Getting the Most from Multi-disciplinary Teams

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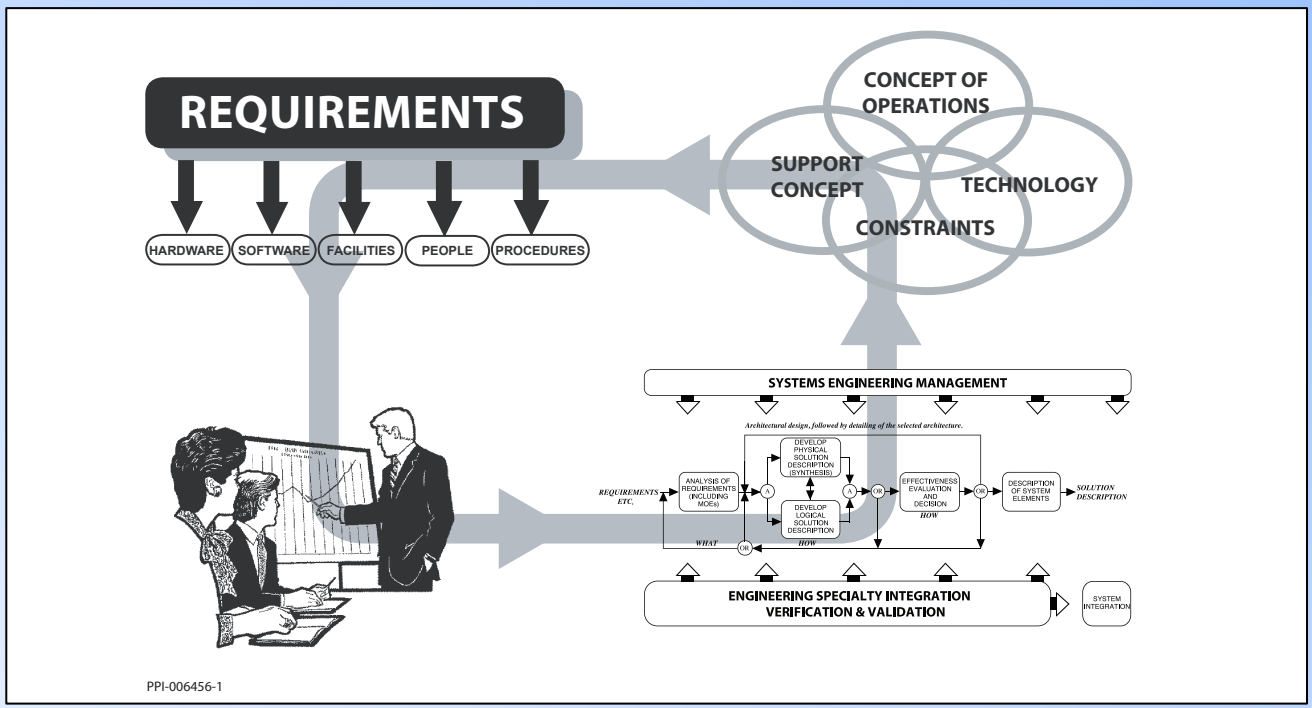

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What are we going to do?

The Integrated Product Team (IPT) is a multidisciplinary organizational unit, sometimes used in conjunction with a strategy of concurrent (or simultaneous) engineering, to improve the outcomes of technical projects.

We are going to place Integrated Product Teams in a business context, addressing the question of an executive or manager with an interest in projects “Why should I be interested in Integrated Product Teams”, and how can I derive the benefits?

Types of Teams in Engineering

- Project Teams
- Integrated Product Teams
- Product Development Teams
- Functional Teams
- Skunkworks
- Process Cells
- Tiger Teams
- Red Teams
- Interface Control Working Groups (ICWGs)

IPTs – Some Evidence

Driver	Relationship to Performance (Gamma)		
	All Projects	Lower challenge	Higher challenge
SEC-Total – total deployed SE	+0.49	+0.34	+0.62
SEC-PP – project planning	+0.46	+0.16	+0.65
SEC-REQ – reqts. devpt. & mgmt.	+0.44	+0.36	+0.50
SEC-VER – verification	+0.43	+0.27	+0.60
SEC-ARCH – product architecture	+0.41	+0.31	+0.49
SEC-CM – configuration management	+0.38	+0.22	+0.53
SEC-TRD – trade studies	+0.38	+0.29	+0.43
SEC-PMC – project monitor & control	+0.38	+0.27	+0.53
SEC-VAL – validation	+0.33	+0.23	+0.48
SEC-PI – product integration	+0.33	+0.23	+0.42
SEC-RSKM – risk management	+0.21	+0.18	+0.24
SEC-IPT – integrated product teams	+0.18	-0.12	+0.40

Gamma	Relationship
-0.2 <| *Gamma* | ≤ 0	Weak negative
0 ≤ | *Gamma* | < 0.2	Weak positive
0.2 ≤ | *Gamma* | < 0.3	Moderate
0.3 ≤ | *Gamma* | < 0.4	Strong
0.4 ≤ | *Gamma* |	Very strong

http://resources.sei.cmu.edu/asset_files/specialreport/2012_003_001_34067.pdf

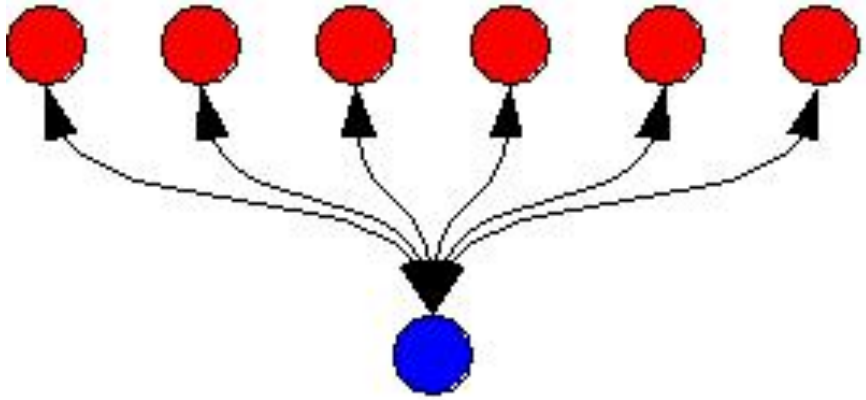
Source: "The Business Case for Systems Engineering Study: Results of the Systems Engineering Effectiveness Survey", CMU/SEI-2012-SR-009, November 2012

Definition of a Team

- “A team, by our definition, is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable. As a result, they deliver extra performance benefits. A real team is more than just the sum of its parts”.

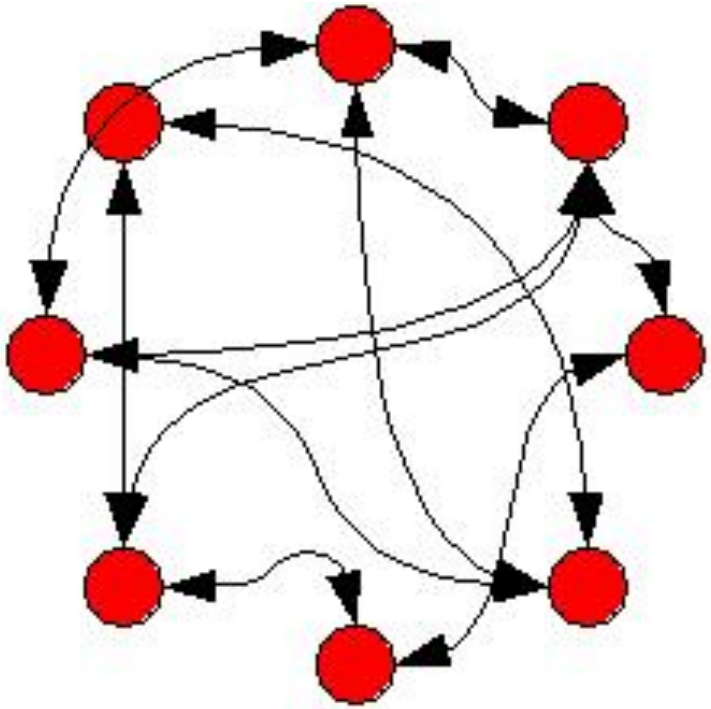
Source: Jon R. Katzenbach and Douglas K. Smith, McKinsey Quarterly (the business journal of McKinsey & Company)

A Group Versus a Team



GROUP

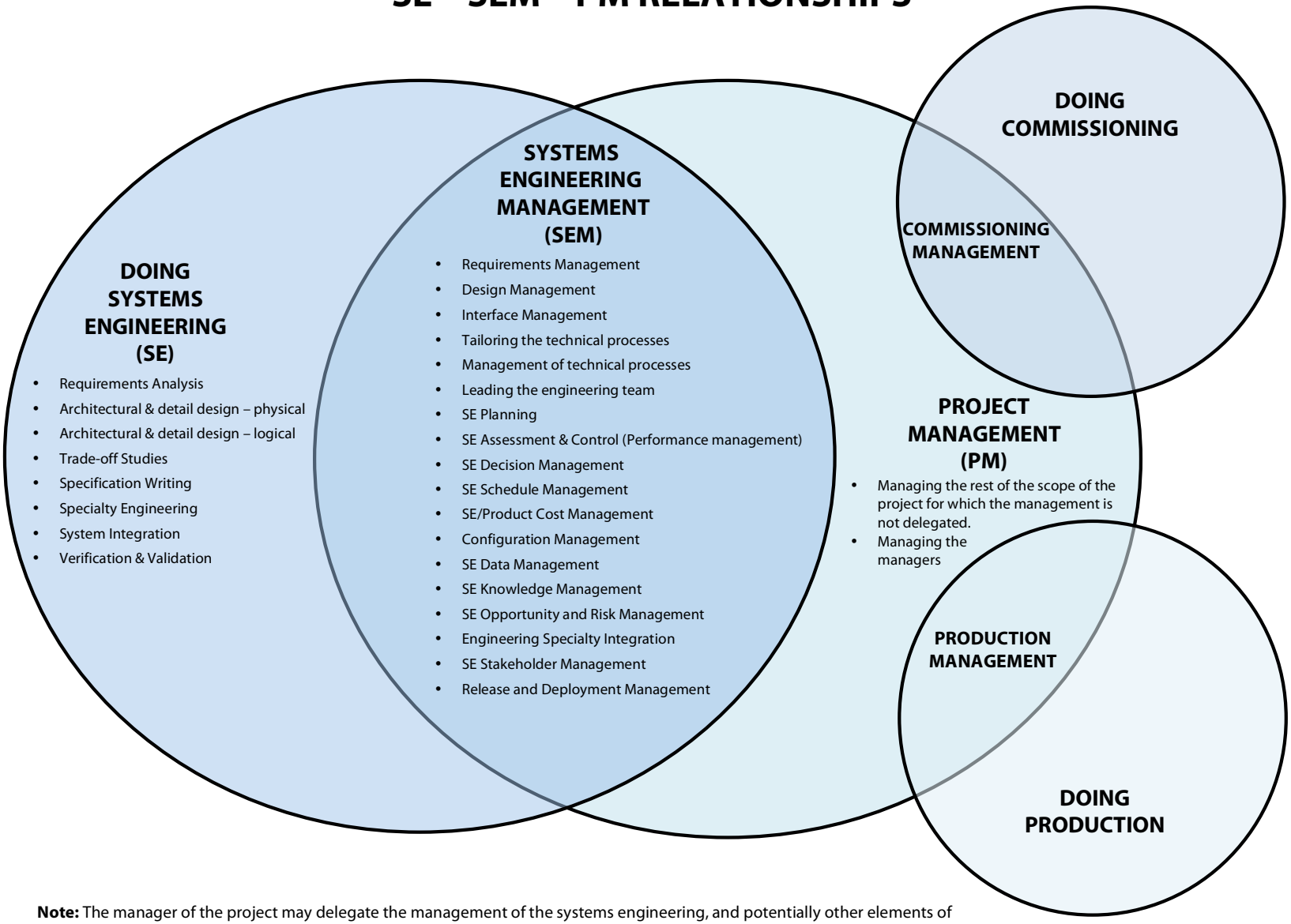
people working towards a goal whose work is coordinated by someone else (e.g. a manager) for them



TEAM

people working towards a common goal who coordinate their work amongst themselves

SE – SEM – PM RELATIONSHIPS



Note: The manager of the project may delegate the management of the systems engineering, and potentially other elements of project scope, e.g., production, commissioning, contract.

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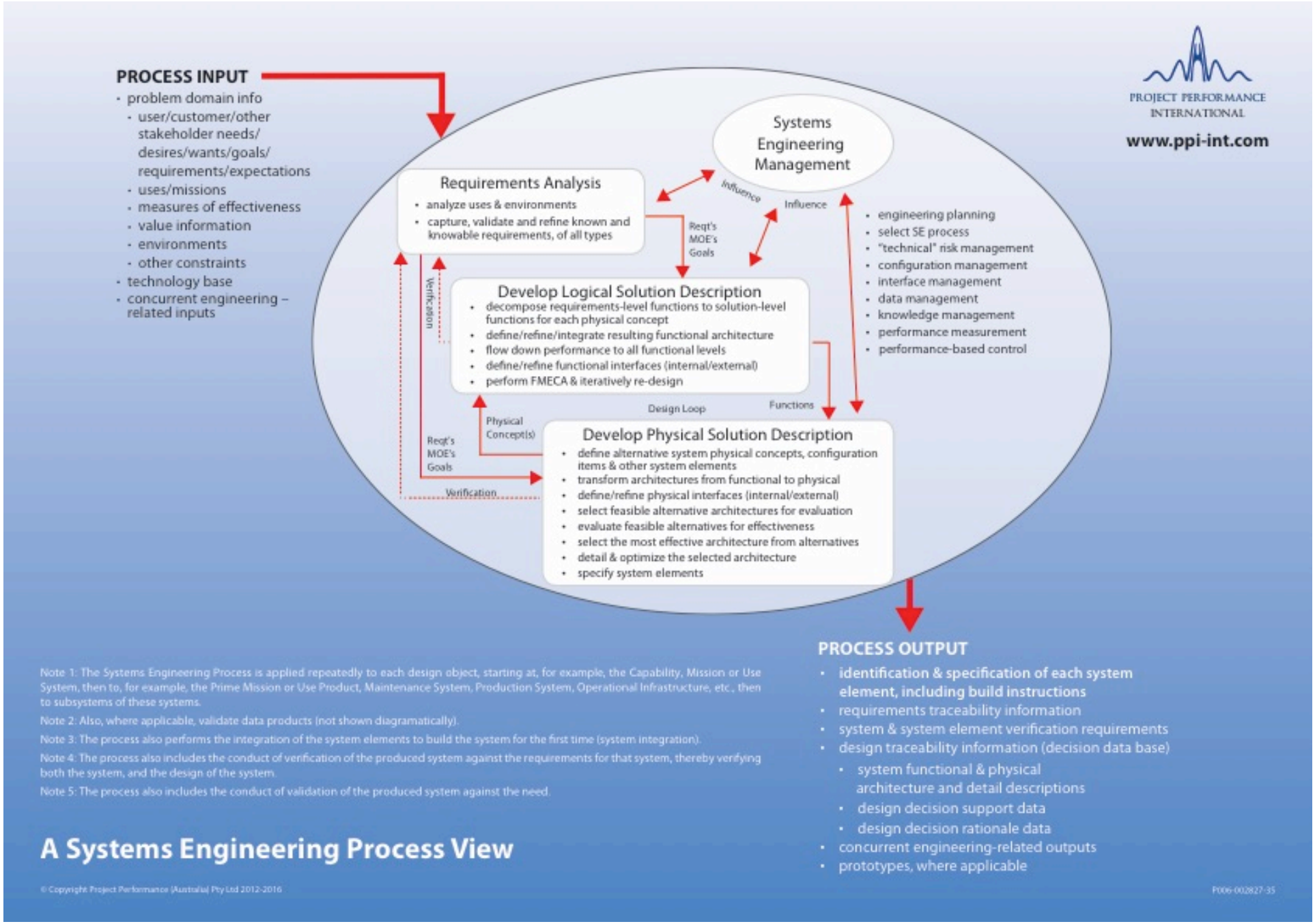
PROCESS INPUT
problem domain info
user/customer/other stakeholder needs/ desires/wants/goals/ requirements/expectations
uses/missions
measures of effectiveness
value information
environments
other constraints
technology base
concurrent engineering – related inputs
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Systems Engineering Management
Requirements Analysis
analyze uses & environments
capture, validate and refine known and knowable requirements, of all types
Influence
Influence
Reqt's MOE's Goals
Verification
Develop Logical Solution Description
decompose requirements-level functions to solution-level functions for each physical concept
define/refine/integrate resulting functional architecture
flow down performance to all functional levels
define/refine functional interfaces (internal/external)
perform FMECA & iteratively re-design
Design Loop
Functions
Physical Concept(s)
Reqt's MOE's Goals
Verification
Develop Physical Solution Description
define alternative system physical concepts, configuration items & other system elements
transform architectures from functional to physical
define/refine physical interfaces (internal/external)
select feasible alternative architectures for evaluation
evaluate feasible alternatives for effectiveness
select the most effective architecture from alternatives
detail & optimize the selected architecture
specify system elements
engineering planning
select SE process
"technical" risk management
configuration management
interface management
data management
knowledge management
performance measurement
performance-based control
PROCESS OUTPUT
identification & specification of each system element, including build instructions
requirements traceability information
system & system element verification requirements
design traceability information (decision data base)
system functional & physical architecture and detail descriptions
design decision support data
design decision rationale data
concurrent engineering-related outputs
prototypes, where applicable
Note 1: The Systems Engineering Process is applied repeatedly to each design object, starting at, for example, the Capability, Mission or Use System, then to, for example, the Prime Mission or Use Product, Maintenance System, Production System, Operational Infrastructure, etc., then to subsystems of these systems.
Note 2: Also, where applicable, validate data products (not shown diagramatically).
Note 3: The process also performs the integration of the system elements to build the system for the first time (system integration).
Note 4: The process also includes the conduct of verification of the produced system against the requirements for that system, thereby verifying both the system, and the design of the system.
Note 5: The process also includes the conduct of validation of the produced system against the need.
A Systems Engineering Process View
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P006-002827-35

Major Factors in Engineering Team Performance

- A **coaching style** of **team leadership**
- **Personal qualities** of the team leader and team members
- Well-defined outcomes-oriented **success criteria** associated with a **shared vision**
- Excellence in the necessary, role-related **Knowledge, Skills and Attitudes (KSAs)** of team members
- **Empowerment** – the authority to make decisions within defined constraints
- A **consensus-basis** of **team decision-making**
- A good **understanding** by team members of **risk and opportunity**

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Systems Engineering Management KSAs - Knowledge

- Broad, but not necessarily detailed, **knowledge of the technologies** involved in the engineering activities being managed, and related methods
- Deep knowledge of the **principles and methods of systems engineering**
- Deep knowledge of the **principles and methods of project management**
- Deep knowledge and **understanding of risk and opportunity**
- Deep knowledge of **human psychology and related behavior**

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Systems Engineering Management KSAs - Skills

- Skills to apply knowledge to **planning, organizing resources, motivating people, measuring performance and applying corrections** where necessary
- Very good **decision-making skills in the presence of incomplete information and uncertainties as to outcomes**
- Skills to **manage outwards, engendering confidence** in the engineering from the stakeholders in the engineering

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Systems Engineering Management KSAs - Attitudes

- **Respect for technical expertise**
- **Results orientation**
- Where subordinates are performing the engineering, **willingness to delegate**
- **Issues focus, not personalities focus**
- **Patience**
- A personality type that **gains satisfaction from enabling others** to succeed
- **No blame**

Example Role:
Requirements Analysis KSAs - Knowledge

- Knowledge of the **history of projects** and the **role of requirements in project outcomes**
- Knowledge of the **information parameters which define the problem domain**
- General **understanding of risk**
- Deep knowledge of the **principles and methods of requirements analysis**
- At least basic familiarity with the **application domain** for the item which is to be the subject of the requirements analysis
- At least base level knowledge of **systems engineering principles and methods**

Requirements Analysis KSAs - Skills

- Deep skills in **applying the knowledge of the principles and methods of requirements analysis**
- Skills in **identifying defects in requirements**
- Skills to **distinguish between**, and **switch thinking between**, **problem domain and solution domain**
- Skills in **measuring requirements quality**
- Deep skills in **human communication**
- Skills in **writing individual requirements**, in applicable language(s)
- Skills in the **development of verification requirements**

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Requirements Analysis KSAs - Attitudes

- **Respect** for the **right of the owners of requirements to decide what they require**
- **Desire to address requirements issues** in terms of **outcomes for the stakeholders**, not in terms of competencies of the requirements owner/ writer - "*projection as being on their side*"
- **Willingness to accept approximation and incompleteness** in requirements, and related requirements analysis tasks - **"adequacy" not "perfection"**
- Subject to the "adequacy" criterion, **attention to detail**

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Example Role:
Physical Design KSAs - Knowledge

- General knowledge of the **problem domain**
- Deep knowledge of the **relevant solution technologies**
- Knowledge of **basic problem solving**, involving problem definition, candidate solution identification, and solution selection
- **General understanding of risk**
- **Understanding that design creates requirements**

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Physical Design KSAs - Skills

- Skill to **distinguish between**, and **switch thinking between, problem domain and solution domain**
- Deep creative and innovative skills in **relating understanding of the problem and knowledge of relevant solution technologies** to develop candidate solutions to the problem
- Skills in **explaining design**, verbally and in writing
- Skills in **creating through sound design decisions, sound requirements** on elements of the solution

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Physical Design KSAs - Attitudes

- Respect for the **right of owners of the requirements to define the problem** that is to be solved
- **Attention to detail**
- Willingness to **accept and respond constructively to questioning**, and to **criticism**, of the design
- Focus on **maximization of value to the stakeholder(s)** whom the design is to serve, normally the employer
- Willingness to **raise requirements issues with stakeholders** when defects in requirements are discovered, rather than unilaterally deciding, or assuming, or guessing

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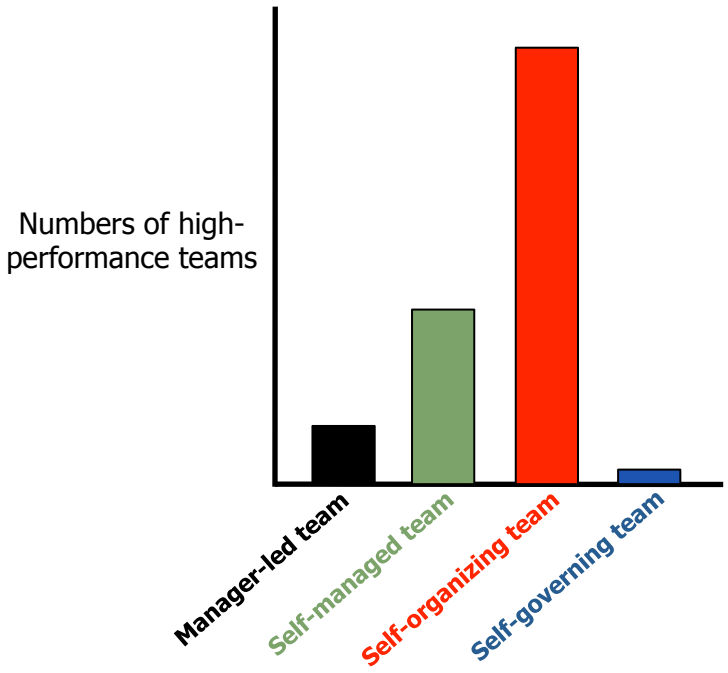
Self-Organizing Teams

Most high-performance teams are self-organizing teams

FOUR TYPES OF TEAM

	Manager-led teams	Self-managing teams	Self-organizing teams	Self-governing teams
Setting overall direction for the team				
Designing the team and its context				
Managing work process and monitoring progress				
Executing the team tasks:				

Where are high-performance teams found?



Source: SteveDenning.com

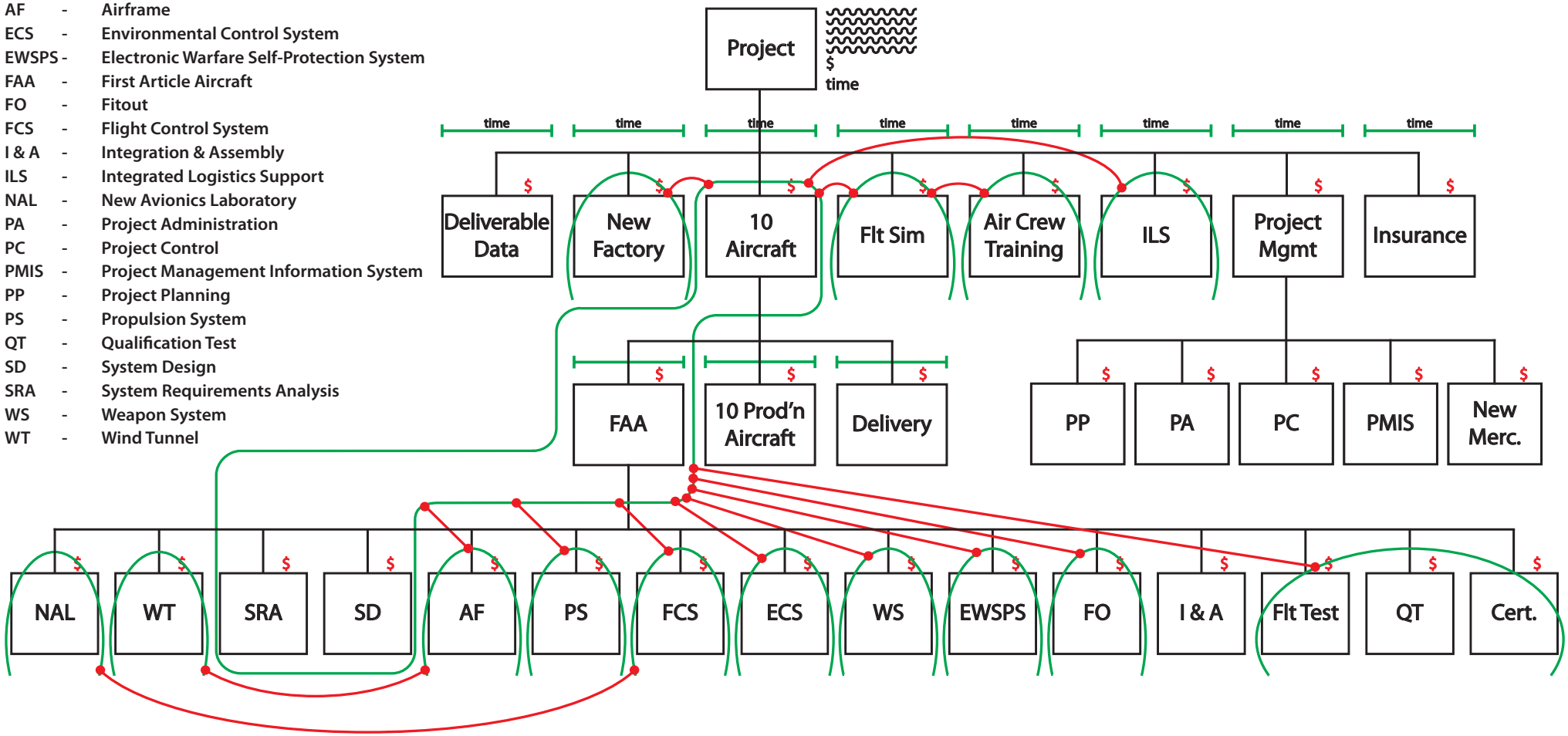
Project (Work) Breakdown Structure (PBS/WBS)

as a Framework for Project Definition, Costing, Scheduling, Risk Analysis, Measurement, Reporting and Organizational Design

Legend:

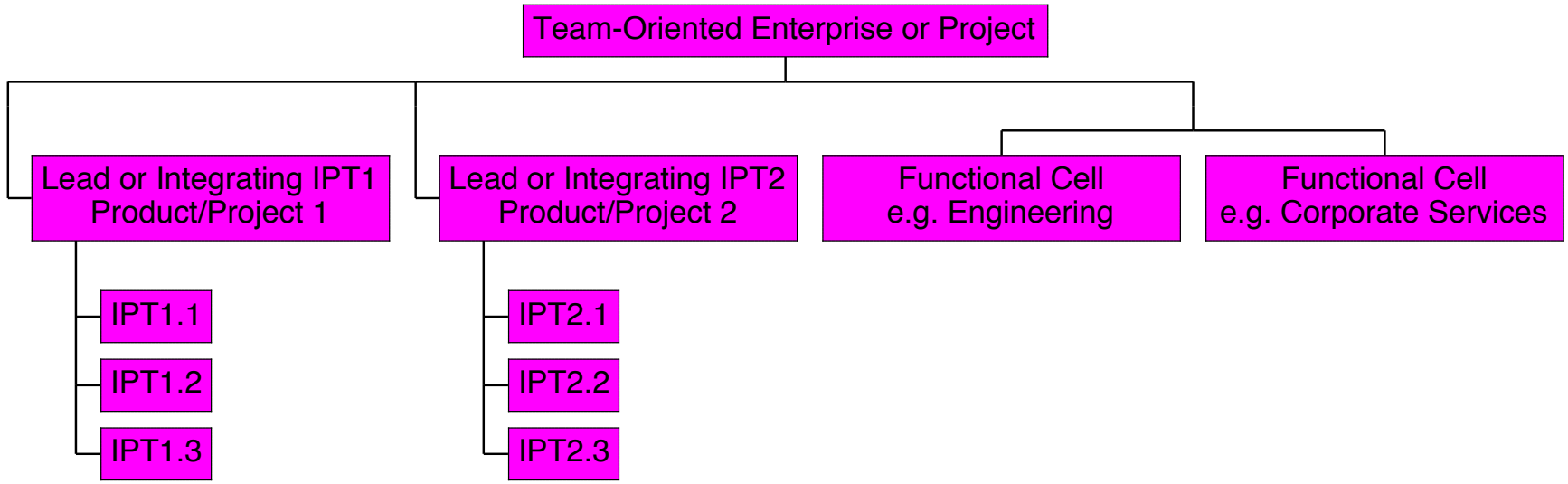
- Boundary of scope of an Integrated Product Team
- Cross-team membership
- Schedule: start and finish

AF	-	Airframe
ECS	-	Environmental Control System
EWSPS	-	Electronic Warfare Self-Protection System
FAA	-	First Article Aircraft
FO	-	Fitout
FCS	-	Flight Control System
I & A	-	Integration & Assembly
ILS	-	Integrated Logistics Support
NAL	-	New Avionics Laboratory
PA	-	Project Administration
PC	-	Project Control
PMIS	-	Project Management Information System
PP	-	Project Planning
PS	-	Propulsion System
QT	-	Qualification Test
SD	-	System Design
SRA	-	System Requirements Analysis
WS	-	Weapon System
WT	-	Wind Tunnel



Systems engineering activities populate the WBS below level 2,
or if there is only one deliverable of the project, at level 2 and below.

An IPT Approach



IPTs are designed to achieve focus on end deliverables, to make consistently good decisions and to maximize the effectiveness of communication within and external to the team.

Integrated Product Teams (IPTs)

- An IPT is a cross-functional (or multi-disciplinary) team with stakeholder representation, formed for the purpose of supplying one or more products to one or more customers, internal or external.
- IPTs facilitate integrated product and process development, and in so doing, to achieve:
  - Greater satisfaction of need
  - Lower cost
  - Shorter timescale.
- It is what IPTs do and how well they do it that makes IPTs important.

Characteristics of an IPT

- IPTs integrate and enhance cross-functional and cross-organizational work to provide better decision-making, problem solving and implementation.

- IPTs can perform better than functionally-based teams in challenging, uncertain, complex and dynamic environments.

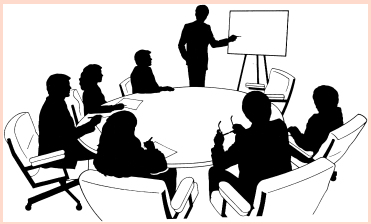
Inside a Typical IPT

Stake-holder needs

Customer & Other Stakeholder Reps

IPT Leader

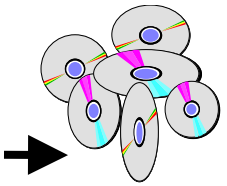
Sub-team Leaders



Functional Area Reps

Specialty Engineers

Other IPT Members



Solution to to stake-holders

- A multi-disciplinary, cross-functional, stakeholder-focussed team solely responsible for taking a product from need to delivery
- Knowledge, skills and attitudes of the team members are complementary

IPT Membership

Membership of a Lead IPT may include:

- Team leaders of subordinate IPTs
- Specialists including specialty engineers
- Functional representative - engineering
- Functional representative - HR
- Functional representative - production
- Functional representative - purchasing
- Functional representative - marketing
- Functional representative - finance
- Functional representative - quality
- Functional representative - IT
- Representatives - interfacing WBS elements
- IPT Leader

The number of people on the IPT will depend on the nature of the IPT and its environment

Effects of IPTs on Process Performance

- Improved identification with the product and the user
- Improved learning through frequent multi-disciplinary communication
- Improved product and process effectiveness through application of systems thinking
- Improved communication through attitude, proximity and IT
- Improved innovation through team environment
- Improved partnering through team structure
- Improved problem solving through multiple participants and mutual ideas stimulation
- Improved conflict management through focus on positive attitudes
- Improved decision-making through multiple participants and mutual ideas stimulation
- Improved generation of alternative solutions through multiple participants and mutual ideas stimulation
- Improved implementation through shared commitment to the desired end result

Effects of the IPT Approach on Human Environment

- Enhances a culture of shared goals - better “teambuilding”
- Increases the perceived value of team members to their peers
- Increases the influence of people as a team, and individually within the team
- Improves customer/supplier relationships
- Improves morale
- Creates a perception of beneficial change

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Benefits Directly to the Individual

- Teams fulfil two of the basic human needs suggested by Maslow's hierarchy of human needs (1954): the need to belong and the need for self-fulfillment
- For most individuals, teams help the individual achieve higher levels of performance and therefore higher self-actualization than is possible alone
- Enhanced professional growth through interaction with colleagues
- Enhanced growth as a human being through enhanced development of interpersonal skills
- Individual empowerment

IPT Effectiveness - Australian Experience

- Abbott Australasia manufactures very specialized pharmaceuticals. When they went to an IPT approach they:
  - Improved productivity by 30%
  - Reduced costs by 20%
  - Improved their achievement of committed supply dates from 72% to 97%

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IPT Effectiveness - Other Examples

Boeing - Reduced delivery time of small satellites from 36 months to 21 months, and halved costs

Rockwell - Reduced cost and schedule by 30% on missile projects

IBM - Reduced electronic design cycle by 40%, quality improved

Hewlett Packard - Reduced manufacturing costs by 42%, development cycle time by 35%, reduced defects by 60%

Deere and Company - Reduced construction equipment development cost by 30%, development time by 60%, improved quality by 67%

Japanese industry - Has been using IPTs for decades, with well-known success

Team Size

- IPTs must be structured to achieve a balance between representation of stakeholders/expertise and effective communication between team members
- Size of 7 - 11 people appears to be optimum
- As team size increases, meetings:
  - Tend to become briefings rather than collaborations
  - Tend to be dominated by a small number of people
  - Tend to stifle active participation of many
  - Work against expression of disagreement
- As team size increases:
  - Building understanding and trust becomes more difficult
  - Understanding of roles, responsibilities and “the game plan” falls

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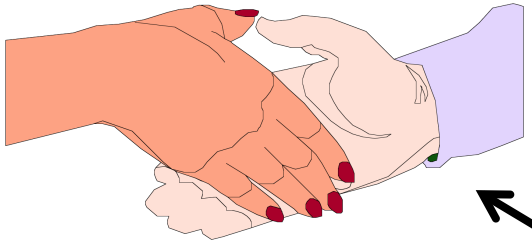
TEAM KEY SUCCESS FACTORS

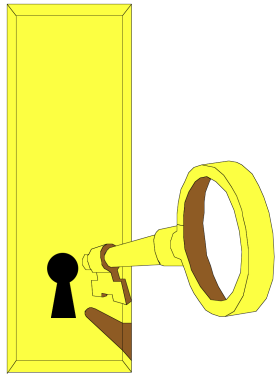
Create an Environment

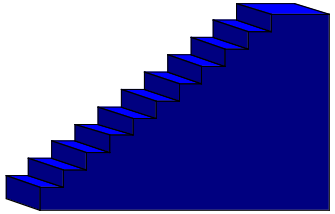
Create an environment that develops:



Trust

Empowerment

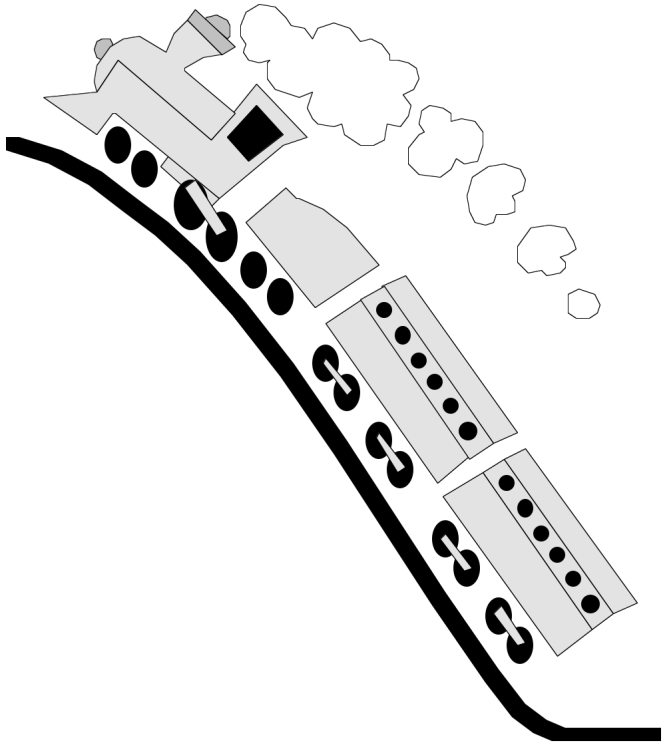




Open Communication

Dedication

Team KSF - Team Leadership



Team leadership: the ability of the team leader to inspire, motivate and develop the team and its members. The team leader is the lead coach and the team members' greatest supporter.

Team KSF - Shared Vision

Shared Vision: the commitment in words and action of the team members to an explicitly stated common goal.

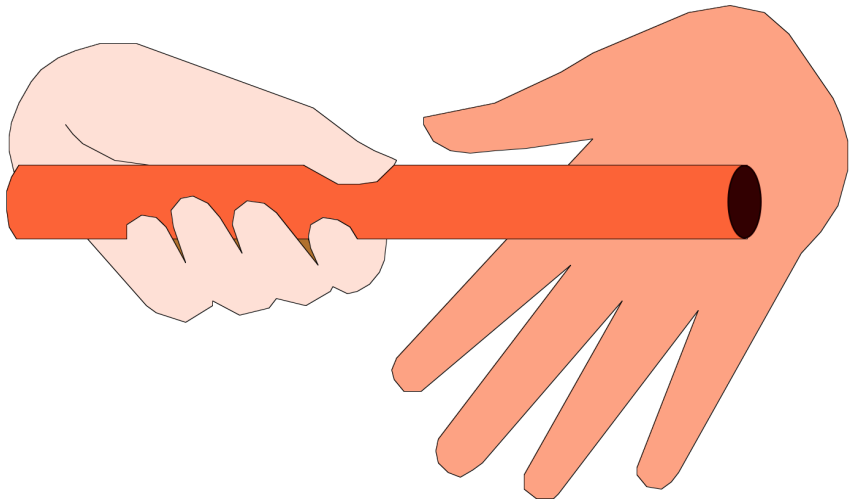
Team KSF - Commitment to Approach

Commitment to Approach: the existence of a common understanding of, and agreement to, the method of approach of the team to the job.

Team KSF - Team Member Collaboration

Team Member Collaboration: a method of working involving mutual support in pursuit of team goals without hidden agenda or power games.

Team KSF - Empowerment



Empowerment: the authority of team members and of the team to make decisions within the scope of performance of the designated IPT task and defined constraints.

Team KSF - Team Learning

Team Learning: When a team is first formed, team members rarely have the complete set of skills, knowledge and attitudes necessary for the team to perform. Mental models of the world differ between individuals. Successful teams incorporate mechanisms for development of a shared mental model, and other aspects of team learning, and exist in an environment in which shared learning is fostered.

Example Code of Cooperation for Teams

1. Attend all meetings and be on time
2. Listen and show respect for the views of the other team members
3. Criticize ideas, not persons
4. Recognize that the only stupid question is the one not asked
5. Pay attention - avoid disruptive behavior
6. Carry out assignments on schedule
7. Avoid conflicts constructively
8. Come prepared
9. Every member is responsible for the team's progress and success
10. Follow agenda
11. Don't interrupt
12. Keep good sense of humor
13. Don't dominate
14. Set agenda
15. Only hold a meeting when a meeting is needed
16. Others????

No-No's

NIH - Not Invented Here

Criticism of the person - rather than the act

Put-downs

Team KSF - Enterprise Partnering

Enterprise Partnering: a condition whereby the host enterprise of the team and stakeholders external to that enterprise have informal or formalized working relationships which support the objectives of the IPT. The relationship should be formalized by a Partnering Agreement in most cases. Successful partnering relies on each party understanding and respecting the other's objectives, whether common or conflicting.

Team KSF - Stakeholder Feedback

Stakeholder Feedback: teams are most effective when team performance is continuously being verified and improved by feedback from the customers of its products and all other external stakeholders to which the team owes allegiance.

Team KSF - Team Size

Team Size: IPTs are most effective when an optimum balance is struck between representation of stakeholders and skills versus effectiveness of communication between team members.

Team KSF - Technology Support

Technology Support: the extent that high performance team working is made possible through the availability and ease of use of communication and decision support technologies. Even more important when team members are geographically dispersed, the “virtual team”.

Team Leader Roles

Team Leader is:

- Leader
- Living Example
- Coach
- Business Analyzer
- Roadblock Remover
- Customer Advocate

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Leadership

Meeting Room Technologies

Shared Design Database Access

Electronic Whiteboards

Multimedia Projection

Conference Phone

Stick-on Dots

Round Tables

Magnetic Shapes

Video Recording

Storyboards

Cards

Picture Frames

Large 'Post-it' Notes

Whiteboards

Butchers' Paper

Internet/Intranet Access

Video Projection

Characteristics of Members of High Performance Teams (1)

- Flexibility - a willingness to avoid rigid positions, a willingness to take some chance in backing the ideas of others.
- Synergy with other team members, leading to potentially good ideas that are progressively refined and developed by the team.
- Multiple levels of experience within the team. Less experienced team members often ask questions and conceive solutions that are incisive, unfettered by “the way it has been done in the past”. Breakthroughs result.

Characteristics of Members of High Performance Teams (2)

- Practice of information filtering, leading to reduced information overload within the team.
- Early disclosure of problems and issues, leading to earlier, lower cost problem solving.
- No blame.

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To Recap: Major Factors in Engineering Team Performance

- A **coaching style** of **team leadership**
- **Personal qualities** of the team leader and team members
- Well-defined, outcomes-oriented **success criteria** associated with a **shared vision**
- Excellence in the necessary, role-related **Knowledge, Skills and Attitudes (KSAs)** of team members
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MAY GREAT TEAMS BRING GREAT SUCCESS TO YOUR PROJECTS AND TO YOUR CAREERS!

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