

INCOSE IW 2019 MBSE Workshop Update...

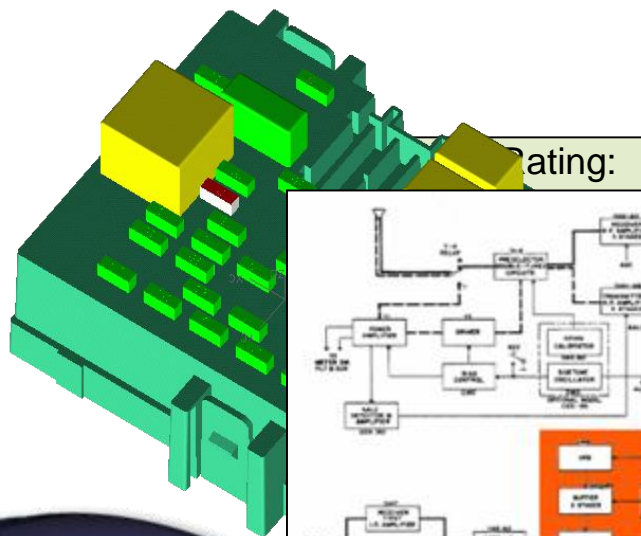
Mark E Sampson
INCOSE MBSE Initiative Co-Chair
Siemens SE Evangelist

Integrated MBSE Vision

What does the integrated systems engineering look like...

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Ingenuity for life



Hydraulic Fluid:
SAE 1340 not-compliant

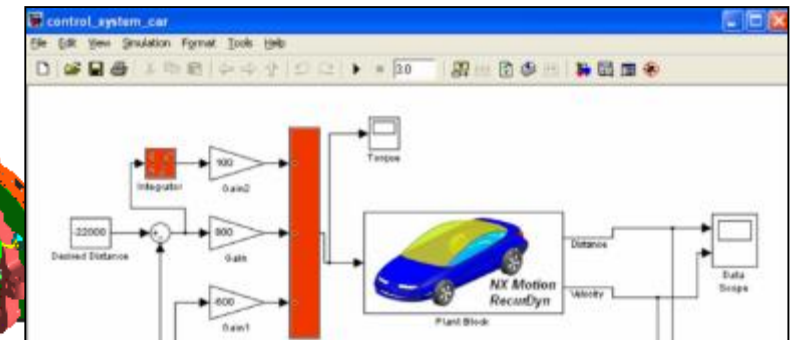
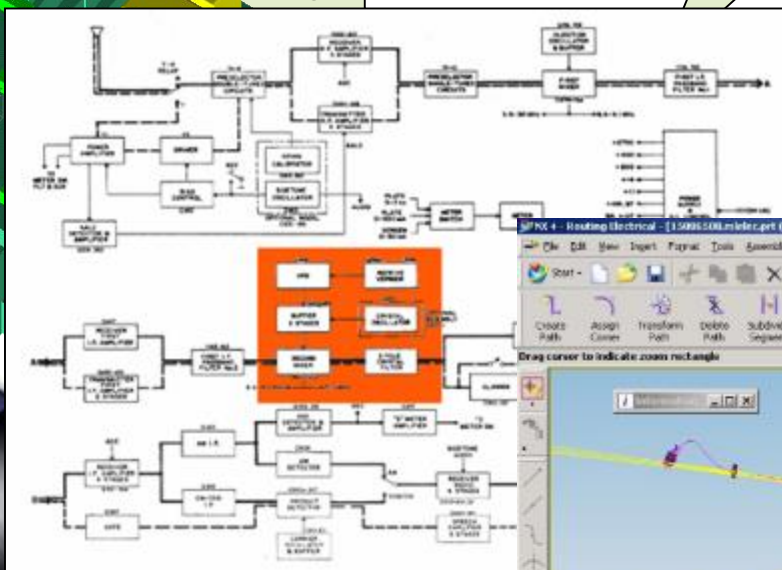
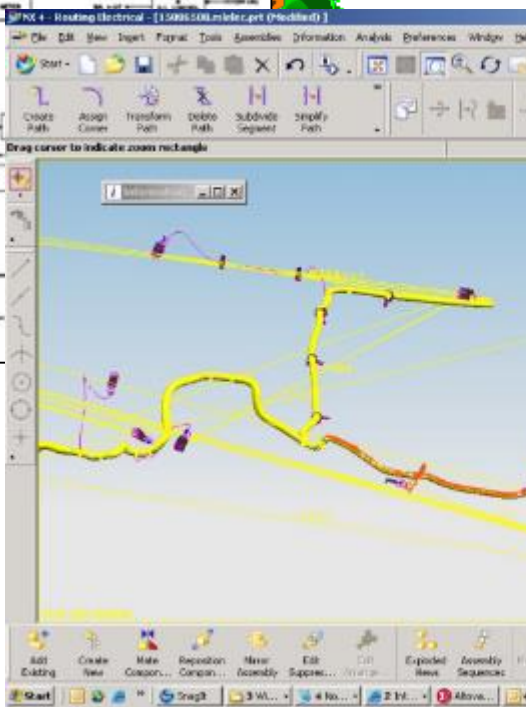


Table II.—Ordinary Joint Life and Last Survivor Annuities—Two Lives—Expected Return Multiples

Ages																												
		Male									Female																	
Male	Female	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	35	36	37	38	39	40	41	42	43
35	40	46.2	45.7	45.3	44.8	44.4	44.0	43.6	43.3	43.0	42.6	42.3	42.0	41.7	41.4	41.1	40.7	40.4	41.8	41.4	41.0	40.6	40.2	39.8	39.4	39.0	38.6	
36	41	45.7	45.2	44.8	44.3	43.9	43.5	43.1	42.7	42.3	42.0	41.7	41.4	41.1	40.7	40.4	40.1	39.8	41.3	40.9	40.5	40.1	39.7	39.3	38.9	38.5	38.1	
37	42	45.3	44.8	44.3	43.8	43.4	42.9	42.5	42.1	41.8	41.4	41.1	40.7	40.4	40.1	39.8	39.5	39.2	40.8	40.4	40.0	39.6	39.2	38.8	38.4	38.0	37.6	
38	43	44.8	44.3	43.8	43.3	42.9	42.4	42.0	41.6	41.2	40.8	40.5	40.1	39.8	39.5	39.2	38.9	38.6	40.3	39.9	39.5	39.1	38.7	38.3	37.9	37.5	37.1	
39	44	44.4	43.9	43.4	42.9	42.4	41.9	41.5	41.0	40.6	40.2	39.9	39.5	39.2	38.9	38.6	38.3	38.0	39.7	39.3	38.9	38.5	38.1	37.7	37.3	36.9	36.5	
40	45	44.0	43.5	42.9	42.4	41.9	41.4	41.0	40.5	40.1	39.7	39.3	38.9	38.6	38.3	38.0	37.7	37.4	39.3	38.9	38.5	38.1	37.7	37.3	36.9	36.5	36.1	
41	46	43.6	43.1	42.5	42.0	41.5	41.0	40.5	40.0	39.6	39.2	38.8	38.4	38.0	37.7	37.4	37.1	36.8	39.0	38.6	38.2	37.8	37.4	37.0	36.6	36.2	35.8	
42	47	43.3	42.7	42.1	41.6	41.0	40.5	40.0	39.6	39.1	38.7	38.2	37.8	37.5	37.2	36.9	36.6	36.3	38.7	38.3	37.9	37.5	37.1	36.7	36.3	35.9	35.5	
43	48	43.0	42.3	41.8	41.2	40.6	40.1	39.6	39.1	38.6	38.2	37.7	37.3	36.9	36.6	36.3	36.0	35.7	38.6	38.2	37.8	37.4	37.0	36.6	36.2	35.8	35.4	
44	49	42.6	42.0	41.4	40.8	40.2	39.7	39.2	38.7	38.2	37.7	37.2	36.8	36.4	36.1	35.8	35.5	35.2	38.5	38.1	37.7	37.3	36.9	36.5	36.1	35.7	35.3	
45	50	42.3	41.7	41.1	40.5	39.9	39.3	38.8	38.2	37.7	37.2	36.8	36.3	35.9	35.6	35.3	35.0	34.7	38.4	38.0	37.6	37.2	36.8	36.4	36.0	35.6	35.2	
46	51	42.0	41.4	40.7	40.1	39.5	38.9	38.4	37.8	37.3	36.8	36.3	35.9	35.4	35.1	34.8	34.5	34.2	38.3	37.9	37.5	37.1	36.7	36.3	35.9	35.5	35.1	
47	52	41.8	41.1	40.4	39.8	39.2	38.6	38.0	37.5	37.0	36.5	36.0	35.6	35.1	34.8	34.5	34.2	33.9	38.2	37.8	37.4	37.0	36.6	36.2	35.8	35.4	35.0	



Minimum Turn Radius: 24 ft.
Automatic Dry Pavement Braking Distance at 60 MPH : ~~140~~ft. 90 ft

Didn't see it coming...

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Do you see the problem?



Integrated MBSE Value: Unforeseen Cross-domain Impacts

“...recalls SUVs because drivers are accidentally turning them off while driving”. Placement of transmission selection/radio next to each other (\$1.4M in direct costs)

NHTSA reports record number of cars (37m) recalled in 2017
25% are never repaired



Do you see the problem?

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Does this work?

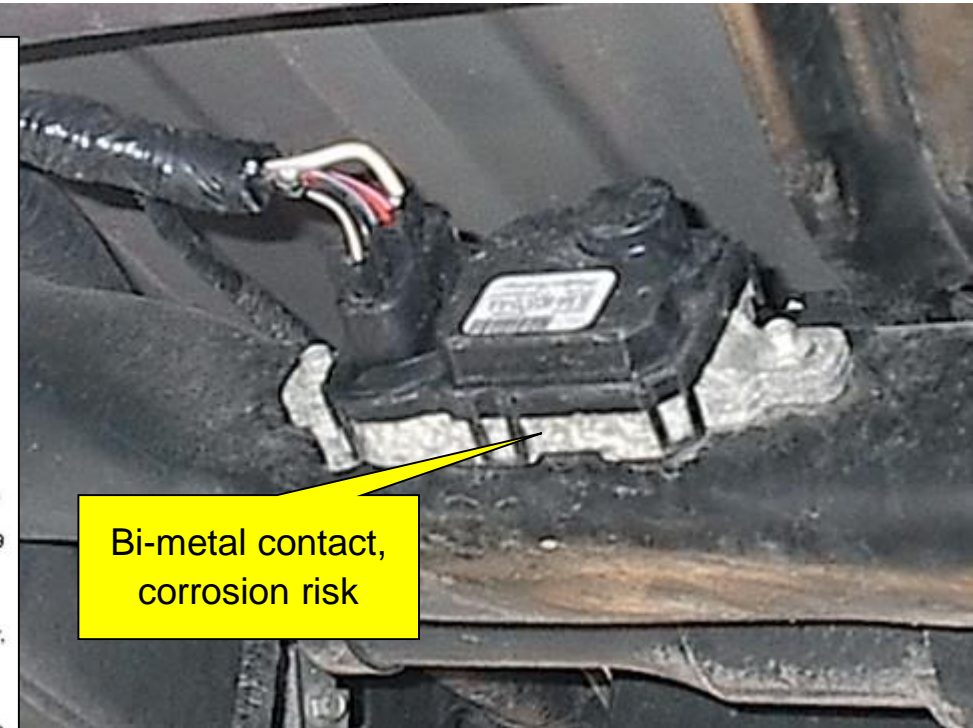
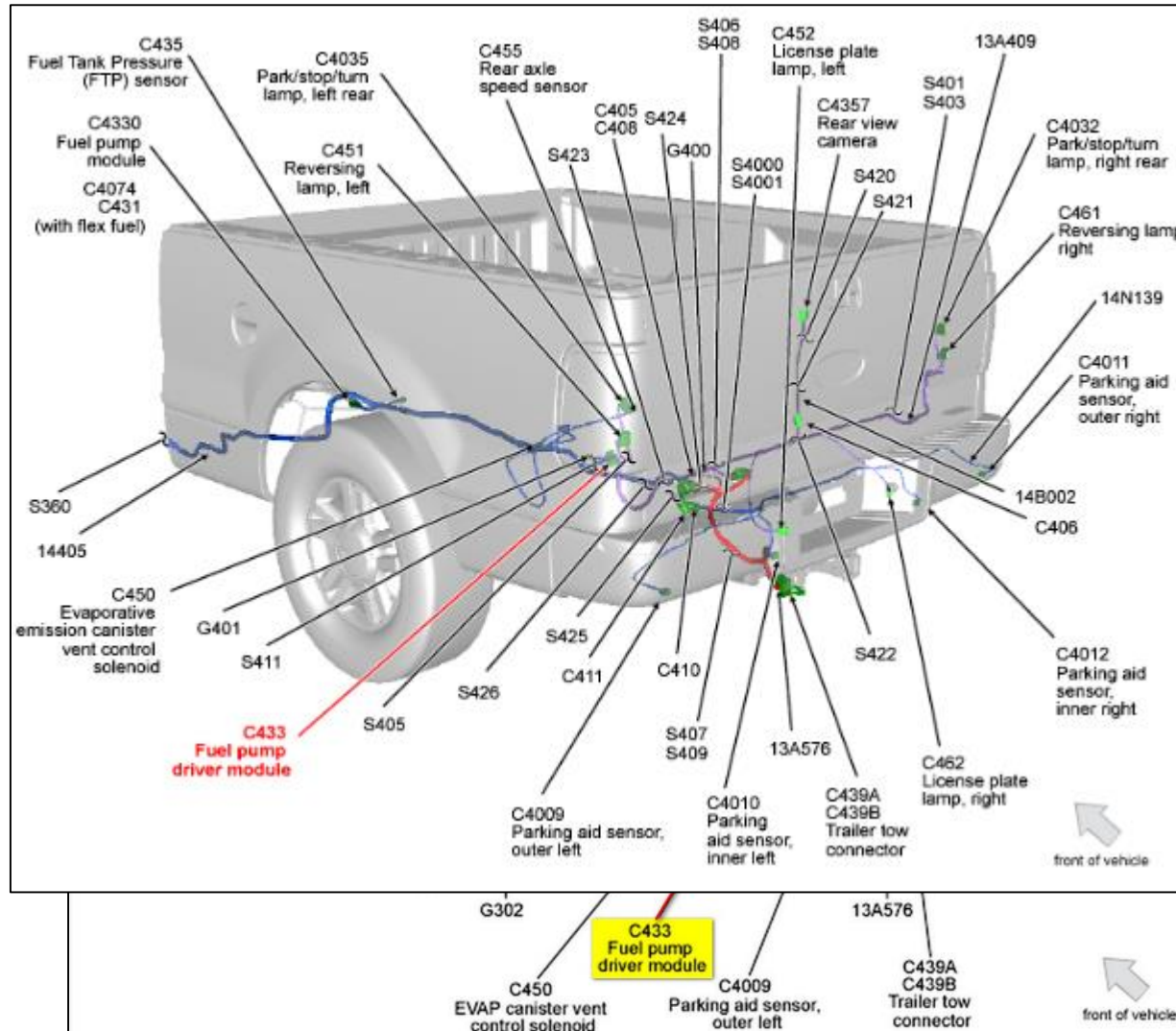
Case Study: Fuel Pump Control Module

Fuel pump control module bad placement...

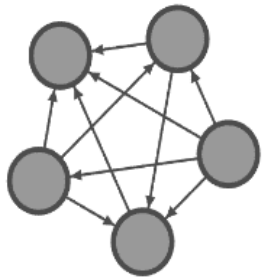
- Resulting in Bi-Metal Corrosion, failed ECU
- 86,000 vehicles recalled.. \$8.6 Million direct costs



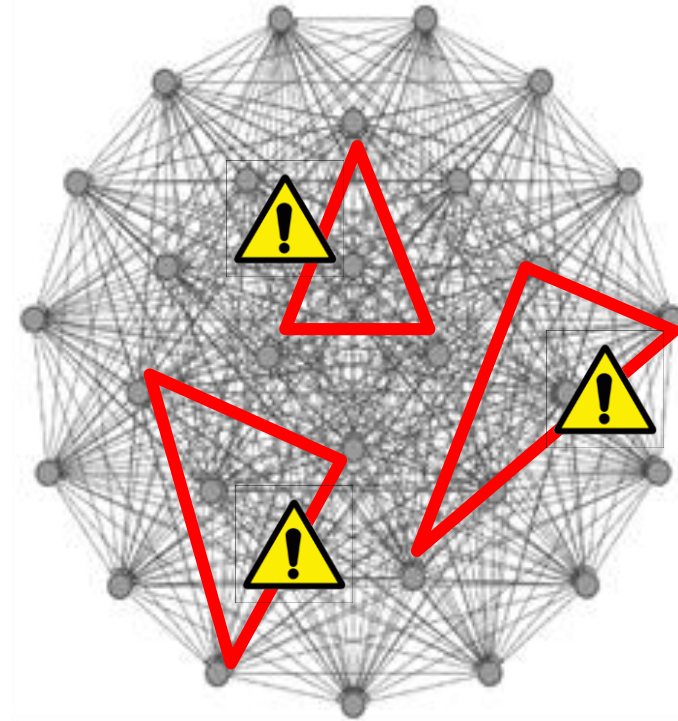
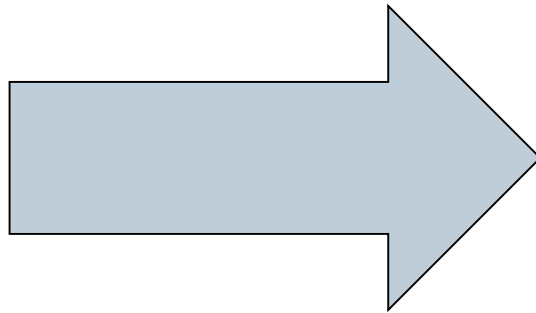
How about now? Even when you were evaluating places to put it.



Doing the math...



Nodes = 5
Potential Links = 10
Networks = 2^{10} 1024



Nodes = 30, potential links = 435, unique configurations = 2^{435}
Number of atoms in the universe est. between 2^{158} and 2^{246}

This requires change...
High-tech experience

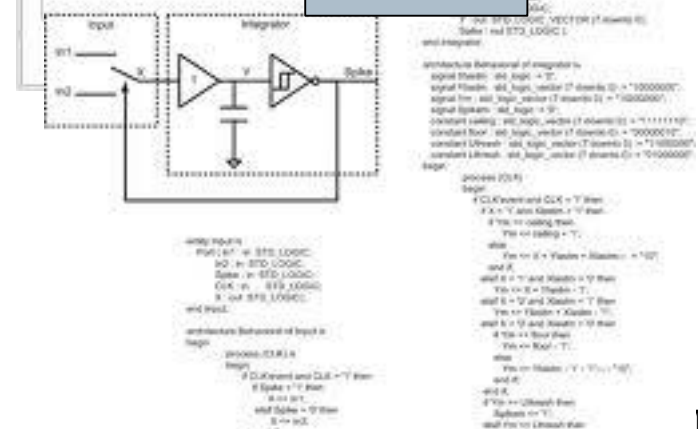
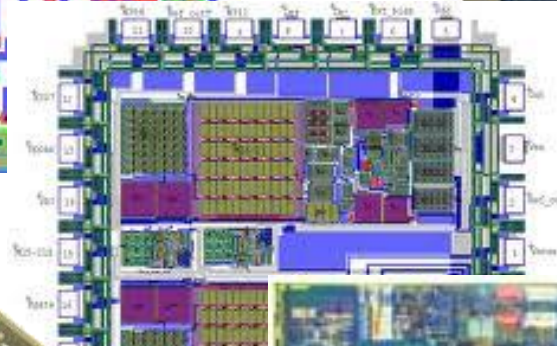
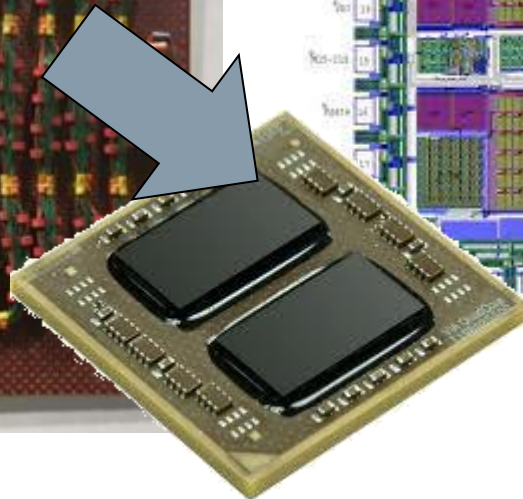
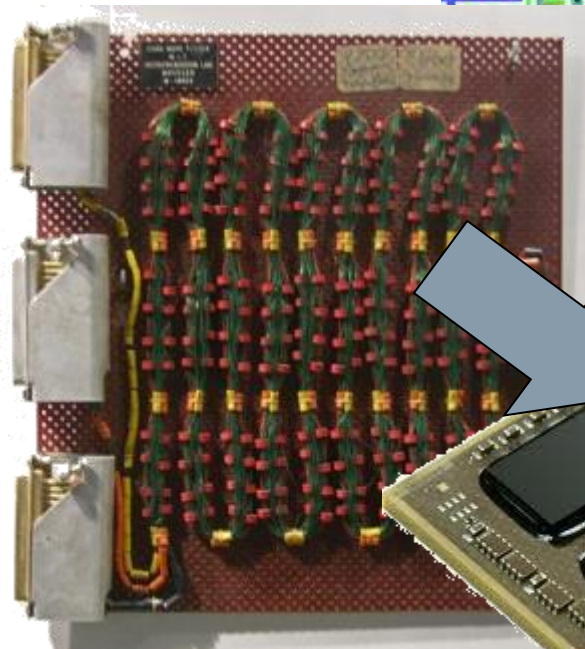
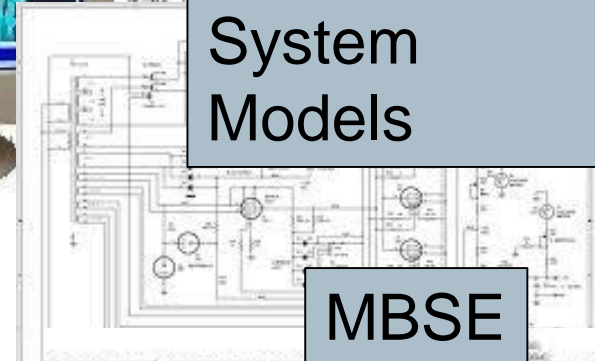
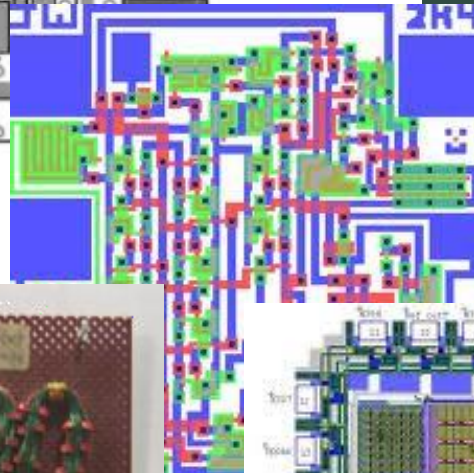
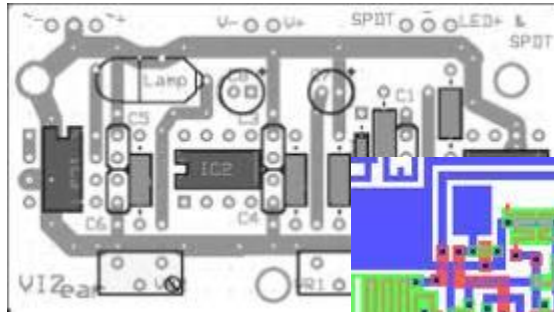
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Documents

Document
Generation

Disconnected
System
Models

MBSE



How to make the culture change?

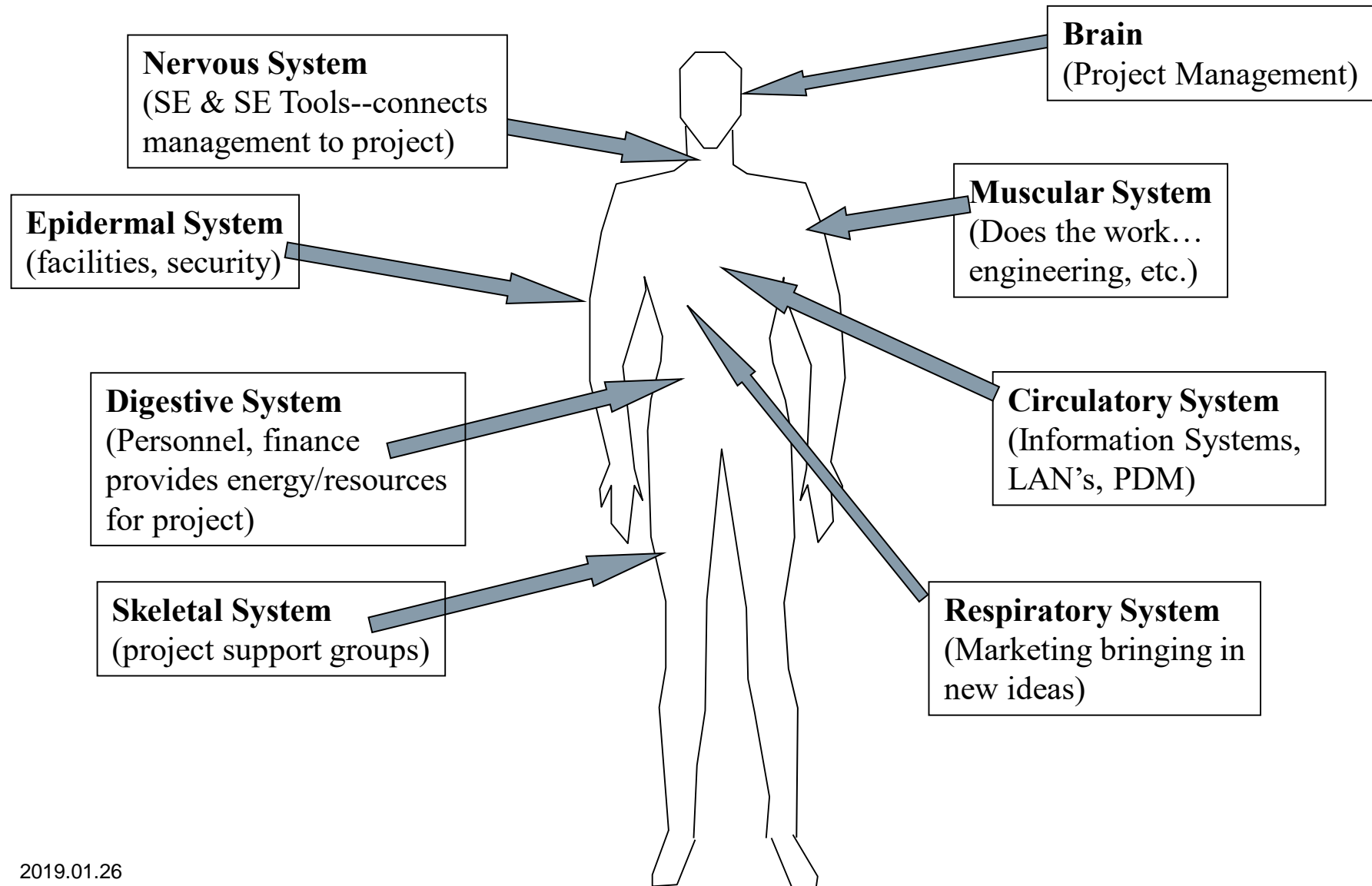
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Q: How many psychologist does it take to change a light bulb?

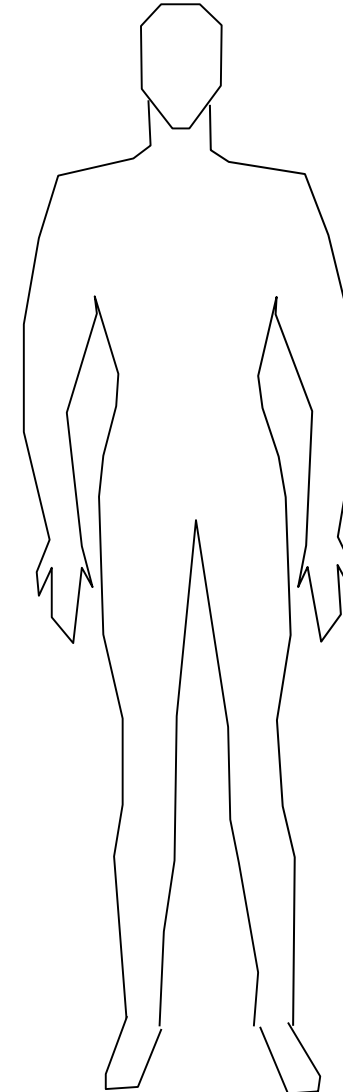
A: Only one, but they have to want to change

Anatomy of an project...



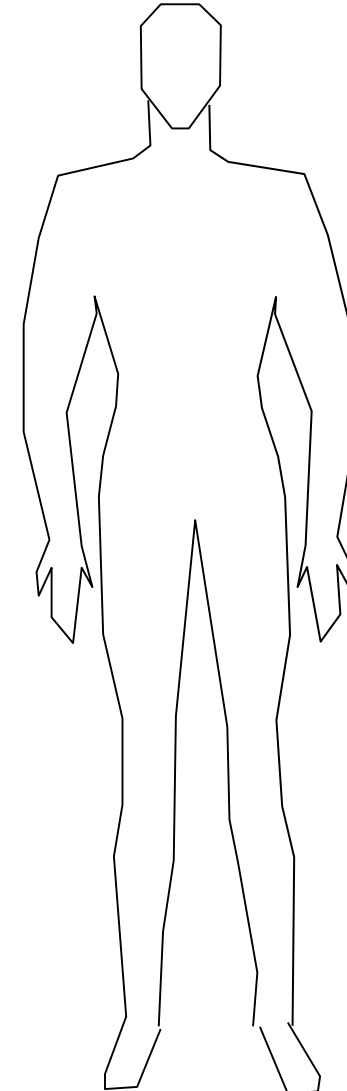
Transplant process...

- Transplant overview/process
- Medical ethics and priority
- Organ function and symptoms
- Social aspects with families,...
- Finances...cost, acquisition, maintenance,...
- Dietitian...weight, nutrition, physical condition,...
- Pharmacology...anti-rejection, side effects, infections,...
- Case worker...prequalification, tests, clearances from...
- Legal...living wills, etc.
- Surgeon...risks, etc.



Transplanting MBSE into an organization...

- Transplant/tool overview/process—agreed new process
- Medical/tool ethics and priority—agreement on when tools will/will not be used, buy-in from organization,...
- Organ/tool function and symptoms—understanding of what functions the tool will perform and what symptoms it addresses
- Social aspects with organization—support organization to support the tools, PR campaign, internal user group,...
- Finances...cost, acquisition, maintenance,--financial budget to cover implementation/maintenance of tools
- Tool Dietitian...weight, nutrition, physical condition—training plan, deployment plans, maintenance, etc.
- Pharmacology...anti-rejection, side effects, infections,--tool usage incentives, metrics, opportunities, etc.
- Case worker...prequalification, tests—on site support, who can use it, etc.
- Surgeon...risks—Project, IT, and Design Center Mgmt



Organization SE Process Maturity

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Auto Medical Device Aero

Capability Assessment:	Basic	Low	Medium				
MBSE Process Maturity Level 4	Disintegrated -----> Integrated				Product-line, Cross-domain optimization & reuse Connected RFLP		
System Modeling/Architecture	PPT in docs	Disconnected Visio models	Sys Models with Simulations	Multiple model exchange/optimize	Integrated architecture models for cross-domain sim/optimize	Connected RFLP	
PLE/Configuration (variation)	None	Variation documents, spreadsheets	Disconnected variation rules	Integrated variation rules	PL variation definition built into architecture decisions	Used to drive logical, parameters, simulation, etc.	
Technical Risk (RAMS, cost,...)	None	Risk documents, spreadsheets	Integrated risk Management Plans with aspects of RAMS	Standalone RAMS with FMECA Dash boards	Integrated RAMS, continuous risk assessment/alerts with dashboards	Project reuse includes RAMS history	
MBSE Process Maturity Level 3						Cross-domain services (Utilization)	
Interface Management	ICD in docs	Managed interfaces	Standard-based Interface library	Reused interfaces	Functions/logical allocation drives interface definitions	including interface optimization & visibility in harness, parts, etc	
Logical Modeling	Logical description documents	Logical hierarchy	Isolated logical behavior models	Integrated logical behavior models	Logical architecture with allocation with traceability		
Parameter Management	Unmanaged spreadsheets	Managed spreadsheets	Parameter library	Integrated with functions	Reusable parameter library with traceability	Parameters come from functions	
MBSE Process Maturity Level 2						Cross-domain services (Definition)	
Feature/Functional Modeling	Functional description docs	Function hierarchy	Isolated functional behavior models	Integrated functional modeling	Functional arch with allocations & Traceability	includes decision capture	
Characteristic/Target Mgmt	None	Uncontrolled Excell/Docs	Controlled targets	Distributed targets/constraints	Integrated targets, budgets, with compliance reports	TPM to manage goal/targets over time	
Change Management	Document-based change process	Isolated models included in change	Impact analysis & suspicion mgmt	Metrics with History for improvement	Project level reuse, starting point for next project	Traceability to view change impact, suspicion to id change	
MBSE Process Maturity Level 1							
Requirement Management	Uncontrolled spreadsheets & docs	Managed Docs	Standalone solutions (disconnected)	PI Traceability exchange	Connected, config domain traceability		
Model Management	Uncontrolled, rules-of-thumb, heuristics	Uncontrolled, behavior models	Shared model repository	Integrated, component library	Model reuse with c parameters		
Verification & Validation	Minimum to no planning	Manually testing everything	Isolated validation simulations	Integrated simulation (HIL, SIL)	Focused testing, re swap out models		
Design Management	unmanaged Cax/SW models	Locally Managed CAX/SW	Enterprise repositories	Integrated models (MIL, SIL,...)	Cross-domain design/optimization	Self configuring models based on usage scenarios	

Is your organization transplant ready?

Thank you