The Case for Thoroughly Testing Complex System Dynamics Models

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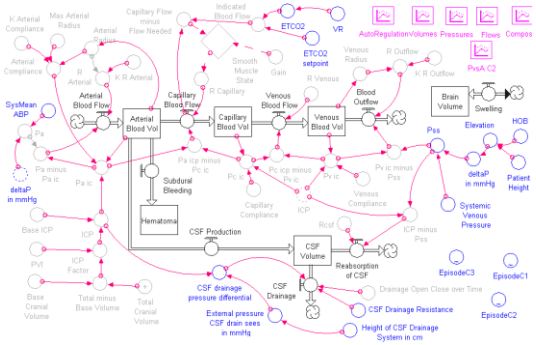
http://cgi.albany.edu/~sdsweb/sds2005.cgi?P201

Objective

Determine the utility of the various SD model tests recommended in the literature.

Method

The Subject Model [1]



The Model Tests Evaluated [2]

- Sensitivity (11)
- Extreme Conditions (5)
- Boundary Adequacy (1)
- Structure Assessment (2)
- Dimensional Consistency (3)
- Parameter Assessment (4)
- Integration Error (6)
- Behavioral Reproduction (7)
- Behavior Anomaly (8)
- Family Member (9)
- Surprise Behavior (10)
- System Improvement (12)

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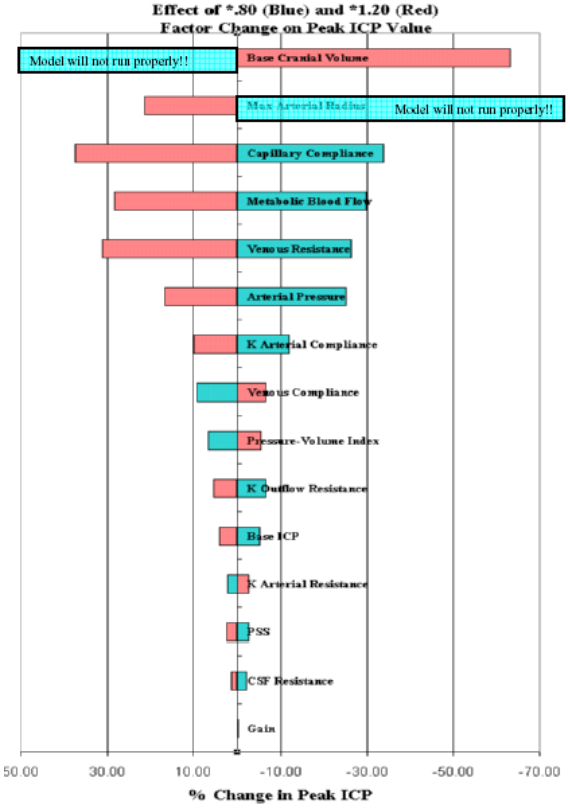
The Procedure

A. Perform each recommended model test
B. Document results, incl. time required (its cost)
C. Subjectively assess benefits
D. Rank the tests in terms of benefit/cost

Results

Model Sensitivity Test Results: Impact of +/- 20% Parameter Value Changes ("Tornado" diagram)



Extreme Conditions Test Results

	Factor	Lower Boundary (As a fraction of the baseline value)	Upper Boundary (As a fraction of the baseline value)
1	Venous Resistance	0.80	1.75
2	Max Arterial Radius	0.82	3.67
3	K Arterial Resistance	0.77	5.77
4	Arterial Pressure	0.85	no limit
5	PSS	0.00	1.27
6	Pressure-Volume Index	0.07	1.45
7	Gain	0.00	1.59
8	K Arterial Compliance	0.04	1.94
9	Base Cranial Volume	0.00	6.40
10	Base ICP	0.01	8.41
11	K Outflow Resistance	0.00	15.00
12	Capillary Compliance	0.00	34.50
13	Venous Compliance	0.25	no limit
14	Metabolic Blood Flow	0.02	no limit

Summary of Model Test Utility (Cost vs. Benefit)

TEST	COST	BENEFIT	BENEFIT/COST
Integration Error	Low	High	Very High
Extreme Condition	Low	High	Very High
Family Member	Low	High	Very High
Structure Assessment	Low	Moderate	High
Dimensional Consistency	Low	Moderate	High
Boundary Adequacy	Low	Moderate	High
Parameter Assessment	Medium	High	Medium High
Behavioral Anomaly	Medium	High	Medium High
Surprise Behavior	Medium	High	Medium High
Behavioral Reproduction	High	High	Medium
System Improvement	High	High	Medium
Sensitivity	High	Moderate	Low

Conclusion

While all of the recommended model tests are beneficial, their utility varies considerably.

References

[1] Wakeland, Wayne, and Brahm Goldstein. 2005. A computer model of intracranial pressure dynamics during traumatic brain injury that explicitly models fluid flows and volumes. *Acta Neurochirurgica* (in press).

[2] Sterman, John. 2000. *Business Dynamics: Systems Thinking and Modeling for a Complex World.* Irwin McGraw-Hill.