



Applying Jury Trial Process Wisdom to Tradeoff Studies:

Hybridization of Systems Engineering and the Law

Odin Smith, Oscar Salcedo, Eric Smith

RIMES: Research Institute for Manufacturing & Engineering Systems

IMSE: Industrial, Manufacturing and System Engineering Dept.



Abstract



	Lunar Enhanced	ILC-1	ILC-2	ILC-3
GLOW, lbs	5,288,699	5,736,486	5,959,860	9,175,392
Height, ft	184	269	283	269
Payload size	6.5 m x 25 m	7.5 m x 30 m	7.5 m x 30 m	7.5 m x 30 m
23.5 deg using EDS stage for OMS (EO)	96.1 mt (99.3 mt)	111.5 mt (95.0 mt)	120.0 mt (112.7 mt)	158.9 mt (143.3 mt)
23.5 deg using OMV stage for OMS (EO)	90.7 mt (85.4 mt)	106.6 mt (90.8 mt)	114.7 mt (107.6 mt)	151.7 mt (136.9 mt)
51.6 deg using OMV stage for OMS (EO)	80.1 mt (75.3 mt)	93.5 mt (79.7 mt)	100.5 mt (92.5 mt)	133.6 mt (120.1 mt)
Comments	3 x SSME, 2 x 5-seg SRBs	4 x SSME, ET stretch 170 Kb added prop; 2 x 5-seg SRBs	3 x SSME, ET stretch 255 Kb added prop; 2 x 5-seg SRBs	4 x SSME, ET stretch 370 Kb added prop; 4 x 3-seg SRBs

Tradeoff studies: Branching tree structure to find best alternative matches ...

Law: conceptual schema to find the best alternative in the natural world of human occurrences.



Tradeoff Study components



Problem Statement

Final Score

Weight 1

Weight 2

Criteria 1

Criteria 2

Utility
functions

Utility
functions

Input Data

Input Data

Alternative 1

Alternative 2

Alternative 3

Judge

Trier-of-Law

Trier-of-Fact

Jury

INCOSE SE Handbook:

3 types of tradeoff studies



Formal. These trades use a standardized methodology, are formally documented, and reviewed with the customer or internally at a design review.

Informal. These trade studies follow the same kind of methodology, but are only recorded in the engineer's notebook and are not formally reviewed.

Mental. appropriate when the consequences of the selection are not too important; when one alternative clearly outweighs all others; or when time does not permit a more extensive trade."

Comparison



Tradeoff studies lend precision to this hybridization, while ...

Legal processes can provide wisdom as to the management of human perceptions & biases

Cross-disciplinary comparison

Complementary qualitative and quantitative

Different apparatus best studied together.

Translation stacks of Engineering and the Law



Engineering



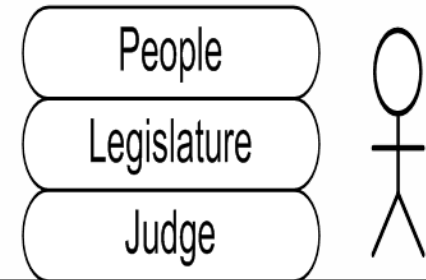
Criteria / Attributes

Data

Measures

Engineer

Law



Laws

Facts

Evidence

Jury / Judge

Active jury:

Process to investigate facts & decide case



Passive Jury:

Process to consider evidence and find facts



Adversarial process:



Test potential solutions by having subject-matter expert witnesses take on the role of devil's advocates to probe for and identify weaknesses in the trade study facts or assumptions made about the facts.

Requiring engineers to defend their solutions in internal design reviews has been suggested as a way to overcome biases

Judge:



Coordinate formal tradeoff studies employing multiple parties

Accurate application of the decision rules

Impartial senior engineer with relevant technical expertise and broad experience.

Resolve disputes

Ensure decision process completes

Jury:



Trier-of-Facts

Credibility of witnesses

Political legitimacy

Community representatives embody a general expertise in the customs and standards of a society, as well as the common features of everyday life.

Collective experience of the jury thus equips it to evaluate evidence, the credibility of witnesses, and ultimately to pass judgment on the conformance of the actions at issue to the rules of law.

Advocates:

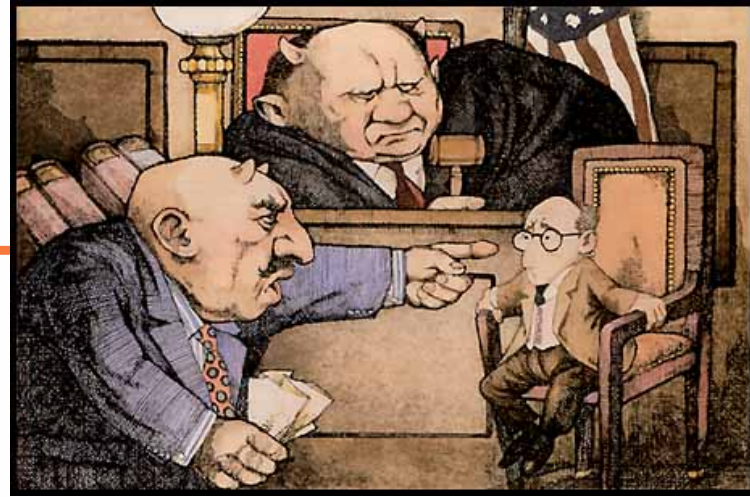


Contending alternatives are each presented and argued for by motivated supporters

Engineers are subject **cognitive biases**

Easy for an engineer to subconsciously favor one alternative over others for reasons of bias, rather than fully reasoned analysis.

Cross- Examination:



“Greatest legal engine ever invented for the discovery of truth.” [1]

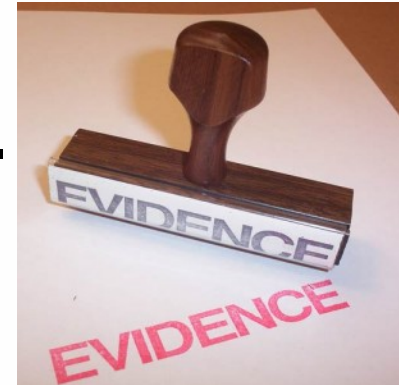
Opposing parties may question each other’s witnesses.
Probe the weaknesses of the opposing argument,
Expose the inconsistencies and logical contradictions of
witness testimony, and to
Question the qualifications, credibility, and impartiality of
an expert witness.
More dynamic mechanism than peer review.

[1] California v. Green, 399 U.S. 149, 158, 90 S. Ct. 1930, 1935, 26 L. Ed.2d 489 (1970) (quoting 5 Wigmore, Evidence § 1367).

Rules of evidence:



Rule for the admissibility of evidence.
Federal Rules of Evidence (FRE)



FRE 403 if its probative value is substantially outweighed by a danger of unfair prejudice

Extremely graphic evidence of violence, which is likely to elicit a decision from the jury based on emotion rather than reason

Relevance:



Threshold requirement for the admission of evidence is that the evidence be relevant. [FRE 402]

“Relevant evidence means evidence having any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence” [FRE 401].

Engineer must decide what soft indicators tend to establish the existence of factors that are directly important to the decision case.



Credibility and Reliability:



Jury determines the ...

Credibility and Reliability of evidence

Panel of engineering experts in a formal tradeoff study can reduce the likelihood of error



**Building
Credibility**



Exclusion of Evidence:



Relevant evidence may be excluded “if its probative value is substantially outweighed by a danger of one or more of the following: unfair prejudice, confusing the issues, misleading the jury, undue delay, wasting time, or needlessly presenting cumulative evidence.” [FRE 403]

- 1, Ensure efficiency in the trial process
- 2, Reduces biases in the jury’s decision

Expert testimony:



FRE 701: only an expert may testify on the basis of scientific, technical, or other specialized knowledge.

A qualified expert may testify on the basis of relevant expertise if his testimony is based on sufficient data and the application of reliable principles and methods to the facts of the case.

[FRE 702]

***Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993)**

Judge acts as gatekeeper to exclude unreliable expert testimony

Testability—objective challenge to subjective conclusion

Peer review and publication;

Error rate of the technique or theory when applied;

Standards and controls

generally accepted in the scientific community.



Actual Cases and Controversies:

Article III, Section 2 of U.S. Constitution

No abstract and generalized grievances that are not concrete and definable

Ripe for review and not moot

Support of a critical situation that supports the form and substance of a supportable and purely engineering decision.

Creating benefit and relief

Advisory opinions are discarded by real decision makers



Co-Placement of representatives



Actively engaged:

Public represents the people

Judge represents the laws and the judicial establishment

Parties represent themselves and also the people

Lawyers are the proponents of arguments and cases.

Engineering debates:

Presence of all relevant stakeholders

Customer is present throughout a decision hearing, with top management serving as an arbiter between engineers pushing their cases forward with the help of representative counsel.

Conclusions



Engineering tradeoff studies could benefit from the use of trial-type procedures

Engineering decision rules formulated *a priori* may not encompass the variety of factual scenarios

Juries can be of great utility in making decisions in complex problems

Jury or panel of experts can reduce the risk of error

Jury trial: Hundreds of years of organic evolution, proven effective in the judicial determination of dispute

CONCLUSION



Baltimore & Ohio Railroad Co. v. Goodman, 275 U.S. 66 (1927)

Justice Oliver Wendell Holmes decided that a driver is contributorily negligent in a railroad grade-crossing collision if he fails to stop, and if necessary, get out of the vehicle to look, before crossing a railroad track.

Holmes believed that the discretion of the jury should be limited whenever a judge can determine a superior decision rule.^[1]

Rule was soon proven unworkable by factual situations in which grade-crossing accidents can occur

Jury discretion was restored in *Pokora v. Wabash Railway Co.*, 292 U.S. 98 (1934), in which Justice Benjamin Cardozo detailed situations in which **the rule was not only unreasonable, but actually dangerous**.

^[1] Robert L. Rabin, *Reassessing Regulatory Compliance*, 88 Geo. L.J. 2049 (2000)