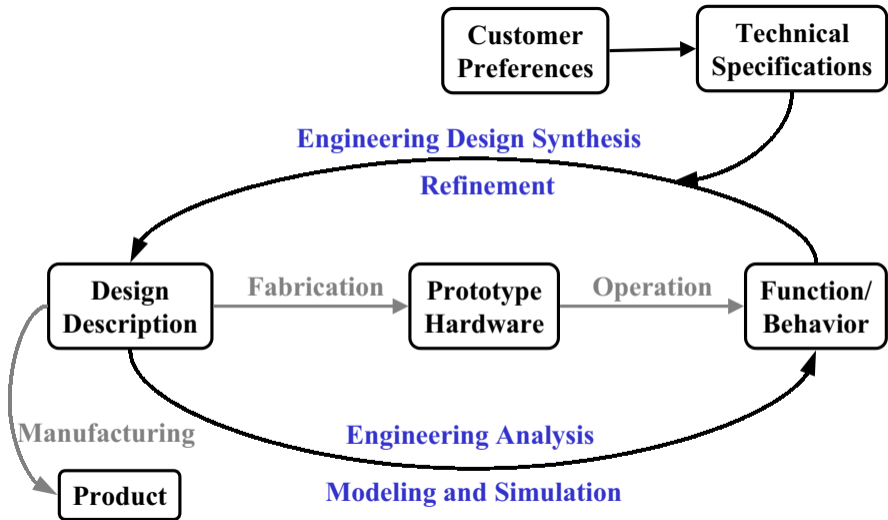


Traditional Engineering Design

[G. Pahl and W. Beitz,
Engineering Design,
 The Design Council,
 Springer-Verlag,
 New York, 1984, page 41.]





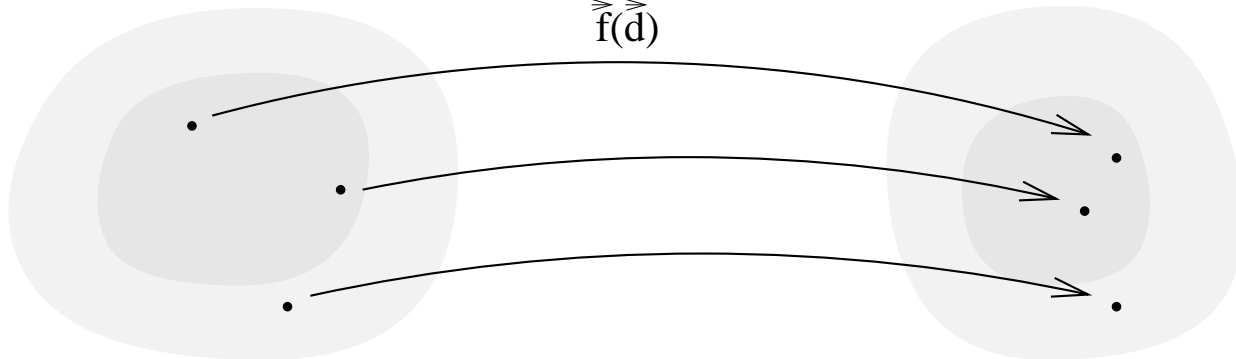
DVS

(Design Variable Space)

PVS

(Performance Variable Space)

$\vec{f}(\vec{d})$

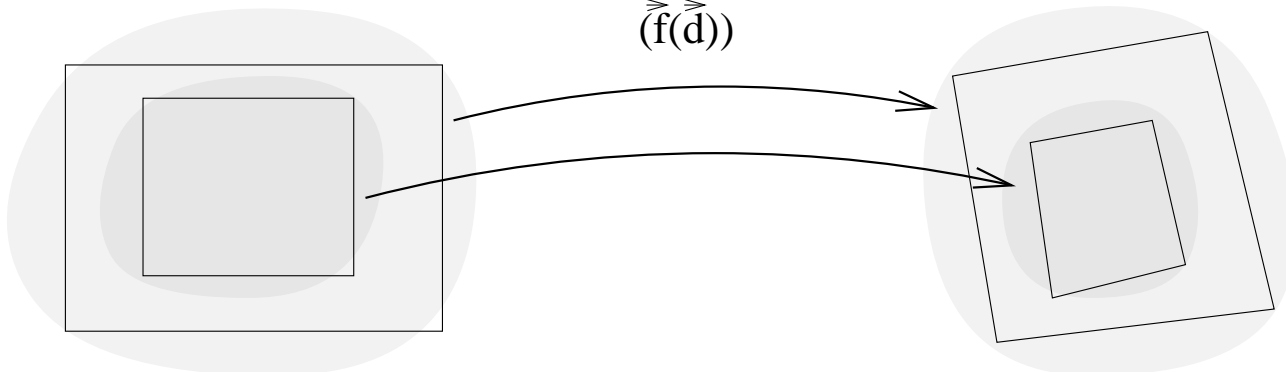


**Design Exploration
Point by Point**

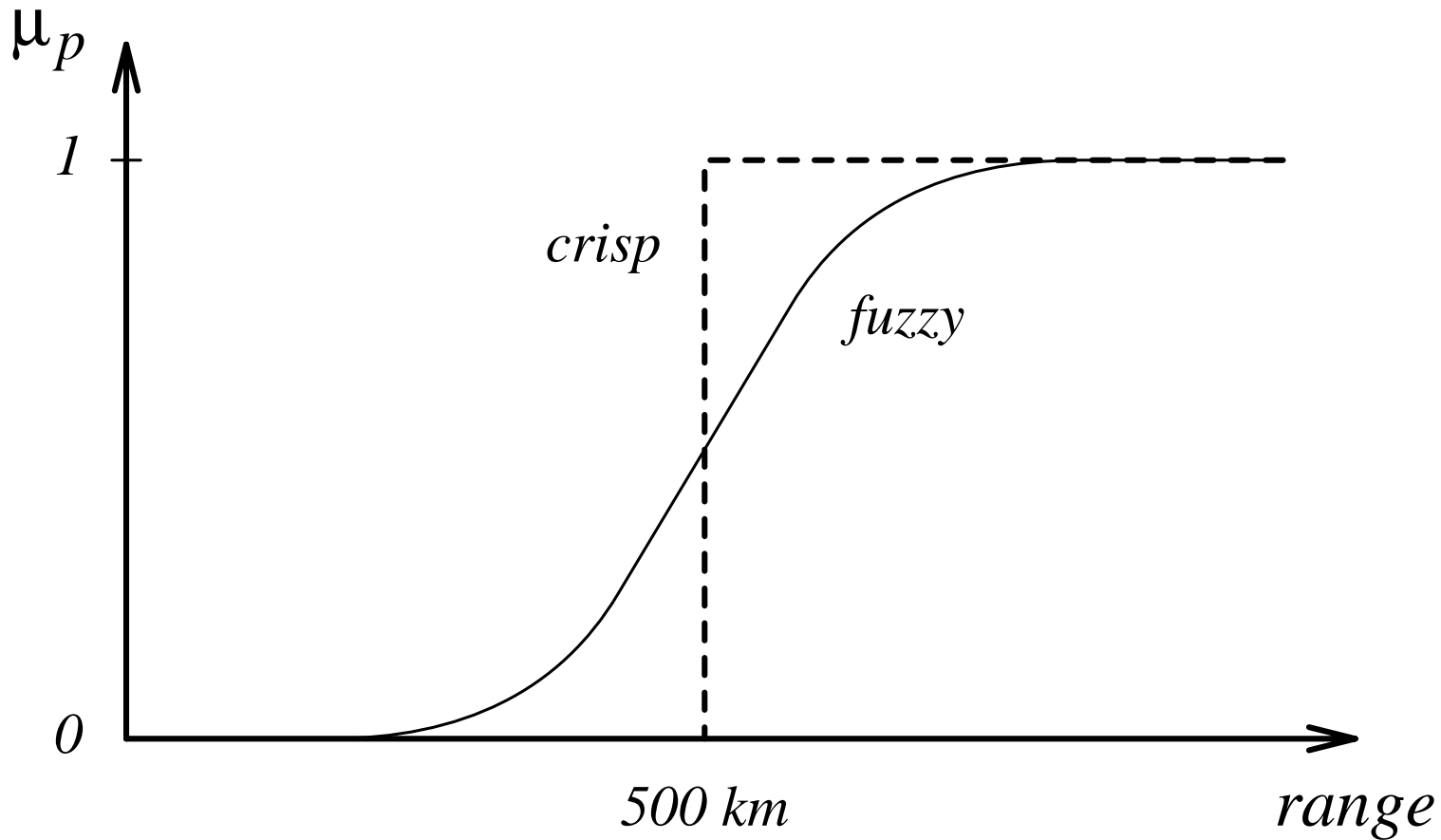
DVS

PVS

$\vec{f}(\vec{d})$



**Design Exploration
Sets at a Time**



Aggregation Operator Axioms

At each point \vec{x} the following hold:

1. **Monotonicity:**

$$\begin{aligned} \mathcal{P}(\mu_1, \mu_2; \omega_1, \omega_2)(\vec{x}) &\leq \mathcal{P}(\mu_1, \mu'_2; \omega_1, \omega_2)(\vec{x}) \quad \forall \mu_2(\vec{x}) \leq \mu'_2(\vec{x}) \\ \mathcal{P}(\mu_1, \mu_2; \omega_1, \omega_2)(\vec{x}) &\leq \mathcal{P}(\mu_1, \mu_2; \omega_1, \omega'_2)(\vec{x}) \quad \forall \omega_2 \leq \omega'_2; \mu_1(\vec{x}) < \mu_2(\vec{x}) \end{aligned}$$

2. **Symmetry:**

$$\mathcal{P}(\mu_1, \mu_2; \omega_1, \omega_2)(\vec{x}) = \mathcal{P}(\mu_2, \mu_1; \omega_2, \omega_1)(\vec{x})$$

3. **Continuity:**

$$\begin{aligned} \mathcal{P}(\mu_1, \mu_2; \omega_1, \omega_2)(\vec{x}) &= \lim_{\mu'_2(\vec{x}) \rightarrow \mu_2(\vec{x})} \mathcal{P}(\mu_1, \mu'_2; \omega_1, \omega_2)(\vec{x}) \\ \mathcal{P}(\mu_1, \mu_2; \omega_1, \omega_2)(\vec{x}) &= \lim_{\omega'_2 \rightarrow \omega_2} \mathcal{P}(\mu_1, \mu_2; \omega_1, \omega'_2)(\vec{x}) \end{aligned}$$

4. **Idempotency:**

$$\mathcal{P}(\mu, \mu; \omega_1, \omega_2)(\vec{x}) = \mu(\vec{x}) \quad \forall \omega_1 + \omega_2 > 0$$

5. **Annihilation:**

$$\mathcal{P}(\mu, 0; \omega_1, \omega_2)(\vec{x}) = 0 \quad \forall \omega_2 \neq 0$$

6. **Self-scaling weights:**

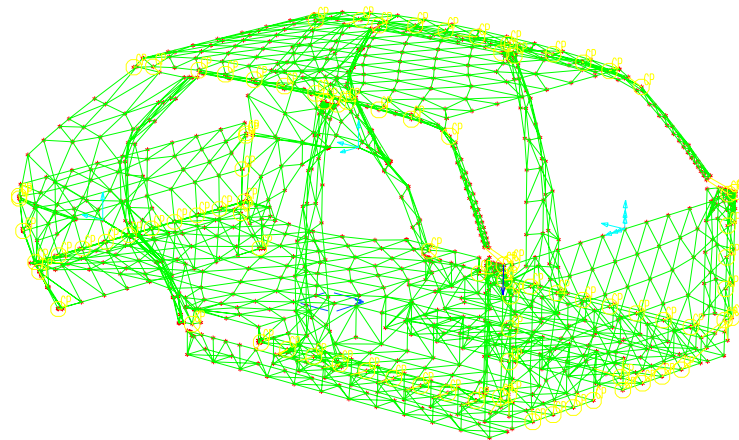
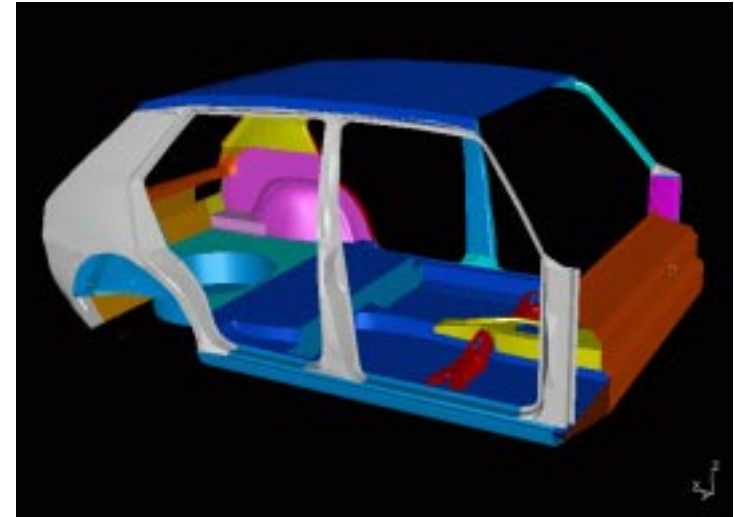
$$\mathcal{P}(\mu_1, \mu_2; \omega_1 t, \omega_2 t)(\vec{x}) = \mathcal{P}(\mu_1, \mu_2; \omega_1, \omega_2)(\vec{x}) \quad \forall \omega_1 + \omega_2, t > 0$$

7. **Zero weights:**

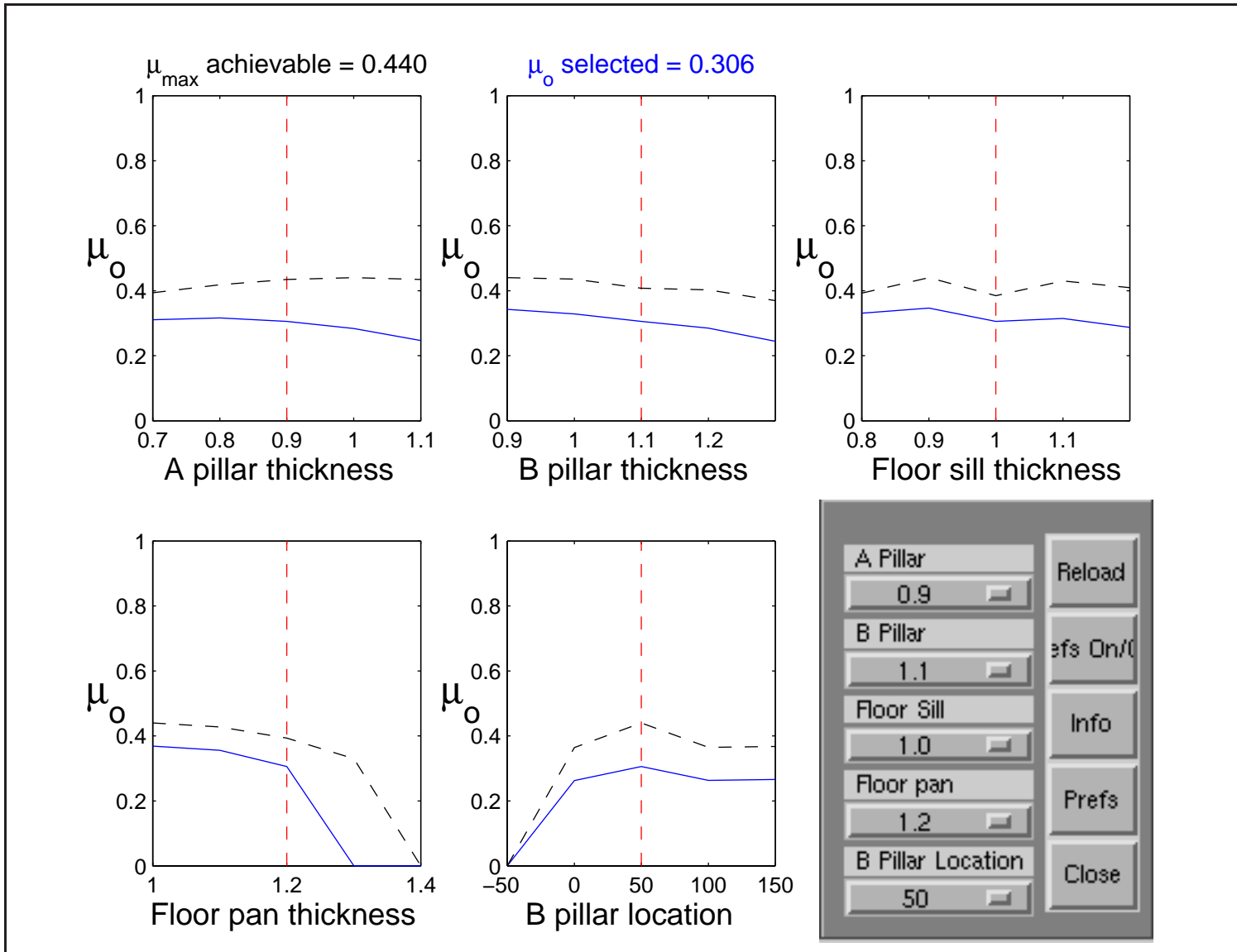
$$\mathcal{P}(\mu_1, \mu_2; \omega_1, 0)(\vec{x}) = \mu_1(\vec{x}) \quad \forall \omega_1 \neq 0$$

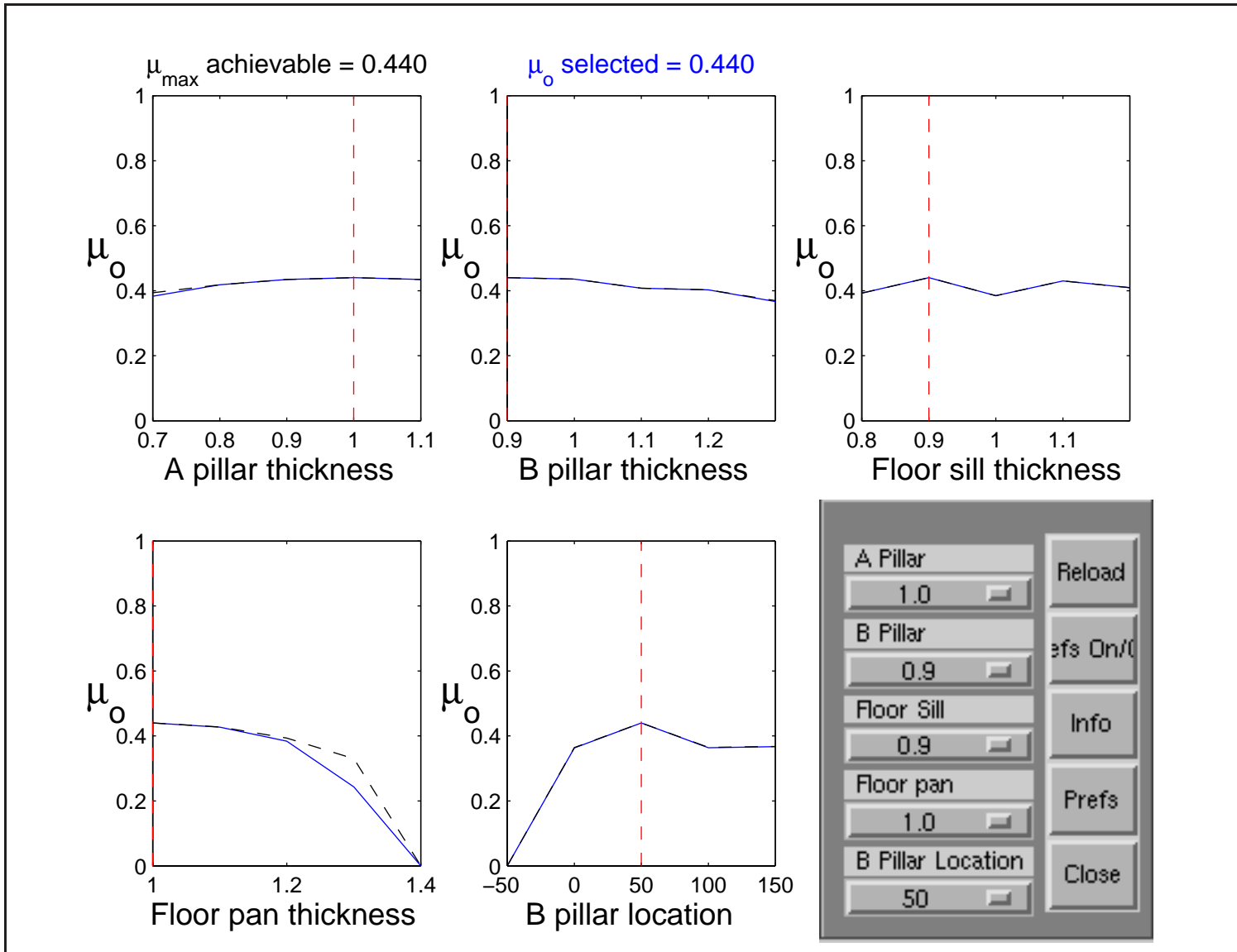
Current Related Work at Caltech

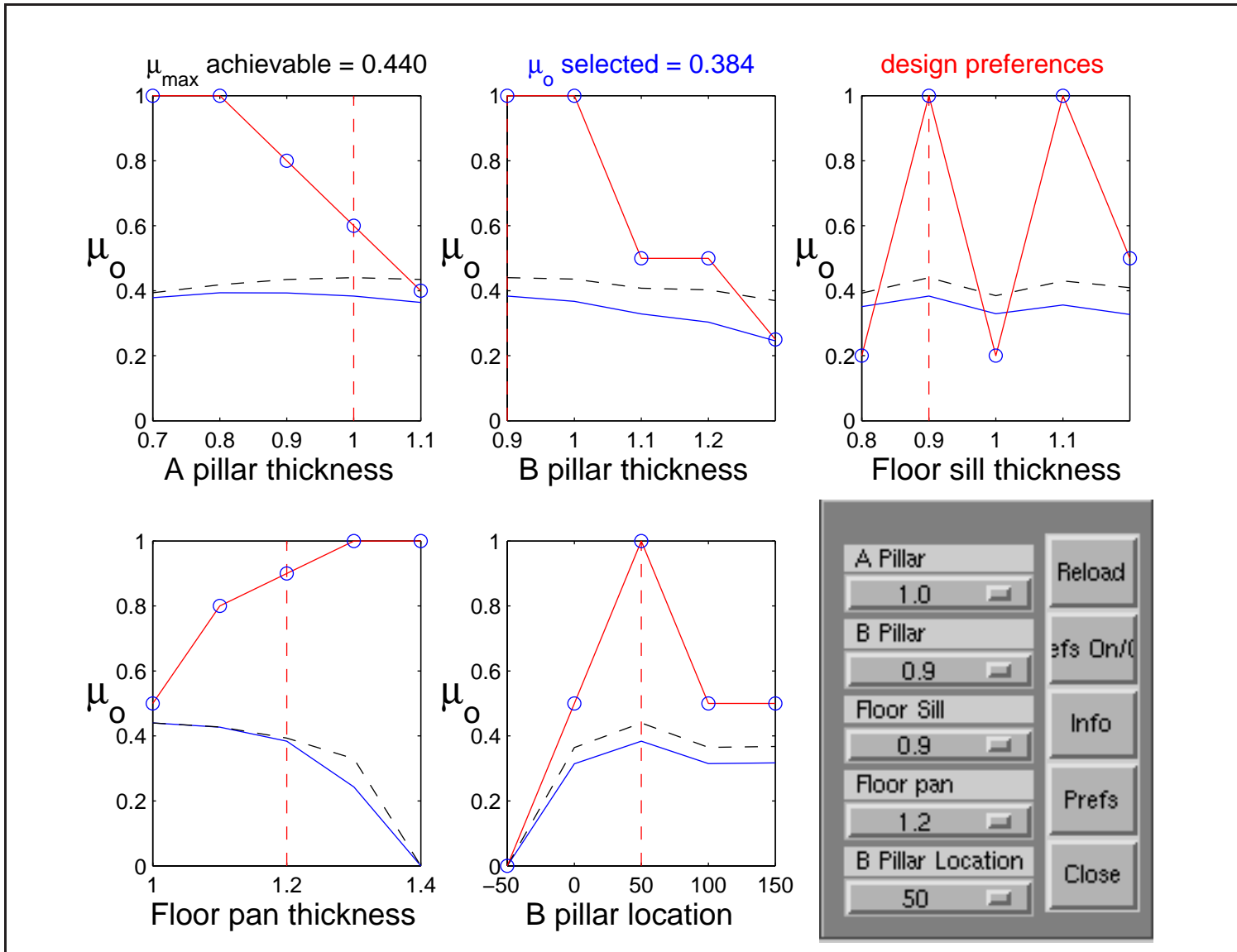
Rapid Exploration of a Large Design Space

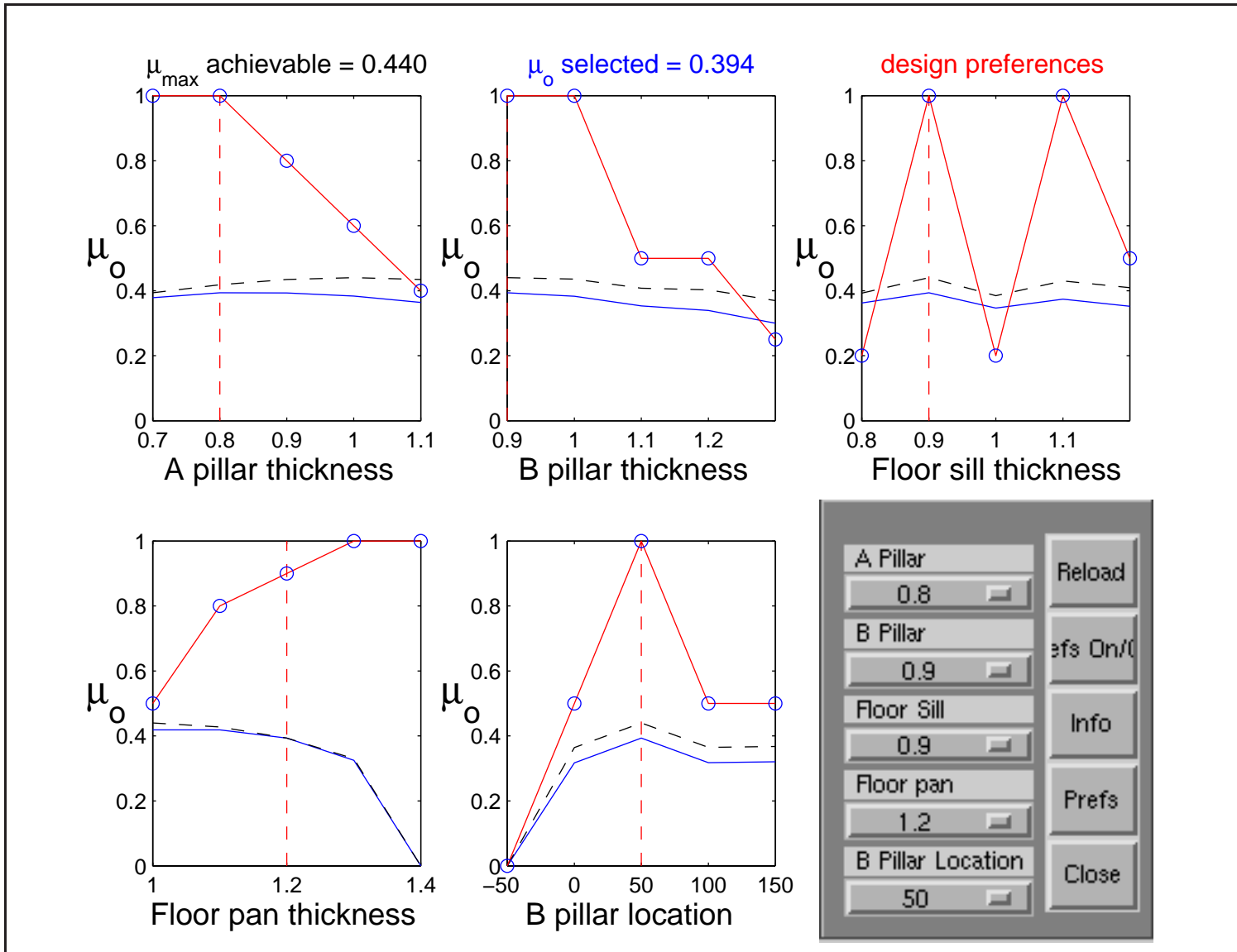


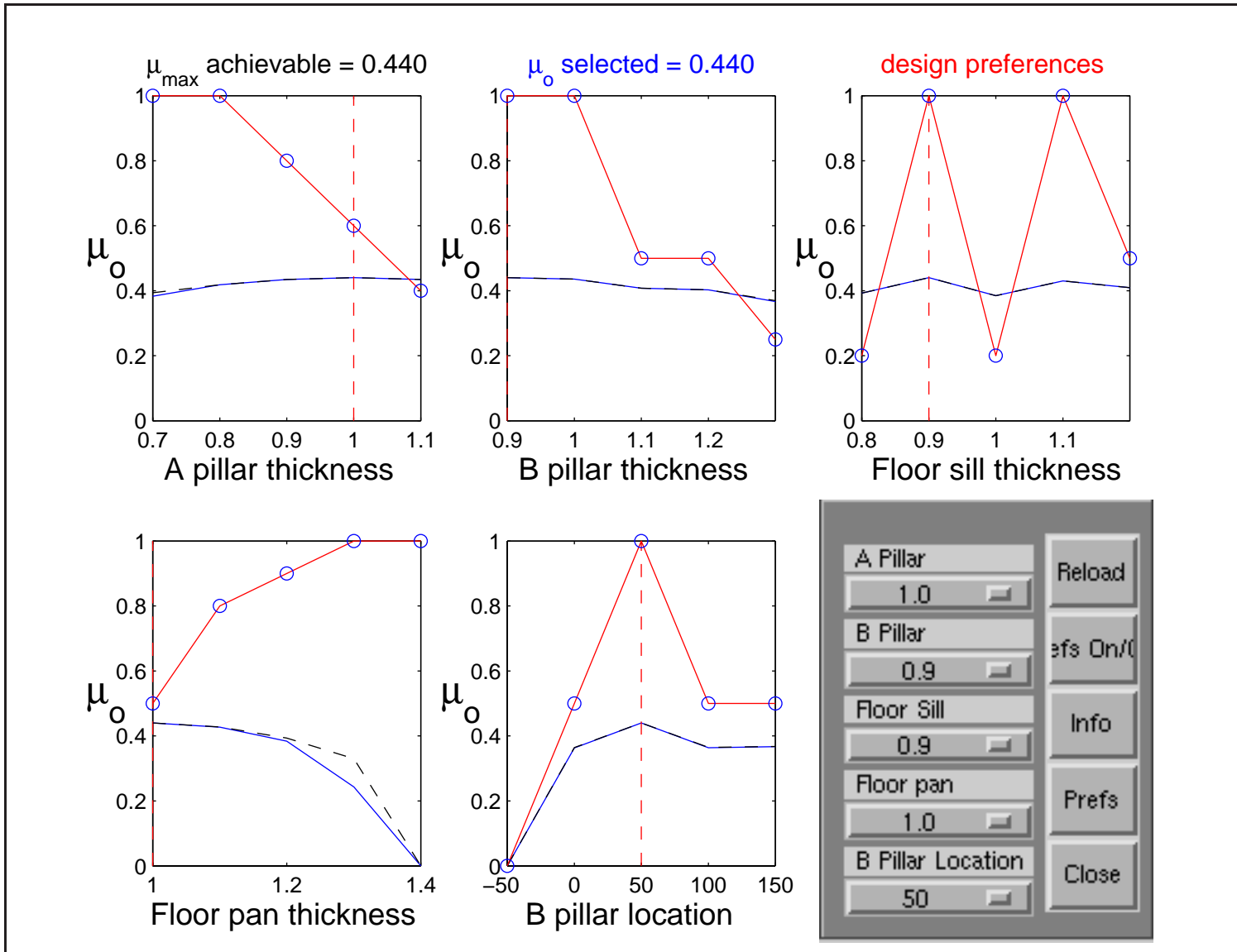
z





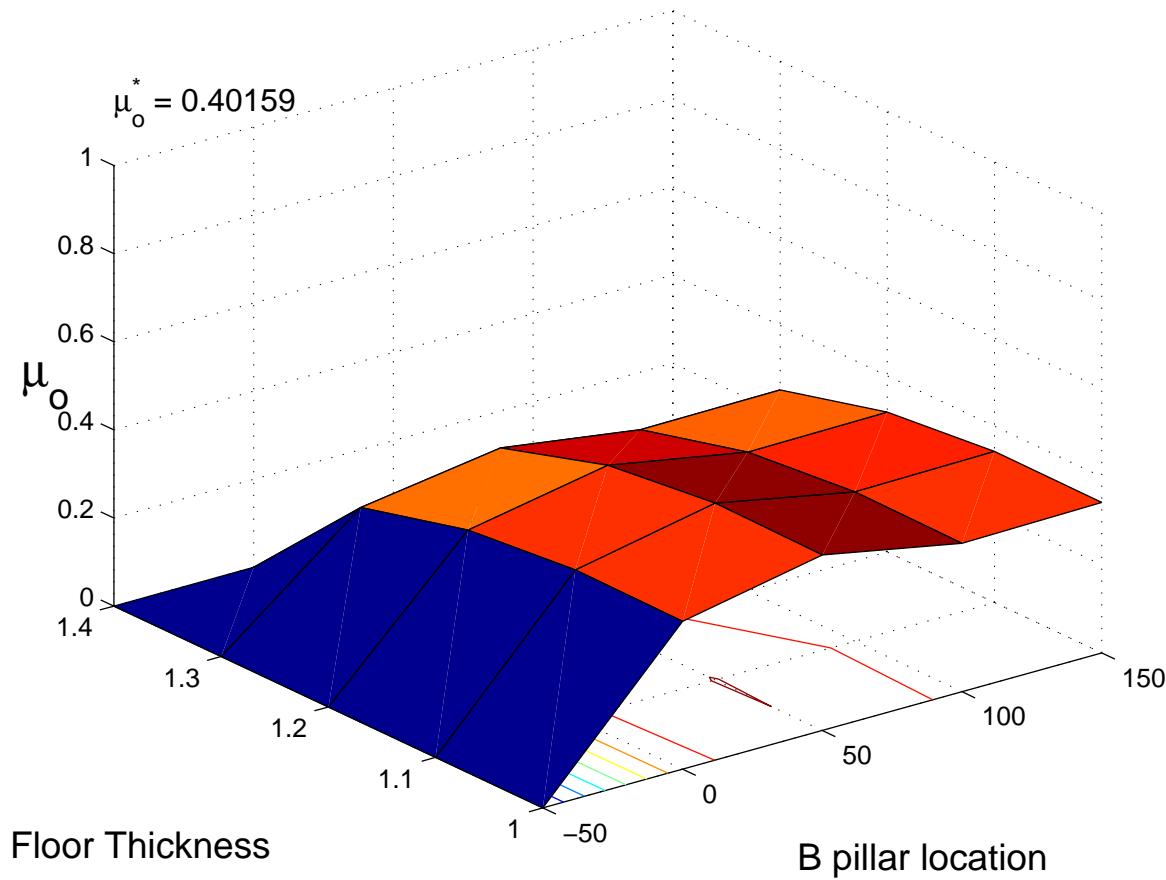






Current Related Work at Caltech

Rapid Exploration of a Large Design Space



Floor Thickness

B pillar location

```
MiniCommand Window
global DATA
dv(1) = 0.7; i1=1;
```

A Pillar Thickness	0.7	
B Pillar Thickness	1.1	
Floor Rail Thickness	0.8	
Floor Thickness	free	
B Pillar Location	free	
Info	Prefs	
X	Y	Iso
Close		

Sobieski Paradox (1988)

