CONTRACTUAL SAFETY OF MODEL-BASED REQUIREMENTS: PRELIMINARY RESULTS OF AN EXPERIMENTAL STUDY

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RESEARCH QUESTION

- PROBLEM
  - Textual requirements do not provide acceptable levels of contractual safety
  - They remain a major source of problems in acquisition programs

- PROPOSED SOLUTION
  - Model-based requirements have been proposed as an alternative to textual requirements, with the promise of enabling higher accuracy, precision, and completeness when eliciting requirements
  - This promise has not been demonstrated yet

- RESEARCH QUESTION:
  - Examining this promise and demonstrate whether it is an acceptable alternative.

RESEARCH DESIGN

- 40 Participants volunteered to conduct the experiment.

- Divided into the control group (textual req) and experiment group (Model-based req)

- Designed a 10-hour training session to avoid confounding effects.

- Training conducted by independent instructors.

- Created randomly assigned teams of two students

- All the teams worked on the same problem statement.

HYPOTHESIS

The study was designed to test the following three hypotheses:

- H1. Model-based requirements yield less unbounded requirements than textual-based requirements.

- H2. Model-based requirements yield less unnecessary constraints than textual-based requirements.

- H3. Model-based requirements achieve higher completeness than textual-based requirements.

FACTORS MEASURED IN DESIGN

Four dependent variables were measured:

- <u>Number of inapplicable requirements</u>. This variable provides a measure of the actual effectiveness of both the control method and the experimental method to elicit inapplicable-free requirements.

- <u>Number of unnecessary constraints</u>. This variable provides a measure of the actual effectiveness of both the control method and the experimental method to elicit unnecessary requirements, such as solution-dependent ones.

- <u>Number of unbounded requirements</u>. This variable provides a measure of the actual effectiveness of both the control method and the experimental method to elicit adequately bounded requirements.

- <u>Level of completeness of the requirement set</u>. This variable provides a measure of the completeness of the resulting requirement sets when using both the method employed by the control group and the method employed by the experimental group.
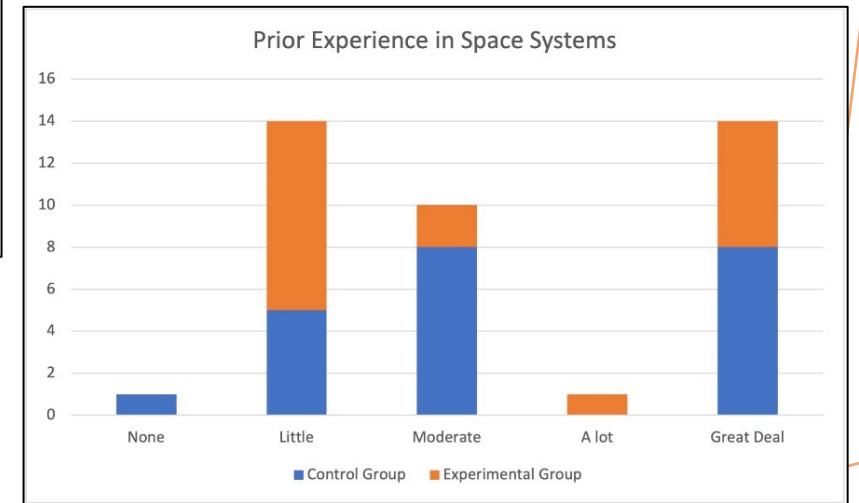
GROUP COMPOSITIONS
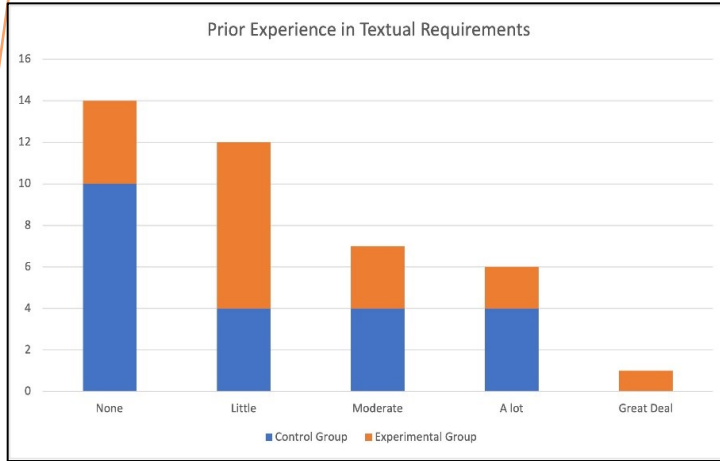
Prior experience using textual requirements
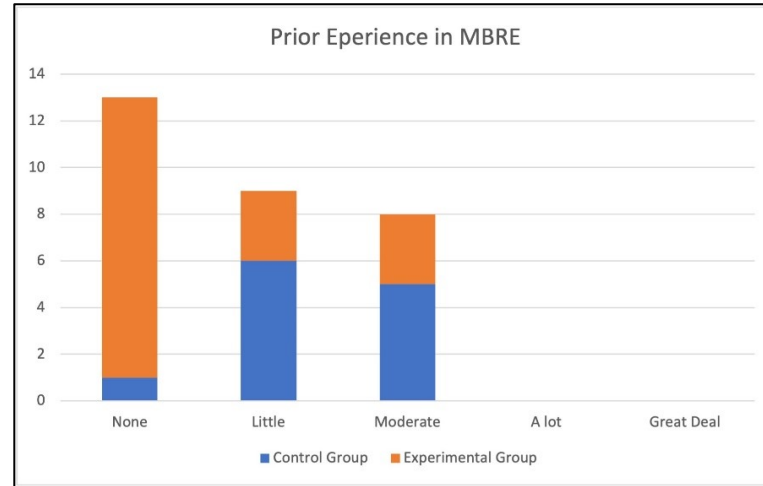
Prior experience using MBSE.

Prior experience in designing or working with space systems.

EVALUATION OF TEXTUAL REQ

Summary assessment of textual requirements

Project	Total Req	Unbounded Req	Unnecessary constraint	Inapplicable Req	Adequate Req
1	45	16	10	16	4 (10%)
2	145	49	40	55	7 (5%)
3	98	27	41	1	32 (33%)

Requirement examples from the participants' responses.

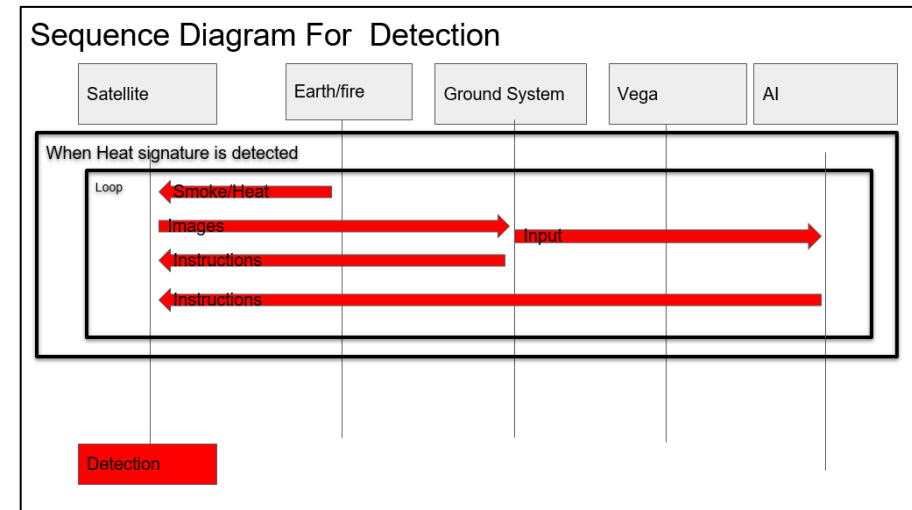| Unbounded requirements	The system shall provide space-based "fire-scouts" that survey the US daily.
Unnecessary constraints	The antenna shall allow the satellite to communicate with the ground.
Inapplicable requirements	The rockets shall withstand temperatures from XXX-to-XXX-degree Fahrenheit.

Comparison against performance of practicing engineers.

Variable		Practicing engineers [48]	This experiment
Relative number of unbounded requirements	Mean	n/a	32%
	Median	n/a	34%
Relative number of unnecessary constrains.	Mean	27%	31%
	Median	26%	28%
Relative number of inapplicable requirements	Mean	16%	25%
	Median	18%	36%

CONTROL AND EXPERIMENT GROUPS COMPARISON

Results comparison between control and experiment groups.

Variable		Control group (textual reqs)* (sample size = 3)	Experiment group (TMBR) (sample size = 1)
Relative number of unbounded requirements	Mean	32%	0%
	Median	34%	0%
Relative number of unnecessary constrains.	Mean	31%	0%
	Median	28%	0%
Relative number of inapplicable requirements	Mean	25%	0%
	Median	36%	0%
Adequate requirements	Mean	14	31
	Median	7	31
Coverage	Mean	26%	51%

Example of MBRE

THANK YOU