

# Hidden Costs of Decomposition: the need for fit between technical and organizational architectures

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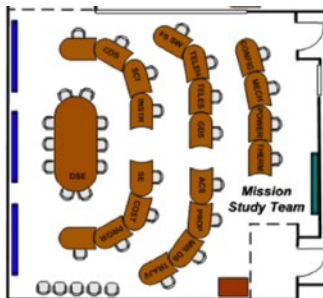
# The hidden costs of decomposition

- Motivating example: Team X at JPL (and other concurrent design facilities)
  - Concurrent design is increasingly used because it is fast, efficient, and multi-disciplinary
  - However, there are hidden risks: it imposes a consistent, assumed decomposition on the design problem, which **either** usefully hides information **or** leads designers to miss important elements/interactions



*A Team X session in progress. Subject matter experts design each of the main subsystems, and spreadsheet models capture the evolving spacecraft design. Photo from Sherwood and McCleese (2013)*

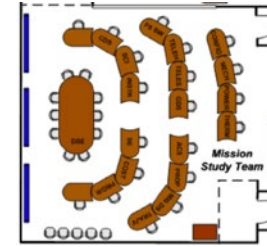
(Nearly) consistent organizational architecture



Wide variety of product architectures

# Measuring “fit” between product and organizational architectures

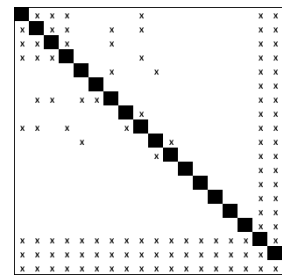
- To understand those potential hidden costs, we looked at studies with different “fit”, and examined the impact on the design process
- But how to measure “fit”?



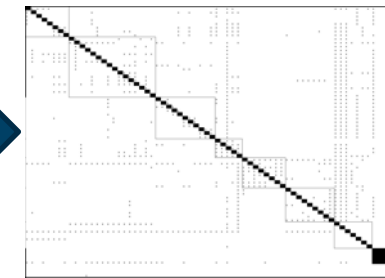
org. structure



product architecture



org. DSM



product DSM



Systems	31	15	22	22	28	16	25	24	26	10	15	6
ACS	31	12	20	22	23	10	22	22	25	10	9	6
FD	15	32	12	10	11	11	11	11	8	8	6	
Prop	22	20	12	19	19	11	15	19	19	10	6	
C&DH	22	22	10	19	24	12	16	21	22	10	9	6
Comms	28	23	11	19	24	16	17	21	22	10	9	6
Ops	16	10	11	11	12	16	9	10	10	8	10	6
Mech	25	22	11	15	16	17	9	18	18	10	9	6
Thermal	24	22	11	19	21	21	10	18	23	10	8	6
Power	26	25	11	19	22	22	10	18	23	10	8	6
Rel	10	10	8	10	10	8	10	10	10	10	7	6
Cut	15	9	8	10	9	9	10	9	8	8	7	6
TL	6	6	6	6	6	6	6	6	6	6	6	6

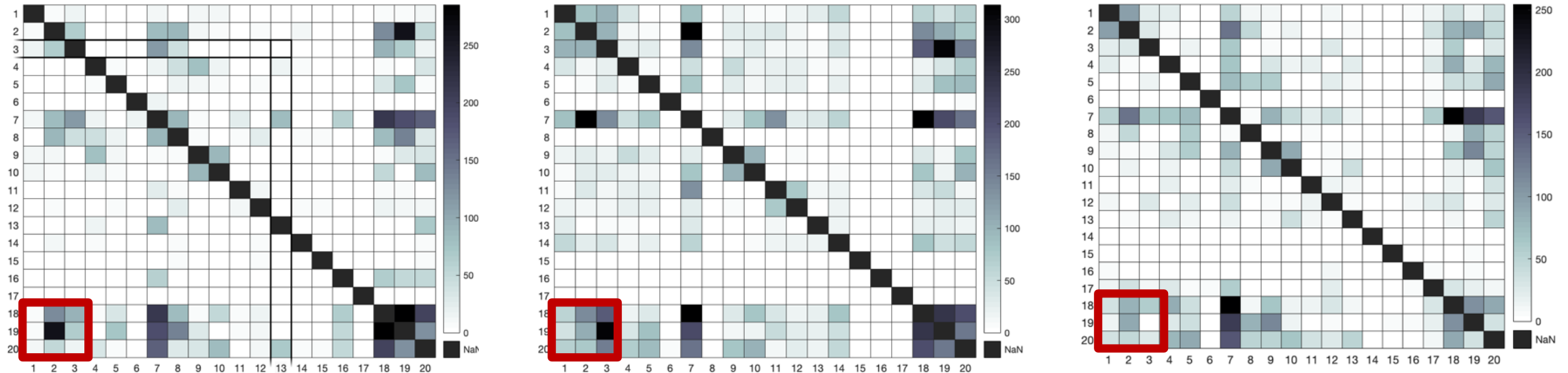
task DSM for standard process

Systems	38	24	30	38	51	24	45	32	34	10	28	39	
ACS	38	12	19	21	30	10	29	21	24	10	9	15	
FD	24	32	12	19	20	20	11	11	11	8	17	15	
Prop	30	19	12	27	18	11	23	27	27	10	10	15	
C&DH	38	21	19	27	31	11	20	24	29	30	10	17	24
Comms	51	30	20	18	31	24	24	20	21	10	17	24	
Ops	24	10	20	11	20	24	9	10	10	8	18	15	
Mech	45	29	11	23	24	24	9	26	26	10	16	30	
Thermal	32	21	11	27	29	20	10	26	31	10	8	15	
Power	34	24	11	27	30	21	10	26	31	10	8	15	
Rel	10	10	8	10	10	8	10	10	10	10	7	6	
Cut	28	9	17	10	17	17	18	16	8	8	7	21	
TL	39	15	15	24	24	15	30	15	15	6	21	6	

optimized task DSM for this product



# Impact on the design process: hidden costs?



- Collected data on the amount of communication between all pairs of engineers.
- If the same “standard” process worked well for all products, we should not see such major differences.
  - Heavy/unusual communication late in the design process indicates trades/interdependencies in unplanned-for places.
  - Can connect “fit” problems to changes in communication during the design process
- Once hidden costs are understood, measures can mitigate problems / enhance fit

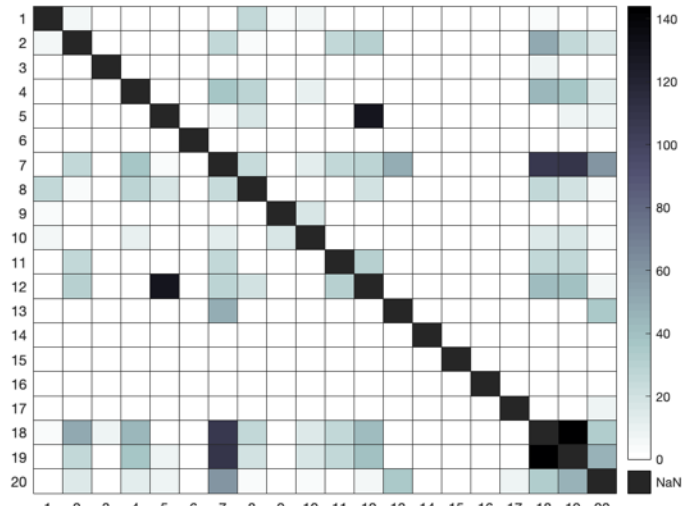
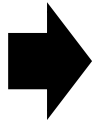
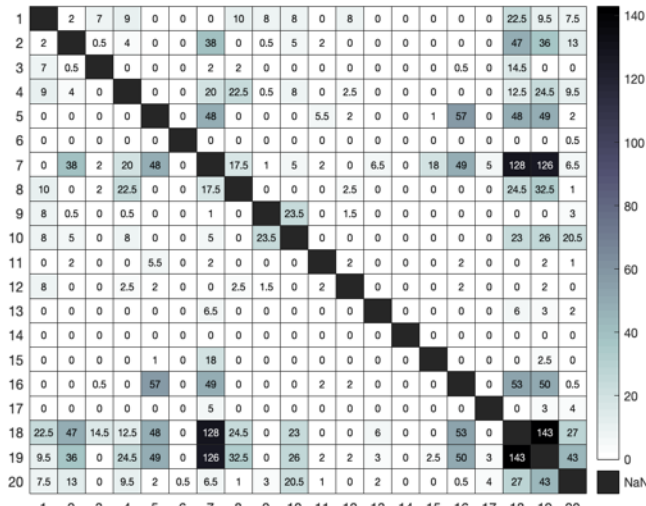
# Thank you

Erica Gralla and Zoe Szajnfarter

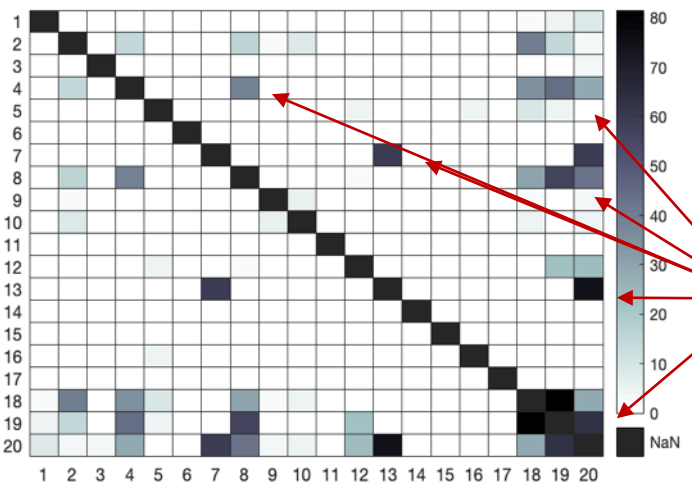
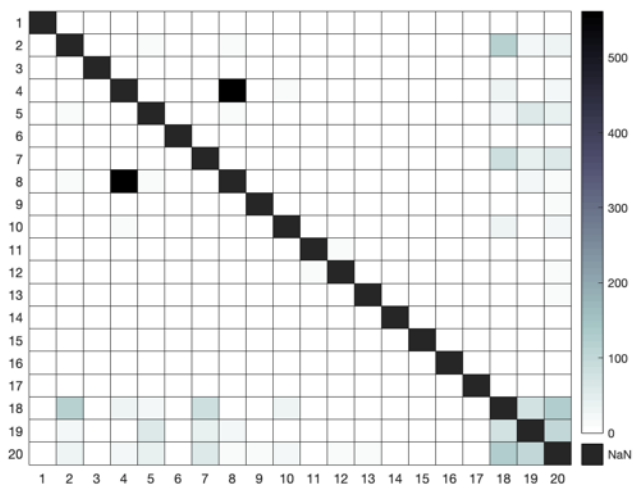
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# Impact on the design process: hidden costs?



Late in the design an error was discovered in the instrument design (an unaccounted for heater) that created a 100-watt deficit. There was a scramble to try to fix the design on the last day.



Last day is usually quiet, but we see large amounts of heavy communication, especially via integrators