

Change Propagation Considerations within Design Methods

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Change Propagation

Change propagation is the process where a change in one element of a design or system provokes changes in other elements. It can be a driving force in engineering system design, as without proper management, a single change can unintentionally cascade into many causing schedule and cost overruns [1,2]

Change Propagation Scenario

Example of change propagation mapping and how one change can lead to many as it moves through multiple designers and product components

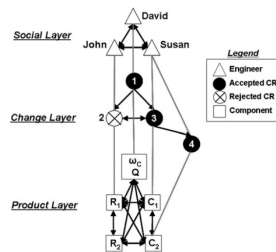
John, Susan, and David are designing a low pass filter

John is in charge of the resistors, R1 & R2

Susan is in charge of the capacitors C1 & C2

David is in charge of setting cutoff frequency and quality factor ω_c & Q

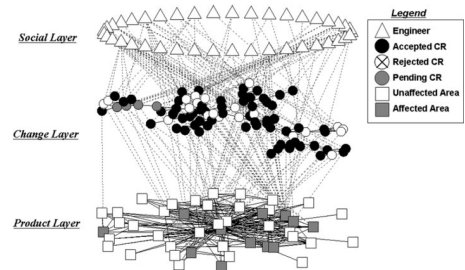
- David needs to change cutoff frequency from 10kHz to 5kHz, but the quality factor has to remain the same
- David requests John change a resistor to allow for the new specs, John rejects this change because the resistors have already been purchased
- David requests Susan change a capacitor to allow for the new specs, she accepts
- Susan cannot change just one of her two capacitors, she has to change both



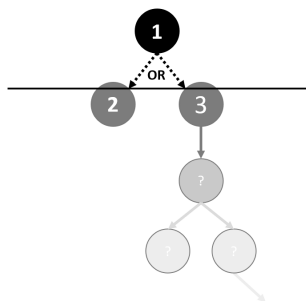
Pictures and Scenario from Pasqual and de Weck 2012 [1]

Change Propagation Example

Real world change propagation chain



Research Questions



How do designers choose between potential solutions during a branch point in design

Question 1: Tools and Organization

How is the design industry currently incorporating change propagation considerations into design choices?

Question 2: Priorities and Weights

What factors are the most dominant in determining which path a design change takes?

Change Propagation Tools

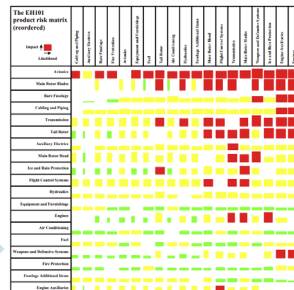
Numerous variations on the design structure matrix (DSM) have been used to map out dependencies within complex systems and help predict where propagation could occur [1,2].

	A	B	C	D	E	F	G	H
A Set specifications	X							
B Design concept	X	X						
C Design shutter mechanism	X	X	X	X	X			
D Design viewfinder	X	X	X	X	X			
E Design camera body	X	X	X	X	X			
F Design film mechanism	X	X	X	X	X			
G Design lens optics	X					X	X	
H Design lens housing	X							X

Design Structure Matrix for a Camera [2]

DSMs can be oriented in whichever direction is the most useful, but the following examples have the initiating elements on the columns and the affected elements on the rows (ex. For the camera a change in A could propagate to B, but not the other way around)[2].

Product Risk matrices show not only that elements are dependent, but also the likelihood and predicted impact of propagation



Product Risk Matrix for a Helicopter [2]

Change Tracking Tools



Some industry professionals use software to aid in tracking ongoing changes within their workflows, but in general these programs are more geared toward documentation and tracking rather than playing an active part in design decision making.



References

[1] Pasqual, M.C., de Weck, O.L. Multilayer network model for analysis and management of change propagation. Res Eng Design 23, 305–328 (2012). <https://doi.org/10.1007/s00163-011-0125-6>

[2] Clarkson, P. & Simons, Caroline & Eckert, Claudia. (2004). Predicting Change Propagation in Complex Design. Journal of Mechanical Design. 126. 10.1115/1.1765117.

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