



28th Annual **INCOSE**
international symposium

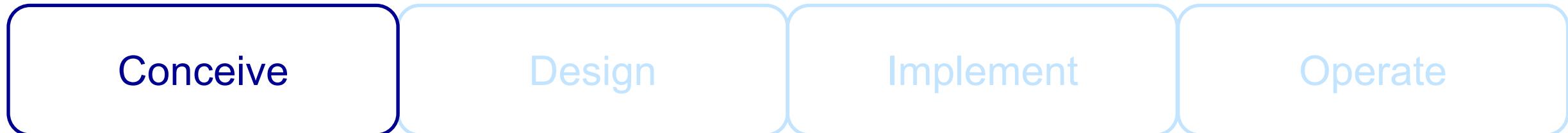
Washington, DC, USA
July 7 - 12, 2018

A Framework for Concept and its Testing on Patents

Yaroslav Menshenin (Skolkovo Institute of Science and Technology, Skoltech)
Prof. Edward Crawley (Massachusetts Institute of Technology, MIT)



Importance of Conceptual Design

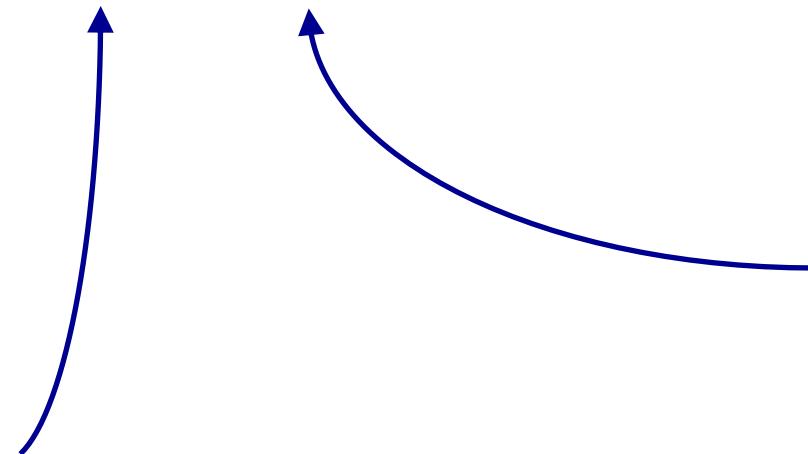


Conceive

Design

Implement

Operate



“In the conceptual design stage, design decisions have the greatest impact on the project outcomes with respect to functionality, performance, appearance, costs and sustainability” (Farid and Suh 2016)

Conceptual design “significantly affects the product novelty, performance, robustness, development time, value, and cost” (Kroll et al. 2001)



Objective of Work

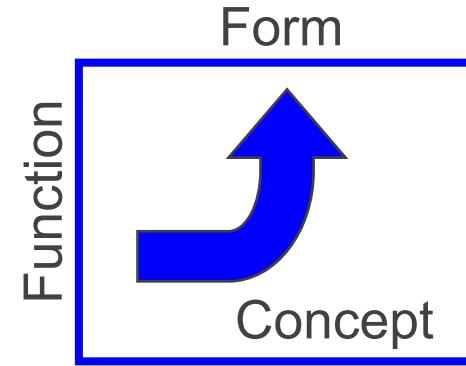
- Develop a model-based concept framework that represents concept's constituents, their definitions and interconnections
- Enable model-based conceptual design in concurrent engineering design environment
- Assess the proposed concept framework by mapping eight US patents, representing a broad spectrum of engineering systems and methods, to the concept framework



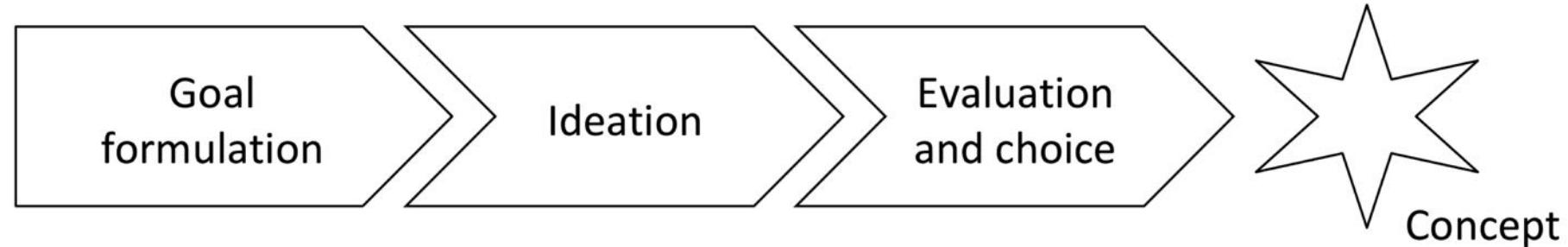
What is Concept?

A product or system vision, idea, notion or mental image which maps Function to Form

- Embodies *principle of operation*
- Includes an *abstraction of form*
- Outlines the solution to come
- Establishes the solution-specific vocabulary
- After the fact, concept rationalizes the architecture



Contemporary Concept Synthesis



Three major steps of Concept Synthesis Model (from Andreasen et al. 2015)

- Creative conceptualization
- A human process
- Not easy to represent analytically
- No indication of completeness or optimality



Adding Analytical Conceptualization

- Support brainstorming and creativity
- Analytical representation
- Comprehensive coverage of space
- Record and inventory of concepts
- Support of Concurrent Design Facilities



Essentials of Concept

Source: snowsbest.com

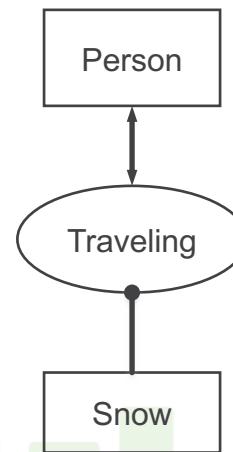
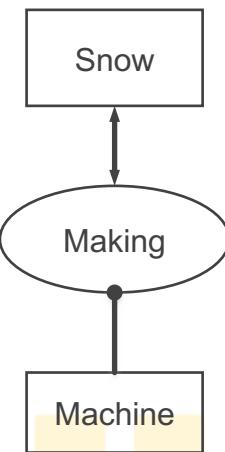


Snow Machine

Source: snowmobile-ed.com



Snow Machine



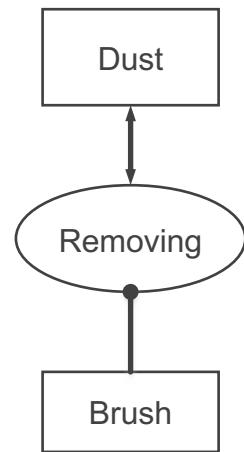


Essentials of Concept (2)

Source: fishersci.com



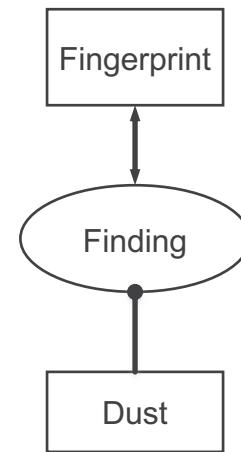
Dusting



Source: youtube.com



Dusting

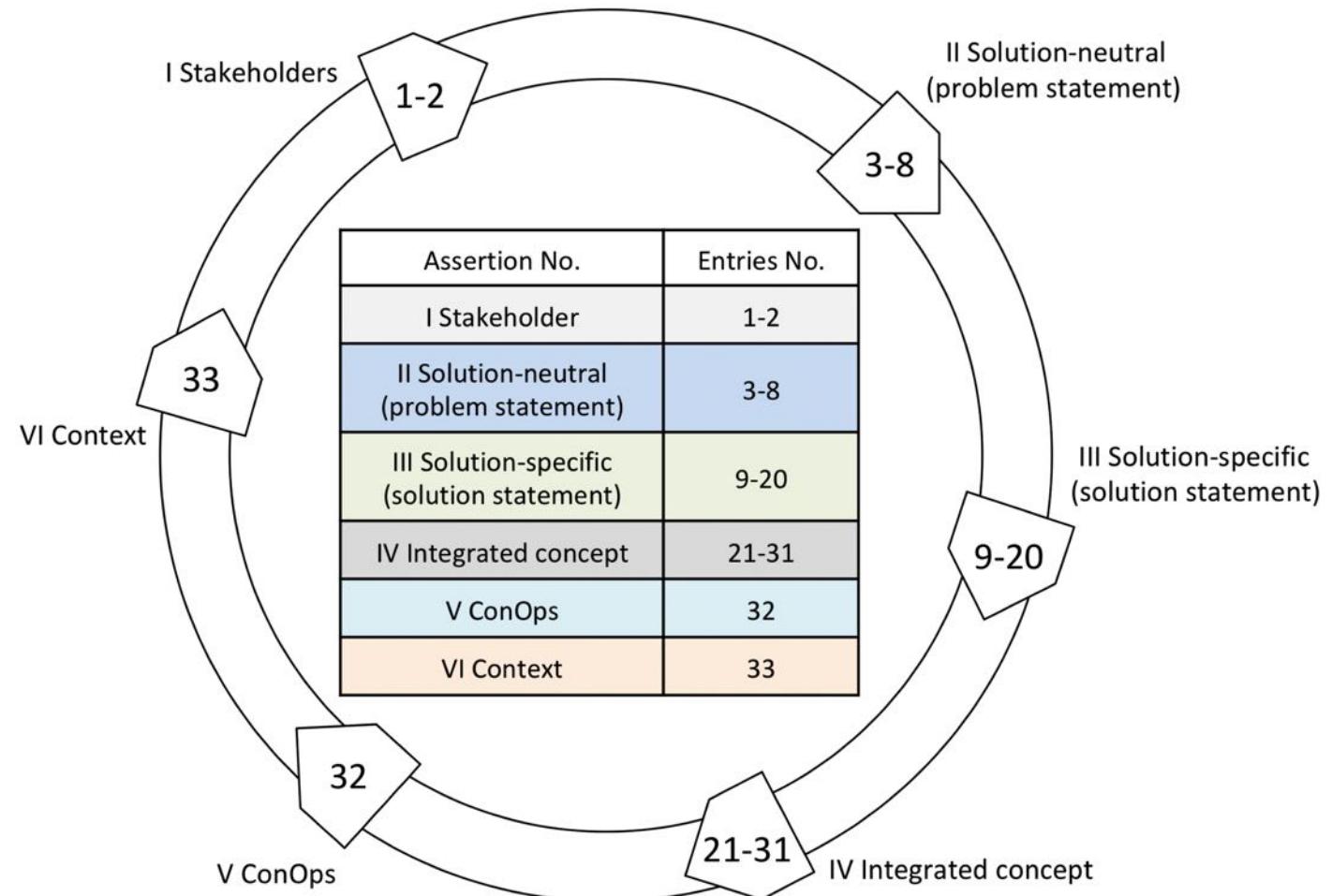




Concept Framework Model

Assertions of concept framework:

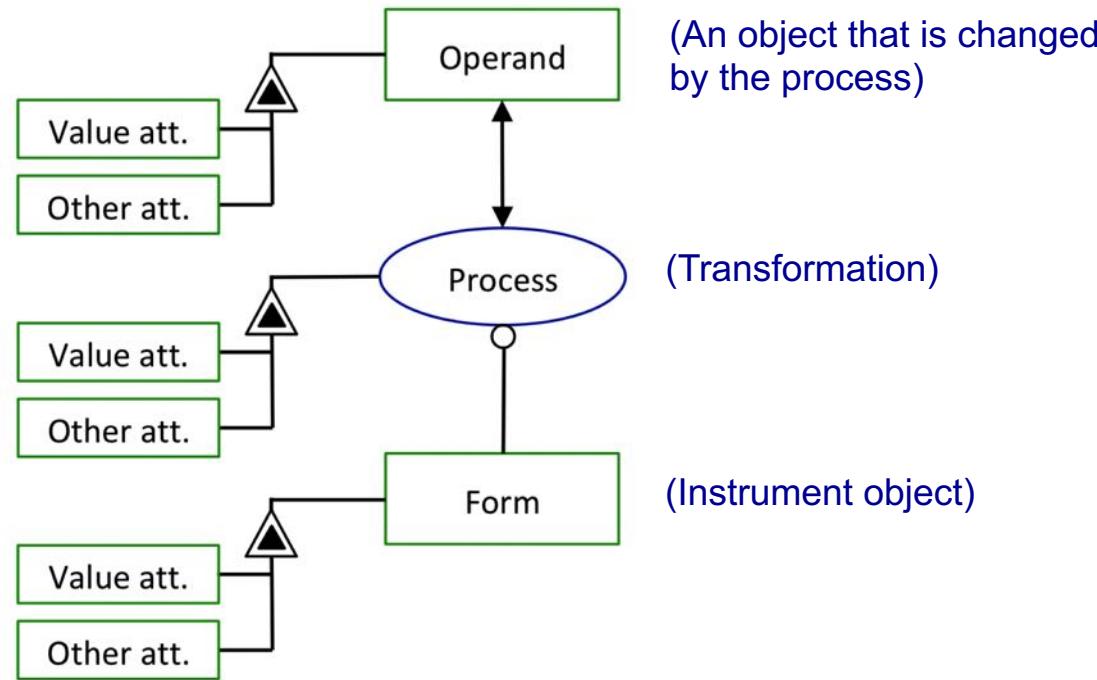
- I. Stakeholder
- II. Solution-neutral (problem statement)
- III. Solution-specific (solution statement)
- IV. Integrated concept
- V. ConOps
- VI. Context



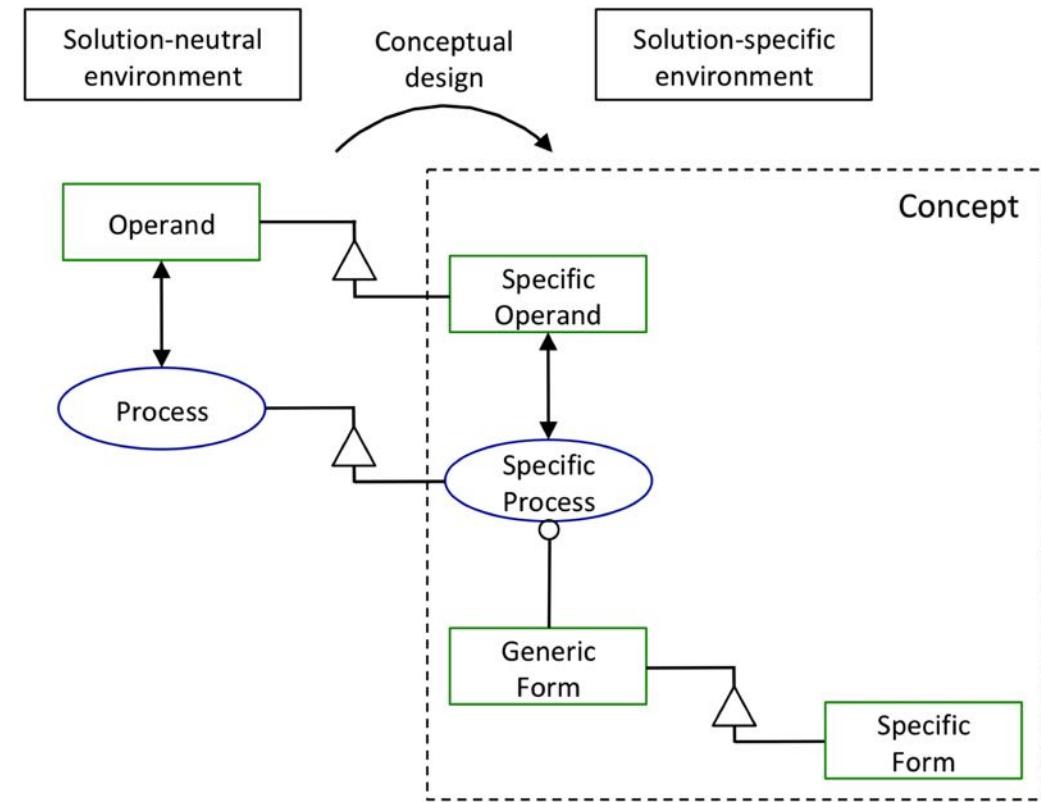


Model-Based Canonical Representation of System

Canonical Representation of system



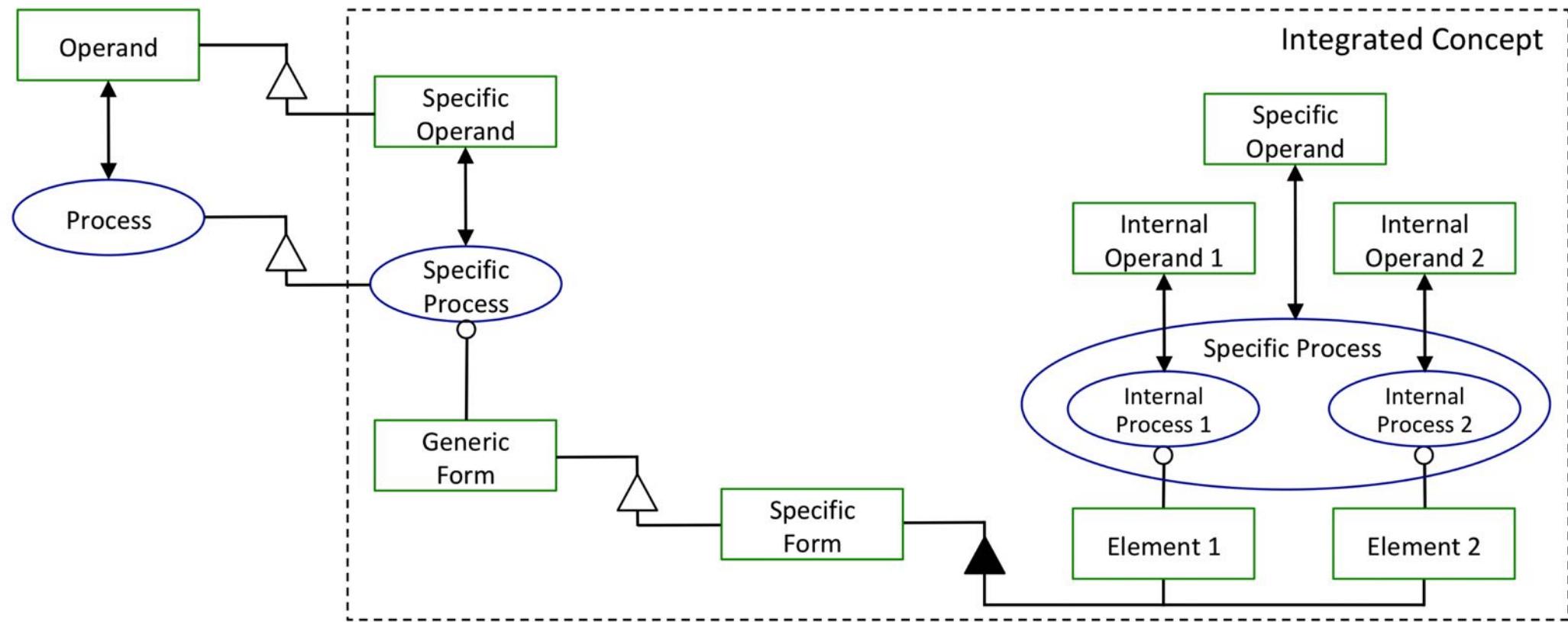
Representation of conceptual design





Model-Based Integrated Concept

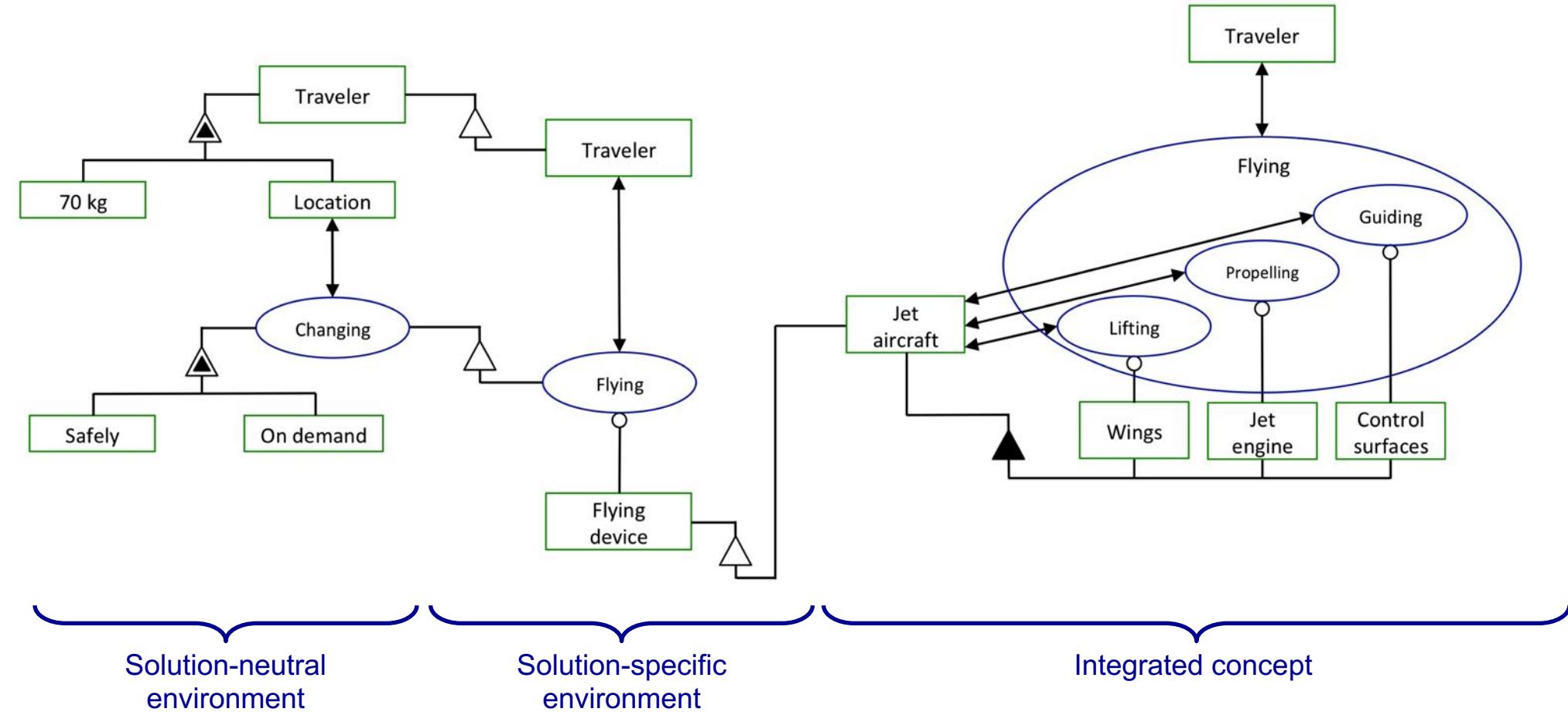
Conceptual design extended to include the integrated concept





Integrated Concept for Air Transportation Service

Integrated concept framework for air transportation service





Patents surveyed

- Because they represent new intellectual property in the form of an invention, a patent almost certainly must contain a concept (which is novel, not obvious and reduced to practice)

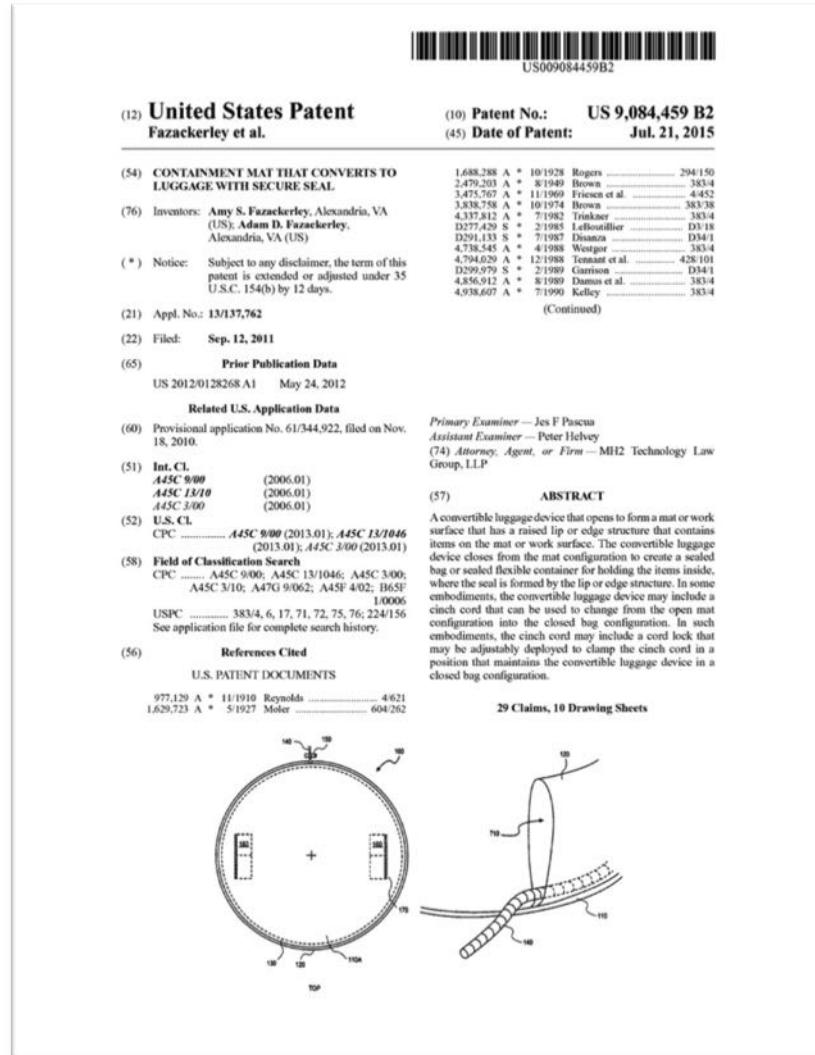
Electro-mechanical patents

Software patents

Biological patents

Thermodynamic patents

Mapping Patents to Framework



Results of experiment



Where in the patent is the information drawn from?

A – Abstract

D – Description

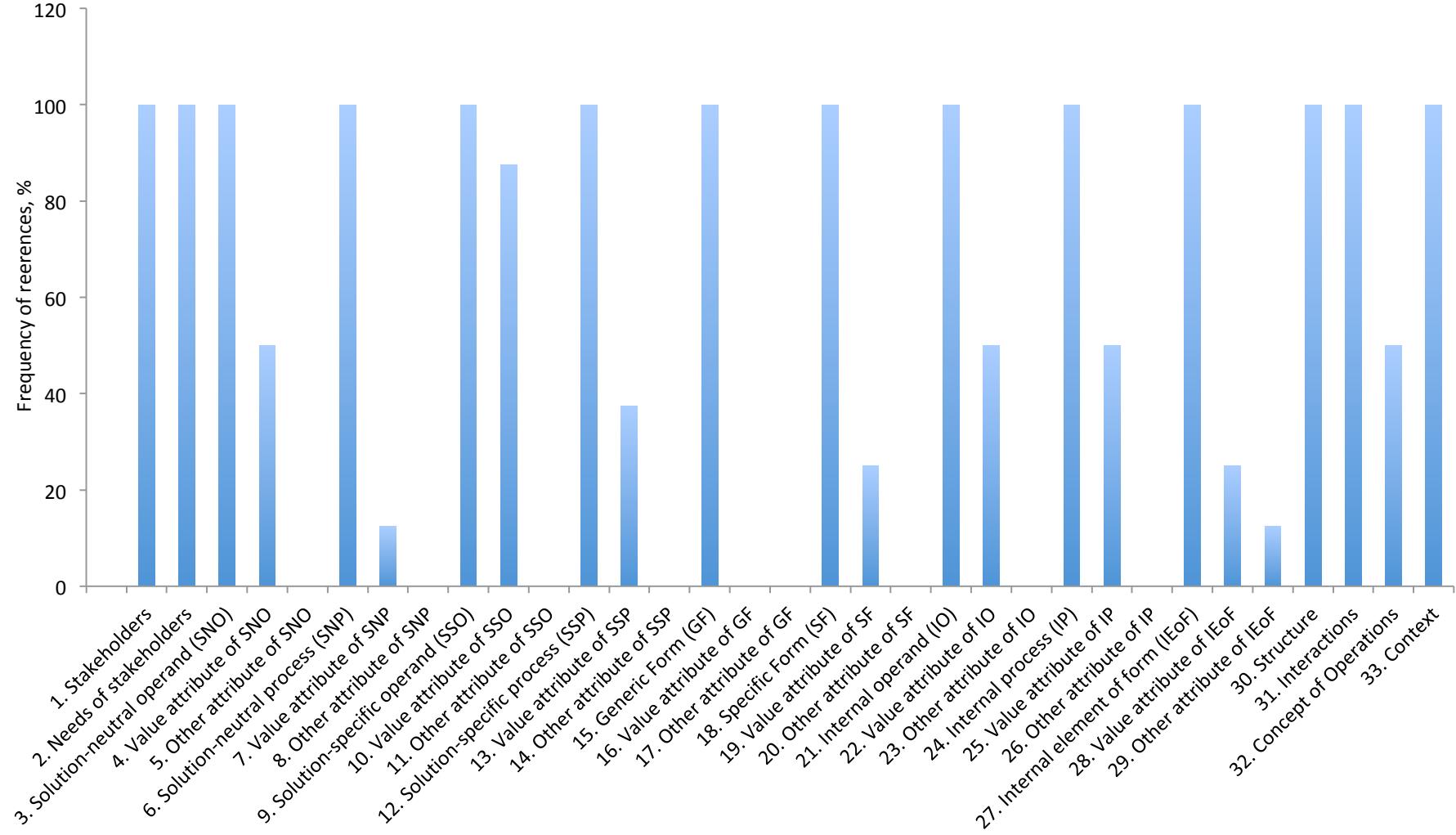
C – Claims

Name	# of Patent								Occurrence, %
	1	2	3	4	5	6	7	8	
1. Stakeholders	D	D	D	D	D	A	D	D	100
2. Needs of stakeholders	D	D	D	D	D	D	D	D	100
3. Solution-neutral operand (SNO)	D	D	D	A	D	D	D	D	100
4. Value attribute of SNO	D	D	D	A	-	-	-	-	50
5. Other attribute of SNO	-	-	-	-	-	-	-	-	0
6. Solution-neutral process (SNP)	D	D	D	D	D	D	D	D	100
7. Value attribute of SNP	D	-	-	-	-	-	-	-	12,5
8. Other attribute of SNP	-	-	-	-	-	-	-	-	0
9. Solution-specific operand (SSO)	A, D	A, D	A	D	D	D	D	D	100
10. Value attribute of SSO	A, D	A, D	-	D	A	A, D	C	D	87,5
11. Other attribute of SSO	-	-	-	-	-	-	-	-	0
12. Solution-specific process (SSP)	A, D	A, D	A	D	A	A, D	C	D	100
13. Value attribute of SSP	A, D	A, D	A	-	-	-	-	-	37,5
14. Other attribute of SSP	-	-	-	-	-	-	-	-	0
15. Generic Form (GF)	D	D	D	D	D	D	D	D	100
16. Value attribute of GF	-	-	-	-	-	-	-	-	0
17. Other attribute of GF	-	-	-	-	-	-	-	-	0
18. Specific Form (SF)	A, D	A, D	A	D	A	A, D	A, D, C	A	100
19. Value attribute of SF	D	A, D	-	-	-	-	-	-	25
20. Other attribute of SF	-	-	-	-	-	-	-	-	0
21. Internal operand (IO)	D, C	D, C	D, C	C	D, C	C	A, D, C	C	100
22. Value attribute of IO	D, C	D, C	D, C	-	D, C	-	-	-	50
23. Other attribute of IO	-	-	-	-	-	-	-	-	0
24. Internal process (IP)	D, C	D, C	D, C	C	D, C	C	A, D, C	A, D, C	100
25. Value attribute of IP	-	-	-	C	-	C	A, D, C	A, D, C	50
26. Other attribute of IP	-	-	-	-	-	-	-	-	0
27. Internal element of form (IEoF)	D, C	D, C	D, C	C	D, C	C	A, D, C	A, D, C	100
28. Value attribute of IEoF	D, C	D	-	-	-	-	-	-	25
29. Other attribute of IEoF	-	D	-	-	-	-	-	-	12,5
30. Structure	D	D	D	D	D	D	A, D	D	100
31. Interactions	D	D	D	D	D	D	A, D	D	100
32. Concept of Operations	A, D	A, D	A, C	A, D, C	-	-	-	-	50
33. Context	D	D	D	D	D, C	D	D	D	100

Results of experiment



- Other attributes can be omitted
- Extended concept is required
- Operator should be added



Conclusions



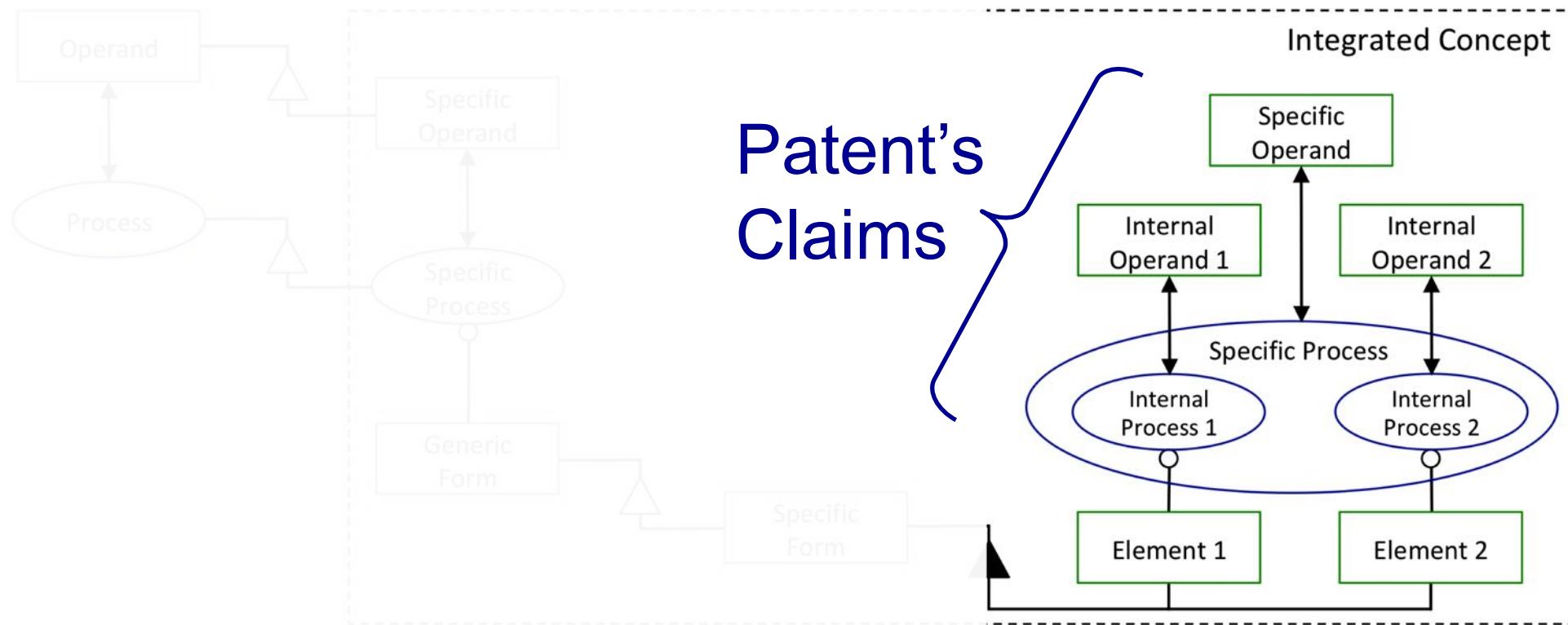
- Concept Framework
 - Provides naming convention based on essentials
 - Provides a template (syntactic and semantic) to describe the essential elements
 - Supports Integrated Concept
 - Supports mixing and matching of internal processes and instrument
- Framework validated (passed necessary condition) based on small N US patent study
 - Affirms that extended concept must be included in a complete definition of a concept
- A supplement to, not a replacement for traditional creative human conceptualization





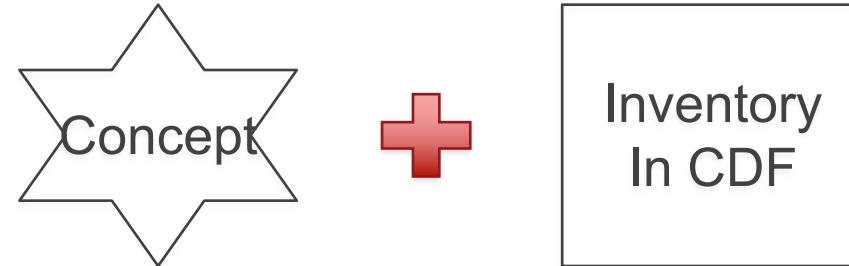
Claims and Integrated Concept

The claims section of a patent, the key area of legal protection, contain information on form and function at one level of decomposition below the concept itself, in what we call the integrated concept





Combined Concept Synthesis





28th Annual **INCOSE**
international symposium

Washington, DC, USA
July 7 - 12, 2018

www.incose.org/symp2018

Thank you for your attention!

crawley@mit.edu