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Customer Success Is Our Mission

MISSION:
A WORLD OF INNOVATION

Best Fit for Mission Success: Aligning Development Processes with Mission Classifications - Engineering Mission Success

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Engineering Mission Success

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"Which path leads to Mission Success?"

"*That depends on your requirements*"

"They are the same as always-"

"*Then do what you always do-*"

"–so long as I am successful,"

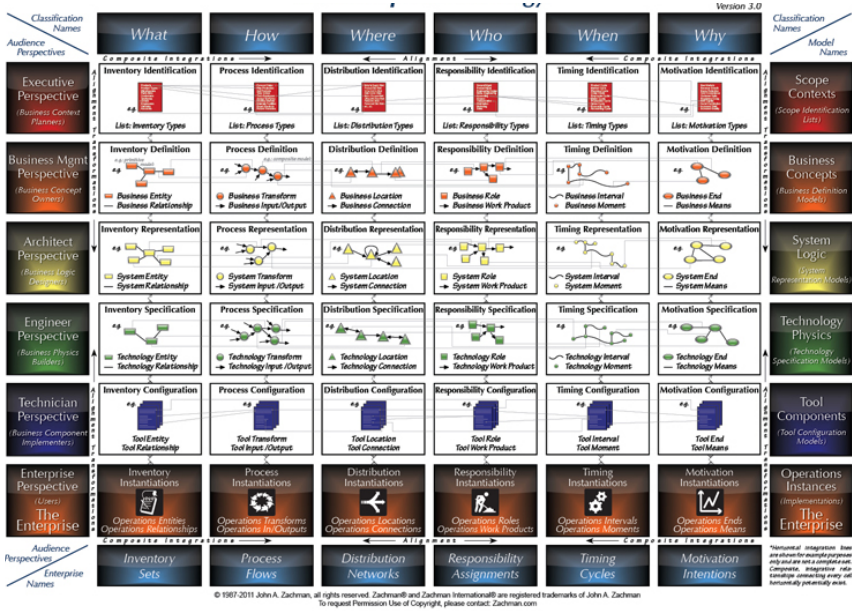
"*Oh, you're sure to be successful*,"

"*if you only work long enough*."

The path to MS is different for every program.
It must be architected, *i.e. defined, planned, measured*, along with the technical solutions

Engineering Mission Success

- Understand what success is for all key stake holders
- Develop a program plan, with the stakeholders, that addresses all aspects of success



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- Assign staff that are;
  - Aligned with program needs and strategy
  - Capable of achieving success as defined
- Ensure that the environment enables success

Mission Success must be Designed into to the Program

Core Process Tailoring

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Category	Mission Success Process
Program Execution	Design Assurance
	Requirement Analysis and Validation
	Parts, Materials, and Processes
	Environmental Compatibility
	Reliability Engineering
	System Safety
	Configuration/Change Mgmt.
	Integration, Test, and Evaluation
Risk, Oversight, and Assurance	Risk Assessment and Management
	Independent Reviews
	Hardware Quality Assurance
	Software Assurance
	Supplier Quality Assurance
Triage, Information, Lessons Learned	Failure Review Board
	Corrective/Preventative Action Board
	Alerts and Information Bulletins

- All applicable processes need to be tailored to further define program execution
- Stakeholders must buy-in to tailoring
  - Ideally they would all participate
- Rarely will a program be entirely in one class

Design Assurance	Tasks	Class A	Class B	Class C	Class D
	Contractor	Full design assurance practices, Test driven verification	Full design assurance practices	Design assurance practices	Essential design assurance practices to mission
	Independent Assessment	Test- Like-You-Fly (TLYF) exceptions, Manufacturing Flow, Mandatory Inspection Points (MIPs)	TLYF exceptions, Manufacturing Flow, MIPS	Internal TLYF, MIPs	None
	Government	Full review and approval of all processes and products	Review and concurrence on process and products, Audit	Review and concurrence, Audit	Periodic review and approval

TOR 2010-(8591)-18, Mission Assurance Program Framework

Example of Contractor SE Process Tailoring

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WI	REQ #	Local Requirements	Tailor	Comments
		Back to Process Tailoring sheet		
EI-01-04	1	Prepare a list of the planned internal gate reviews and technical reviews. For each review, identify stakeholders, Identify key items, and reference schedule in IMS.	A	Documented elsewhere and not part of the System Engineering Work Plan
EI-01-04	2	List program risks and opportunities. Estimate likelihood, consequence, stakeholders, mitigation plans, and thresholds for actions for each.	A	Documented elsewhere and not part of the System Engineering Work Plan
EI-01-04	3	List or reference technical requirements, and assign responsibility for their compliance. Identify TPM parameters, acceptable ranges, and reporting methods.	C	Product Perf meets cust best value. Goals and targets no requirements
EI-01-04	4	List metrics for monitoring progress. Determine collection frequency, methods and responsibility for each.	A	
EI-01-04	5	Identify methods the project will use to establish the system requirements, ensure that these requirements are correct, and flowed down to products and components. Determine stakeholders and their expectations.	C	Customer has given targets and we are not defining requirements, we do our best to to ensure the target meets the targets
EI-01-04	6	Establish a requirements database to capture the rationale for derived requirements, establish requirements traceability, manage requirement changes, and involve stakeholders.	C	Customer has given goals and targets and we are not defining requirements, we will make sure the product will meet specified targets. We will establish a target database to capture the rationale for derived targets establish traceability, manage changes, and involve stakeholders
EI-01-04	7	Define the process for defining and documenting the external and internal interfaces (hardware and software) necessary for system operation, and coordinating these with stakeholders.	A	
EI-01-04	8	Create System / Product Breakdown Structure.	A	Completed in tailoring report (project oversection, pg 7)

Contractor tailors internal processes to align with program

Classify Hardware by End Use

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Hardware Level	Product Description	Type of Deliverable	End Use	Product Type / Example
0	Innovation Center Product	Non-Deliverable to External Raytheon Customer	Raytheon Lab use only	Any item built within a designated Innovation Center (can include Prototype, IRAD products, Breadboard)
1	Raytheon Laboratory Product	Non-Deliverable to External Raytheon Customer	Raytheon Lab use only	Proof of Concept, Proof of Design, Breadboard, Brassboard, Prototype, IRAD products
2	Customer Laboratory Product	Deliverable to External Raytheon Customer	Customer Lab use only	Sales Demo, Lab Use
3	Customer Test Service Use Product	Deliverable to External Raytheon Customer	Operational Service Environment Test Use	Engineering Development Unit/Model, Qualification Article, Reliability Demonstration Article, Flight Test or Field Demo Article
4	Customer Standard Service Use Product and includes Depot/RoR	Deliverable to External Raytheon Customer	Operational Service Environment Use	LRIP, FRP, including Repairs, Retrofits, Upgrades
5	Customer Standard Space Service Use Product	Deliverable to External Raytheon Customer	Operational Space Service Environment Use	LRIP, FRP, Flight Model/Flight Unit

Assigning Quality by End Use is Straightforward

Acquisition Phase not a good Class Discriminator

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Program Acquisition Phase	TD Technology Development	SD&D System Development and Demonstration	P&D Production and Deployment	O&S Operations and Support
Typical Hardware	Hardware Level 1 (Engineering Prototype) Hardware Level 2 (Customer Lab Deliverable)	Hardware Level 1 (Engineering Prototype) Hardware Level 2 (Customer Lab Deliverable) Hardware Level 3 (Customer Service Use Deliverable) Hardware Level 5 (Space Customer Deliverable)	Hardware Level 4 (Standard Customer Deliverable) Hardware Level 5 (Space Customer Deliverable)	Hardware Level 3 (Customer Service Use Deliverable) Hardware Level 4 (Standard Customer Deliverable) Hardware Level 5 (Space Customer Deliverable)
Possible Hardware	Hardware Level 3 (Customer Service Use Deliverable) Hardware Level 4 (Standard Customer Deliverable) Hardware Level 5 (Space Customer Deliverable)	Hardware Level 4 (Standard Customer Deliverable)	Hardware Level 1 (Engineering Prototype) Hardware Level 2 (Customer Lab Deliverable) Hardware Level 3 (Customer Service Use Deliverable)	Hardware Level 1 (Engineering Prototype) Hardware Level 2 (Customer Lab Deliverable)

- Each Hardware Level can be seen potentially at any given acquisition phase of the program
- Use of 'Hardware Level' provides a clearer basis to assess the required Quality Level

Use of Acquisition Phase can lead to confusion

Hardware Level mapping to Class

HARDWARE LEVELS					
0	1	2	3	4	5
HARDWARE LEVEL DESCRIPTION					
Innovation Center Non-Deliverable	Raytheon Lab Use Hardware Non-Deliverable	Experimental Deliverable	Customer Field Use Deliverable	Standard Customer Deliverable/ Depot	Space Customer Deliverable
RESPONSIVE SPACE HARDWARE LEVEL DESCRIPTION					
Innovation Center Non-Deliverable	Raytheon Lab Use Hardware Non-Deliverable	Space Demonstration or Limited-Life (typical ≤1 yr) Experimental Flight Unit	Space Demonstration or Limited-Life (typical >1 yr) Operational Flight Unit	Space Operational Flight Unit - Non-critical National Priority	Space Customer Deliverable
EXAMPLES OF TYPICAL HARDWARE TYPES					
Prototype	Space Non-Flight Unit/Model, Proof of Concept/ Design, Breadboard/ Brassboard	Space EDU/EDM Experimental Deliverable Unit/Model, Sales Demo, Lab Use, EDU/EDM, Pathfinder, DOD Handbook 343 Class D	Competition, Qualification, Suitability or Reliability Article, EDU/EDM, Flight Test, Field Demo, DOD Handbook 343 Class C	Pre-Prod, Proof of MFG, LRIP, Test Asset Program (TAP), Prod/FRP/ OT&E, O&S, DOD Handbook 343 Class B	Proto Flight Unit/Model, Flight Unit/Model, LRIP/FRP, DOD Handbook 343 Class A

Hardware may not map to the same Class(es) as Processes

Schedule is a Key Class Differentiator

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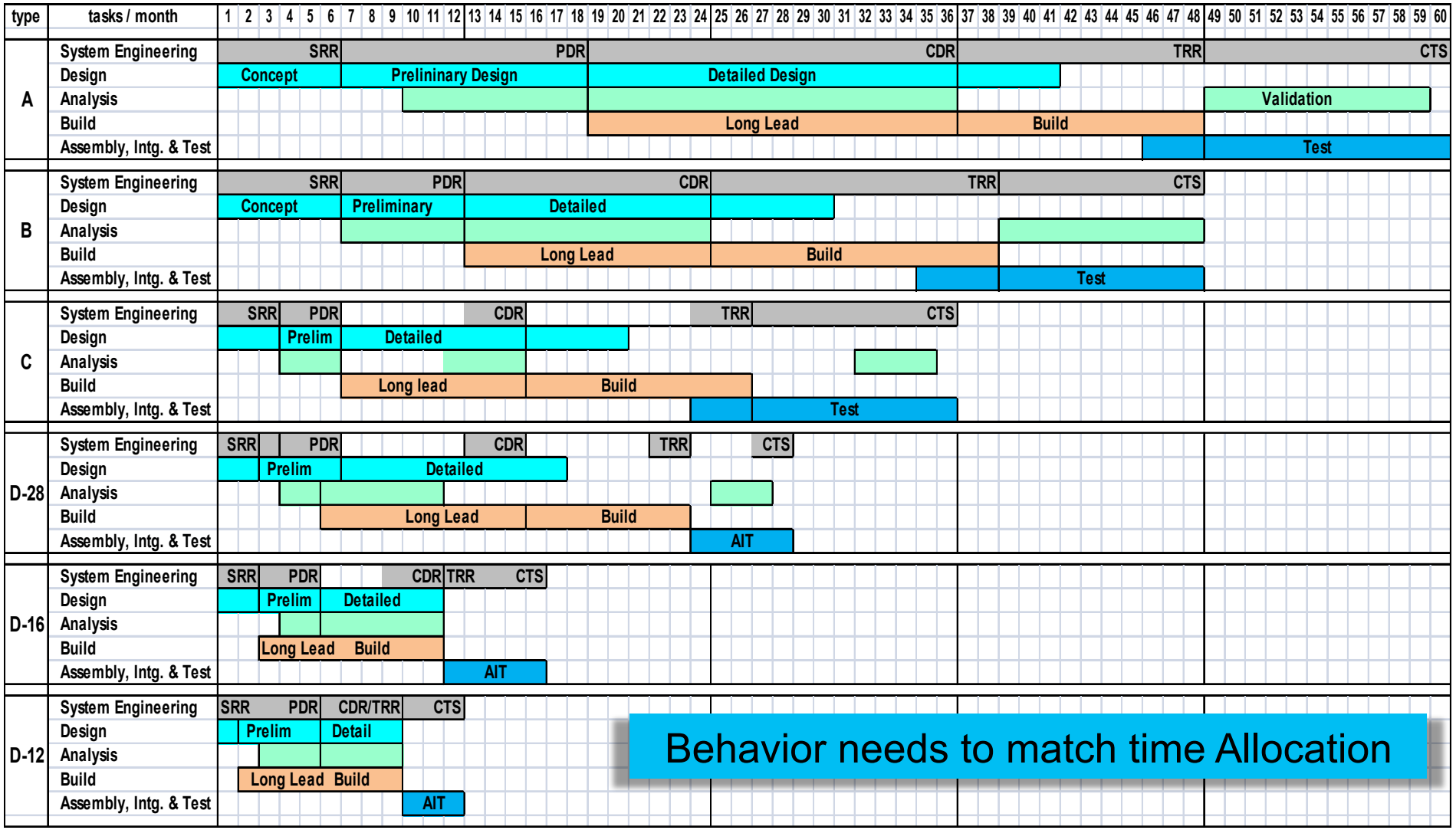

Behavior needs to match time Allocation

Program Elements vary by Class

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Program type	A	B	C	D-28 to D-12
	"Operational"	Demonstration	Experimental	Experimental to Technology Demo
Requirements				
Customer	Formal A Spec & ICD flow down; Missing any rqmt's would jeopardize program success	Formal A Spec & ICD flow down; Missing Key rqmt's would jeopardize program success	Informal A Spec, few Key rqmt's drive program success	Customer Goals, Best effort, Cost/Schedule driven
Contractor	Formal: DOORS, B,C,D spec's, internal ICD's ; Missing any rqmt's would jeopardize program success	Formal: DOORS, B,C,D spec's, internal ICD's ; Missing Key rqmt's would jeopardize program success	Informal flow down; B & ICD, DOORS	Less formal, Flow-up B, C & ICD
Design Gates/Reviews	Formal	Formal	Systems Engineering	Responsible Engineering Authority
SRR	- Requirements allocation complete - System Conceptual Design closes with Requirements - ATP to begin Preliminary Design		- Rqmt's complete - CD closes with minor findings - ATP PD, Purchase Long Lead	- "Kick off mtg" Review of customer goals, proposal - agreement on KPP's, Conceptual design
PDR	- Preliminary Design & Long Lead Dwg's Complete - System shown to meet all requirements by analysis - ATP to Detailed design, Purchase Long Lead		- PD & >30% Dwg's complete - Preliminary/System model meets Rqmt's - ATP DD, Build Flight & STE	- Rqmt's frozen with validation plan - Pre Design & Analysis complete - Dwg release scheduled to meet build
CDR	- Detail Design & >80% drawings complete - System performance demonstrated in Lab/Field tests - ATP to build flight hardware, Design/build STE		- DD & >80% Dwg's complete - Detail analysis meets Rqmt's - ATP subsystem integration	- Detailed analysis complete - >80% of hardware/software in house & test
TRR	- Subsystem, Component & STE testing complete - System integration and functional test complete		- Integration and test plans complete - STE checked out	- typically part of CDR - Test flow & STE in place
CTS	- All System requirements verified by test - Root cause of all failures found and resolved		- Key rqmt's verified - Root cause of Mission critical failures found/resolved	- Performance capability vs. Goals reviewed, anolamilies identified - Reliability & Safety issues resolved
Technical Data Package				
Spec's	CM/DM release	CM/DM release	DOORS	REA Control
Analysis	TRB approval	SE approval	REA Control	REA Control
Engr Data	TRB approval	SE approval	REA Control	REA Control
Drawings	CM/DM release	CM/DM release	CM/DM release	REA Control, Few-no Assy Dwg's
Processes, Procedures	CM/DM release	ENB, SE Approval	ENB, RE Approval	Minimal document as you go, REA Control
Management Reviews	BU, TMR, ToX	BU, TMR, ToX	BU, TMR, ToX	(senior) Technical Advisory Board
Baseline Control				
TRB	Tech Director	Tech Director	SE	REA
ERB	PMO	Tech Director	SE	REA
MRB	PMO	PMO	PMO	PM & REA
FRB	PMO	PMO	PMO	PM & REA
Testing	Formal, Operations	Formal, Operations	SE + Operations	REA

Who Executes the processes differs

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	Program Class				
Core Processes	A	B	C	D-28	D-12
Requirements Analysis and Validation	SE	SE	SE	Eng	Eng
Design Assurance	MA	MA	Eng	Eng	Eng
Parts, Materials and Processes	PMP	PMP	PMP	Eng	Eng
Environmental Compatibility	SE	SE	Eng	Eng	Eng
Reliability Engineering	Eng	Eng	Eng	Eng	Eng
System Safety	SE	SE	SE	Eng	Eng
Configuration Management	SE	SE	SE	Eng	Eng
Integration, Test and Evaluation	SE	SE	SE	SE	Eng
Risk Assessment and Management	MA	MA	PMO	PMO	Eng
Independent Reviews	MA	MA	PMO	PMO	Eng
Hardware Quality Assurance	MA	MA	Eng	Eng	Eng
Software Assurance	Eng	Eng	Eng	Eng	Eng
Supplier Quality Assurance	MA	MA	SC	SC	SC
Failure Review Board	PMO	PMO	PMO	SE	Eng
Corrective/Preventative Action Board	MA	MA	SE	SE	Eng
Alerts, Information Bulletins	PMP	PMP	PMP	PMP	PMP

PMO
MA
PMP
SC
SE
Eng

As programs move towards class D,
Engineering tends to perform more processes

Cost is the Primary Motivation

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Program type	A	B	C	D- 28 m	D-16 m	D-12 m
	"Operational"	Demonstration	Experimental	D Experimental	RS Experimental	Technology Demo
Relative Cost per thing	100%	75%	50%	35%	25%	20%
Relative Complexity (# of things)	100%	60%	30%	20%	15%	10%
Relative Cost (product of above)	100%	45%	15%	7%	4%	2%
Portion of effort (labor)						
PMO; PM, Finance, Contracts	30%	30%	25%	20%	20%	15%
"MA"; Quality, Operations, CD/DM, SCM	30%	25%	10%	5%	5%	3%
Systems Engineering	20%	23%	30%	30%	20%	10%
Engineering; ME, OE, EE, SW	20%	22%	35%	45%	55%	72%
Schedule (months from ATP)						
SRR	6	6	3	2	1	1
PDR	18	12	6	6	6	5
CDR	36	24	15	15	11	9
TRR	48	38	26	23	11	9
CTS (unit delivery)	60	48	36	28	16	12

Dramatic differences in Cost are achieved by Reduction in Complexity, and by Fewer people performing multiple jobs in Less Time

Lessons Learned from a Successful Class C/D Program

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- Both customer and contractor must be disciplined to not allow contract changes
- Schedules and budgets must be realistic
- Best Practices ensure consistent work performance
- Core team continuity through program life essential
- Maintain a senior Technical Advisory Board through life of the program
- Active management/technical oversight of key suppliers
- Traceability of requirements flow down from start through life. Integrated Requirements and verification plan
- I&T processes and procedures defined upfront as part of design
- Combine design and peer reviews with customer participation to provide transparency in design and technical review process.
- Use of E-reviews with *minimal charts* to communicate design maturity level and challenges to customer.
- Proved to be an excellent means to mentor and train young design and system engineers
- Conducted peer review early, applied comments to update risk plan and tracked mitigation progress
- Used leading metrics (example: drawing release statused weekly) enabling actions to be taken prior to impact to schedule

Create Mission Success

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- Define Success: *Know where you are going*
  - Its likely to be complicated or change over time
  - Important to write it down
- Plan for Success: *Know which path to take*
  - All development programs are different. They need unique plans and processes
  - Get buy-in from all stakeholders (Customer, Enterprise, Program)
  - Minimize Technical and programmatic complexity
- Have the right Team *Know who & how to get there*
  - Process will not yield success without the right people
- Operate in a friendly Environment
  - Safe and supportive atmosphere internal and external to the program team

Success does not happen by itself. It takes deliberate effort -
With the right plan you can be successful every time