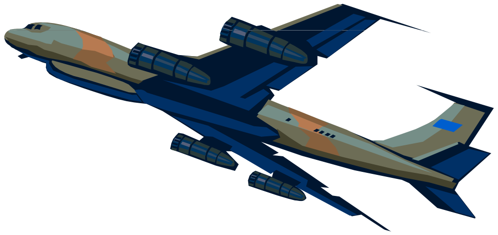
Systems Engineering: From Dream to Reality



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Systems Engineering: From Dream to Reality

Introduction

Who is Dave Cook?

Dr. David A. Cook is Associate Professor of Computer Science at Stephen F. Austin State University, where is teaches Software Engineering, Modeling and Simulation, and Enterprise Security. Prior to this, he was Senior Research Scientist and Principal Member of the Technical Staff at AEgis Technologies, working as a Verification, Validation, and Accreditation agent supporting the Airborne Laser. Dr. Cook has over 30 years' experience in software development and management. He was an associate professor and department research director at USAF Academy and former deputy department head of Software Professional Development Program at AFIT. He was a consultant for the Software Technology Support Center for six years. Dr. Cook has a PhD in Computer Science from Texas A&M University, is a Commissioner for the Accreditation Board for Engineering and Technology (ABET), and is the Senior Vice President for the Society for Computer Simulation.

Who is Judy Bamberger?

Judy Bamberger has 25 years' experience developing software, leading teams, teaching, and developing organisation-wide leaders. An independent consultant, she specializes in project management, process definition and improvement, quality techniques (e.g., formal inspections, metrics), team building, facilitation, and managing change.

Ms Bamberger has:

- **Performed numerous assessments (SPA, CBA-IPI, ARC Class C/B, ISO9001, custom-tailored) and worked with organisations around the world and at all maturity levels.**
- **Created a CMM/CMMI gap analysis method that is highly reliable and cost-effective. This enables her clients to review their strengths and weaknesses against the practices of the CMM/CMMI, provides a likely maturity/capability level rating, and summarises opportunities for improvement - at a fraction of the time and cost of an appraisal. The CMMI gap analysis method complies with ARC Class B/C requirements.**
- **Assisted her clients with improvement plans based on assessment results, which enabled them to meet their strategic business goals and increase their maturity levels.**
- **Trained and coached internal change agents in: basic quality tools, communication skills, managing change and resistance, effective improvement planning, and transition. This enabled her clients to create lasting, positive changes.**

A key author of CMM, Ms Bamberger is one of the original Authorised Lead Assessors.

Ms Bamberger teaches project management and an award-winning course that has the students apply basic quality tools in the contexts of a real team, project, and organization. She provides workshops and on-site mentoring in the CMMI, Personal Software Process, peer reviews, process improvement, and other software engineering, management, and leadership subjects.

Who is Joe Hanson?

Dr. Joe Hanson, is the manager for the Performance and Predictive Analysis team on the ITT SENSOR contract in Colorado Springs. He has over 30 years experience in satellite operations, software development, system management, system integration and system engineering. In his current position, he has the responsibility for a major software demonstration project as well as monitoring the metric performance of the AF Ground Based Sensor network. He has a bachelor's degree from Regis University, a master's degree from Chapman University, and a doctorate degree from Colorado Technical University.

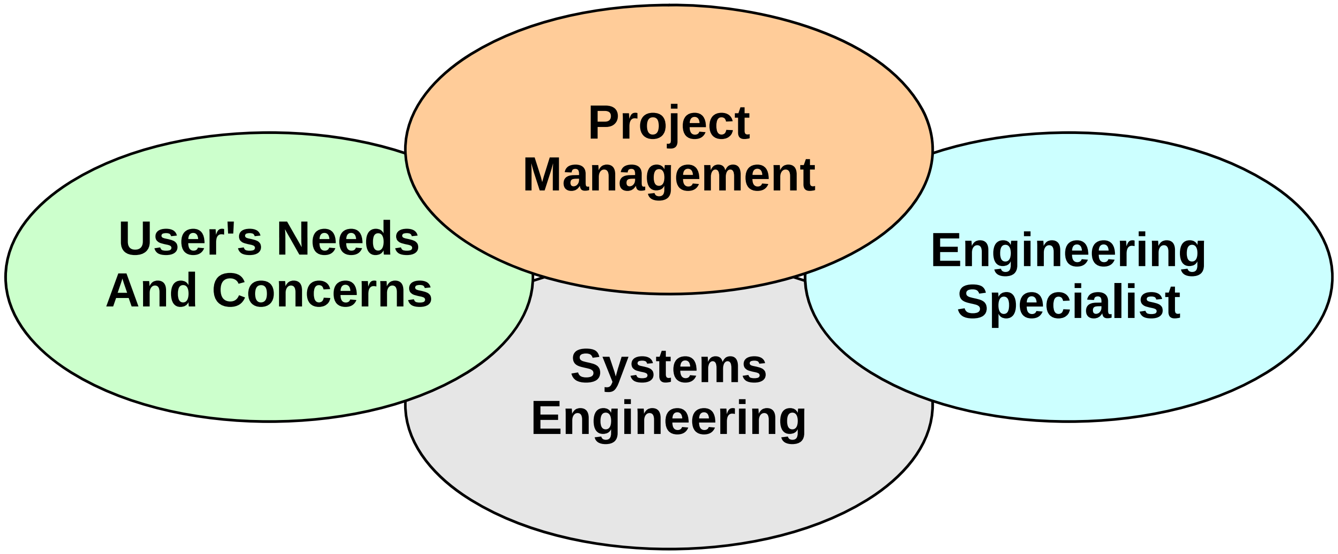
Who is Joe Thiessens?

Joe Thiessens has over forty years experience in system integration, systems and software engineering, and software process engineering. He is the Software Center of Excellence Lead on the ITT SENSOR contract in Colorado Springs. In this capacity, he is currently working on promoting the synchronization and synergy of software processes across seven product lines. He develops and updates software engineering processes to evolve legacy software applications to modern implementations. He provides subject matter expertise in software design and implementation and mentors product line engineers in effective peer review procedures and techniques. He has a bachelor’s degree from Colorado Technical University.

Systems Engineering: From Dream to Reality: Agenda

- **Foundations of Systems Engineering**
- **System's User's Needs and Concerns**
- **Project Manager's Financial and Schedule Constraints**
- **Capabilities and Ambitions of the Engineering Specialists**
- **Epilogue, Wrap-Up, and Questions**

Foundations of Systems Engineering



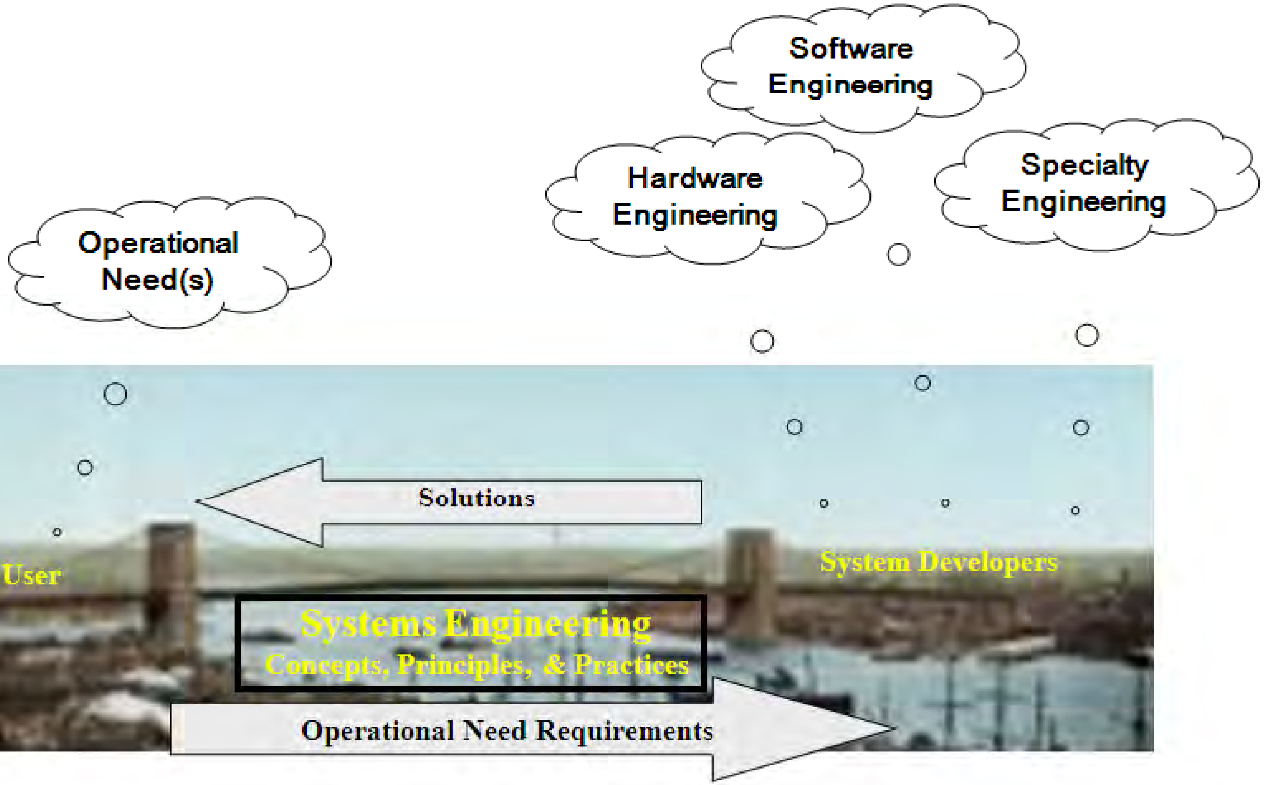
Foundations of Systems Engineering:
Agenda

- **What is Systems Engineering?**
- **Origins of Systems Engineering**
- **Systems Engineering Viewpoint**
- **Systems Engineering as a Profession**
- **The Power of Systems Engineering**

Foundations of Systems Engineering:

What is Systems Engineering?

Bridging the Gap



Operational Need(s)

Hardware Engineering

Software Engineering

Specialty Engineering

Solutions

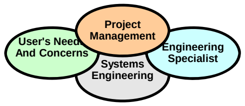
User

System Developers

Systems Engineering

Concepts, Principles, & Practices

Operational Need Requirements



Foundations of Systems Engineering:

Origins of Systems Engineering

- Been in play since the building of the pyramids

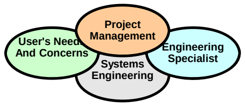
- Developed into what we know today from complex WW II systems
- Developed into a problem solving approach during the 20th century

Foundations of Systems Engineering:
Systems Engineering Viewpoint

- **A new way of thinking**

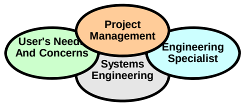
Foundations of Systems Engineering:

Systems Engineering as a Profession



- Primarily recognized in the Department of Defense
- Does not correspond with traditional engineering disciplines
  - Of the 6900+ accredited colleges and universities only 80 offer a degree in Systems Engineering

Foundations of Systems Engineering:
The Power of Systems Engineering



- As measured by authority over
  - People
  - Money
- As measured by influence over
  - System design
  - Major characteristics
  - Success of failure of system development

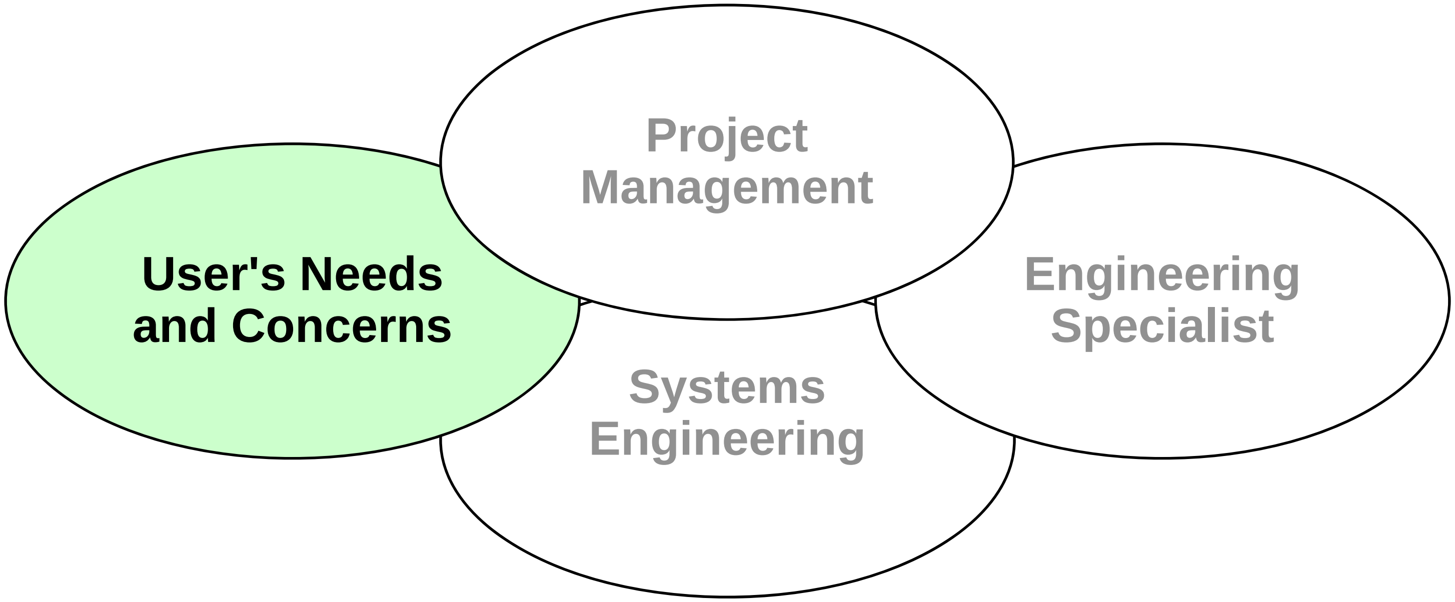
Foundations of Systems Engineering:
The Power of Systems Engineering (2)

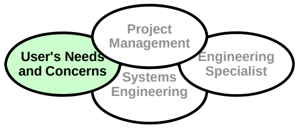
- A project is a veritable "Tower of Babel"
- Potentially dozens engineering specialist
  - SE provides linkage to enable them to function as a team

Foundations of Systems Engineering:
Summary

- Bridging the Gap
- Systems Engineering has existed almost since the beginning of time
- Systems Engineering is a way of thinking
- Systems Engineering mainly in the Department of Defence but is now expanding into the commercial sector
- The power of Systems Engineering is based mainly on influence

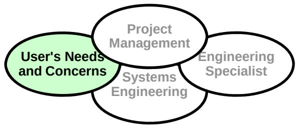
System’s User’s Needs and Concerns





System's User's Needs and Concerns: Agenda

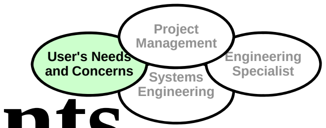
- Where this all fits into Systems Engineering
- A Requirements view of the lifecycle
- Elicitation
- Categorizing the Requirements
- Stability and change



Where This All Fits

- **Requirements Engineering: the subset of systems engineering concerned with discovering, developing, tracing, analyzing, qualifying, communications and managing requirements that define the system at successive levels of abstraction.**

* **Hull, Jackson Dick 2011**



Top 10 Cosmic Truths of Requirements

10. If you don't do the requirments right, it doesn't matter how well you do the rest of the project

9. Requirement development is a discovery and invention process, not just a collection process

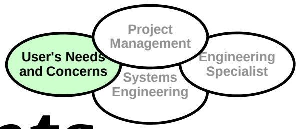
8. Change happens

7. The interests of all stakeholders intersect in the requirements process

6. Customer involvement is the most critical contribution to product quality

5. The customer is not always right, but the customer always has a point

4. The first question an engineer should ask about a new requriement is "is this in scope?"



User's Needs and Concerns

Project Management

Systems Engineering

Engineering Specialist

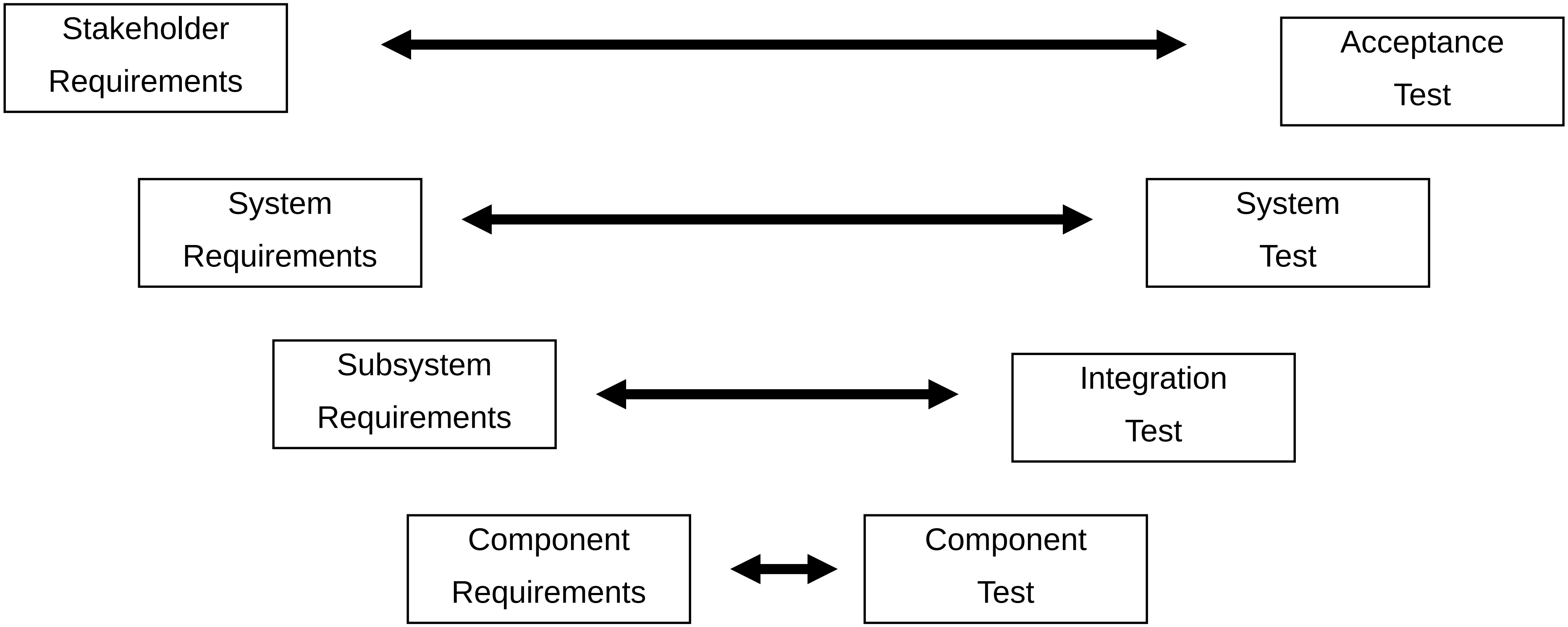
Top 10 Cosmic Truths of Requirements

3. Even the best requirements document can't replace human dialog

2. The requirement might be vague, but the project will be specific

1. There is never a perfect requirement!

Requirements in the Lifecycle



Stakeholder Requirements

Acceptance Test

System Requirements

System Test

Subsystem Requirements

Integration Test

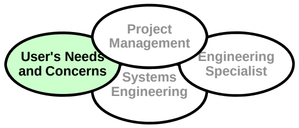
Component Requirements

Component Test

Hull, Jackson Dick 2011

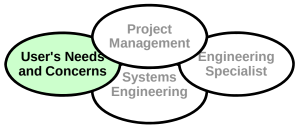
Eliciting Requirements

- **Difficult task**
  - **Can be like talking with your teenager**
- **Need to get to the root of the requirement**



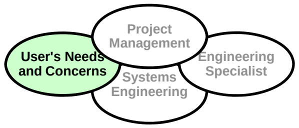
Elicitation Challenges

- Yes but…
- Undiscovered Ruins
- User vs Developer
- Sins of the Predecessors



Elicitation Methods

- **Describe a day in the life of your project**
  - **Look at both nominal and off nominal conditions**
  - **Tell me what you do now**
  - **Tell me what you want to do differently**
- **Prototyping**
- **Modeling**
- **Documentation**
- **Questionnaires**
- **Interviews**
  - **Context free Questions**
  - **Single Input**
  - **Incompleteness**
  - **…**



Project Management

User's Needs and Concerns

Engineering Specialist

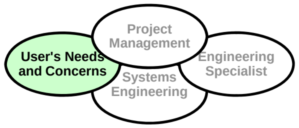
Systems Engineering

Requirement Types

- Customer
- Functional
- Non-functional
- Performance
- Constraint
- Design
- Derived
- Allocated
- Physical

Documenting Requirements

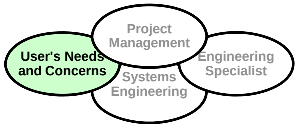
- **One thought**
- **Concise**
- **Simple**
- **Stated positively**
- **Grammatically Correct**
- **Can only be understood one way**



As the Project Progresses…

- Requirements stability
- Impacts of changing requirements
  - To cost and schedule
  - Capability

System's User's Needs and Concerns:
Summary

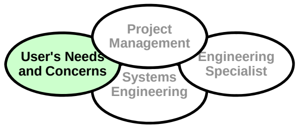


- Requirements are critical to the effectiveness of the project
- Getting them is work
- It is the SE's responsibility to advise the PM of tradeoffs
- Manage change

Systems Engineering: From Dream to Reality

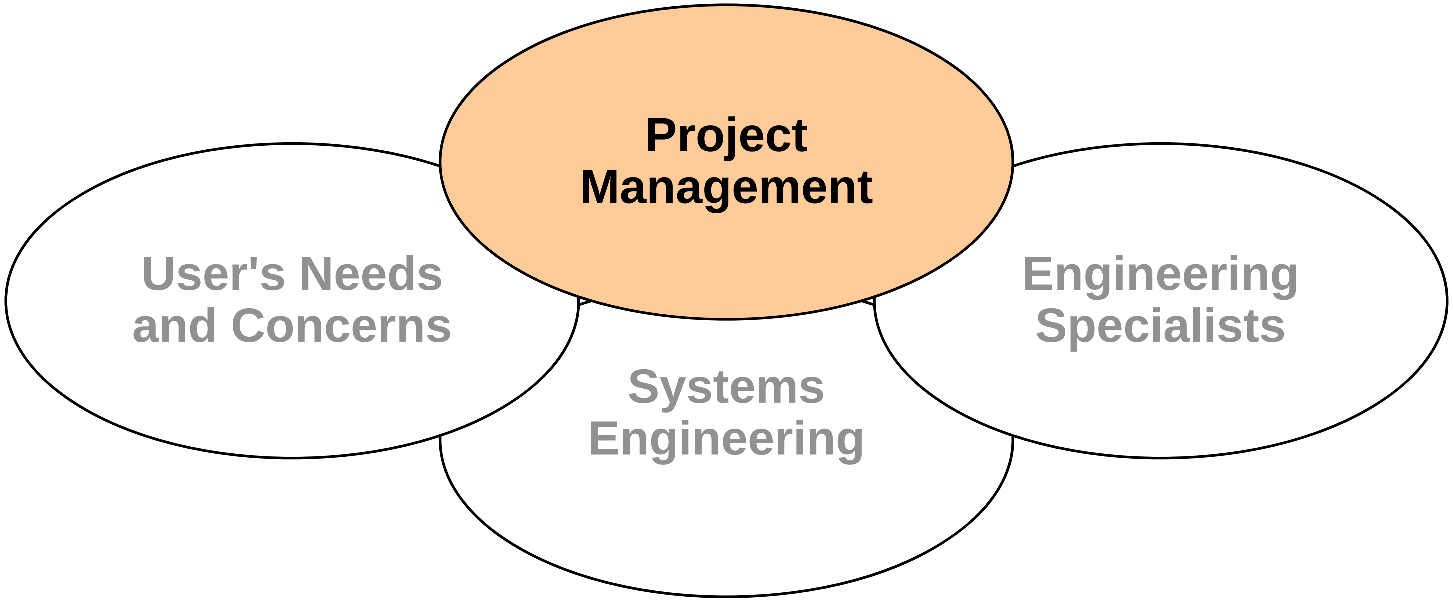
Role Play: Session 1

System's User's Needs and Concerns:
Role Play Session 1 Observations

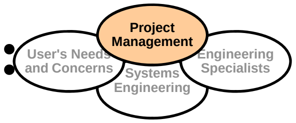


- Were you successful in your effort?
- How hard was it to get the requirements?
- Can you proceed with your project with what you have?
- Any lessons learned?

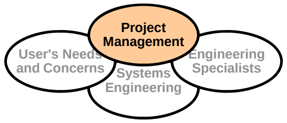
Project Manager's Financial and Schedule Constraints



Project Manager's Financial and Schedule Constraints:
Agenda

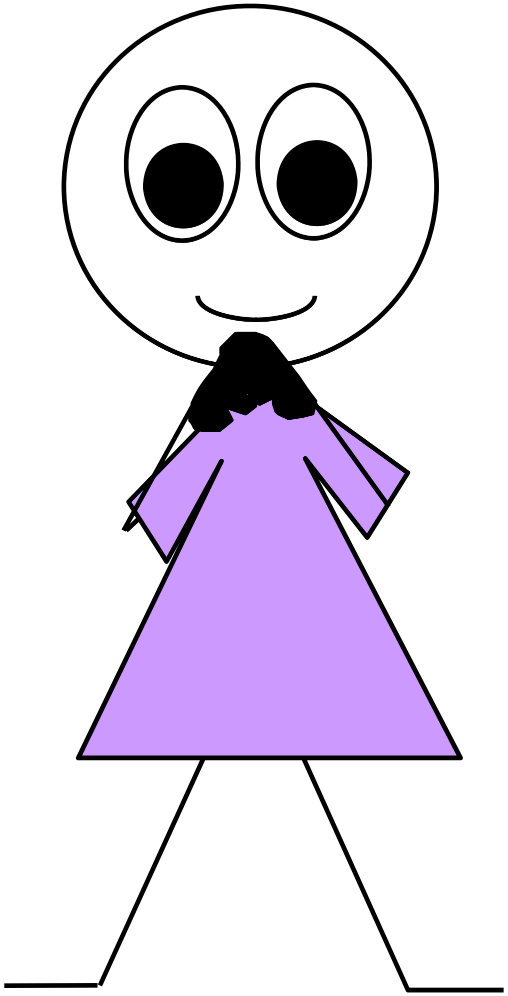


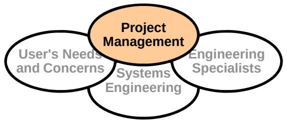
- **In this module, we will explore the systems engineer's responsibilities and authority:**
  - **Guiding the engineering effort itself**
  - **Setting the technical objects for the project**
  - **Evaluating the results of the technical portion of the project**
  - **Prescribing necessary corrective actions to keep the technical portion within project management constraints:**
    - **Schedule, budget, functionality, quality**
- **We will do this by walking through "threads" and role-interactions, leveraging our case study**



Acknowledgement

- My gratitude to Bram van Oosterhout
  - For having been a Systems Engineer
  - For articulating why is a Systems Engineer different from all other engineers (and Project Managers)
  - And for sharing that experience and insight to "shape" this presentation
  - (And for calling the Systems Engineer a "she" in our review meetings ☺☺☺)





Systems Engineer
and
Project Initiation

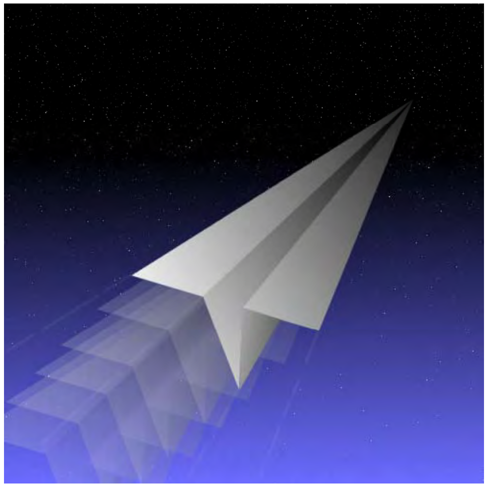
Before we have a project ...

... we have a Customer

... we have a Customer,

with hopes and dreams and wants and wishes ...

... we have a Customer,
sometimes with requirements ...



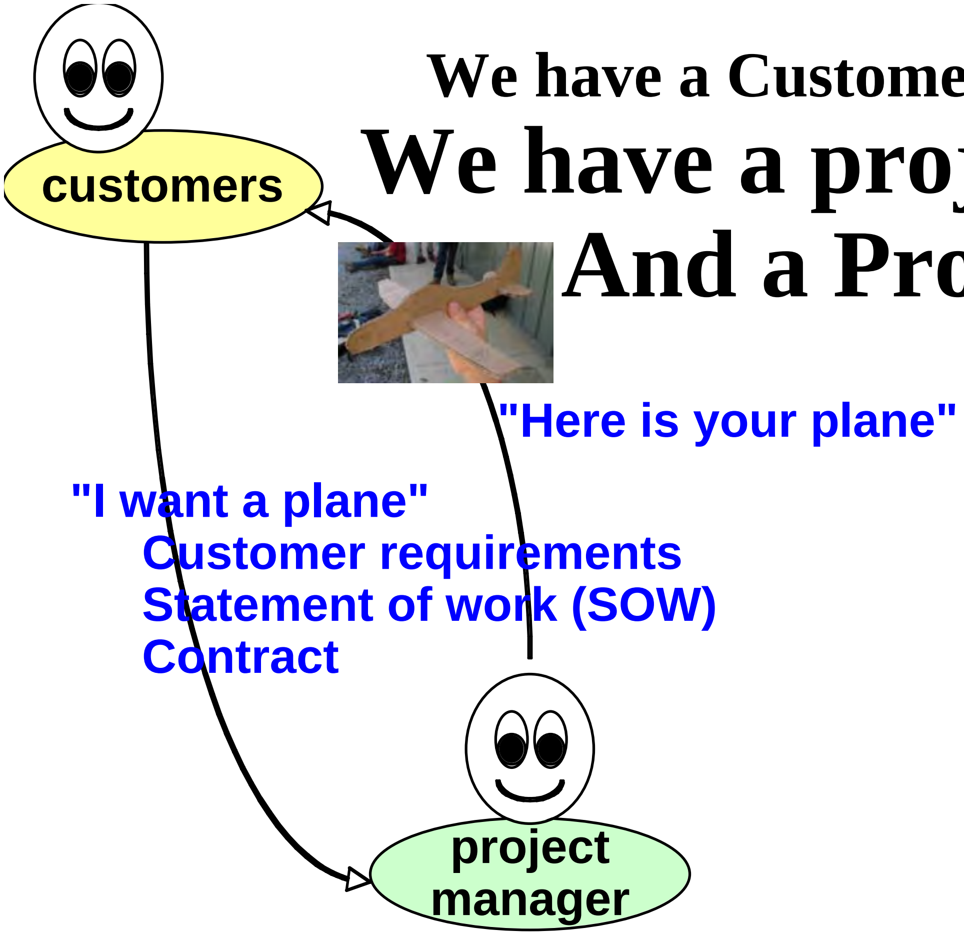
... we have a Customer,
sometimes with requirements ... seriously ...

- **So let's consider today's scenario, with the plane we are producing ...**

We have a Customer who wants something ...

We have a project to build that ...

And a Project Manager



customers

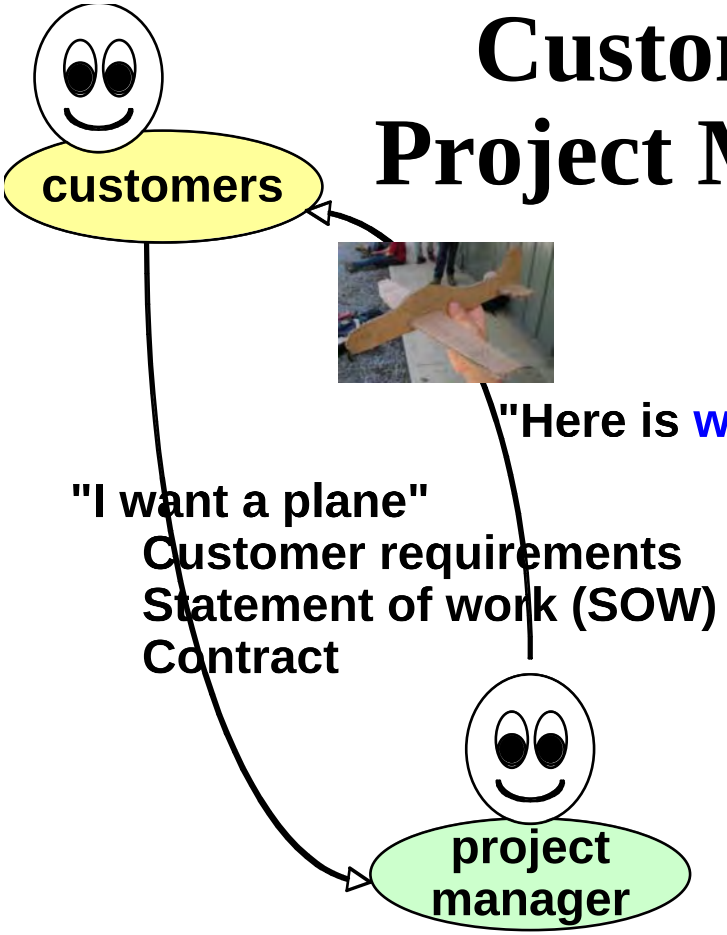
"Here is your plane"

"I want a plane"

- Customer requirements
- Statement of work (SOW)
- Contract

project manager

Customer has constraints ...
Project Manager must work within them



"Here is what we can deliver within budget and delivery date"

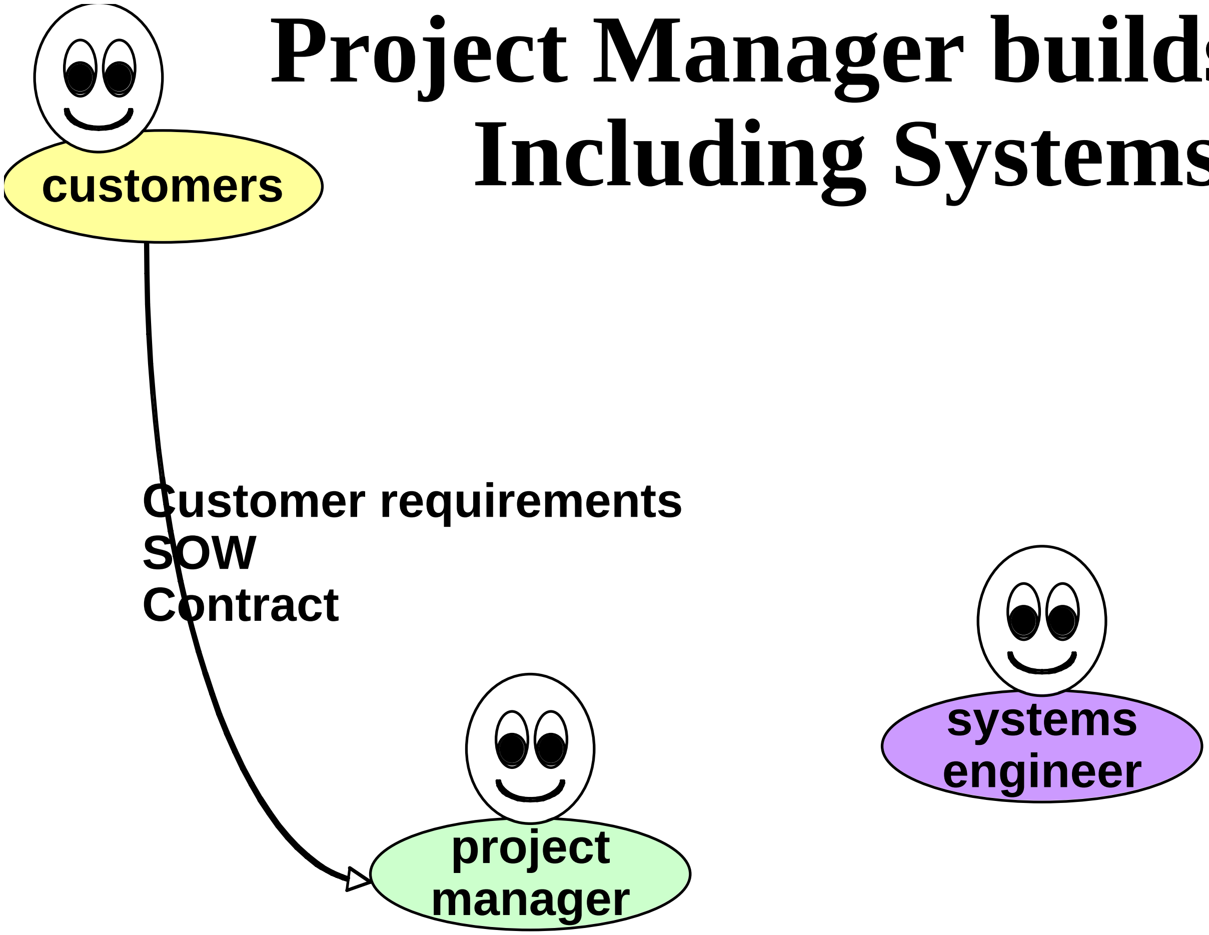
"I want a plane"

- Customer requirements
- Statement of work (SOW)
- Contract

"My constraints are:

- Budget = xxx
- Delivery date = yyy
- Other stuff etc, etc, etc"

Project Manager builds Project Team Including Systems Engineer



customers

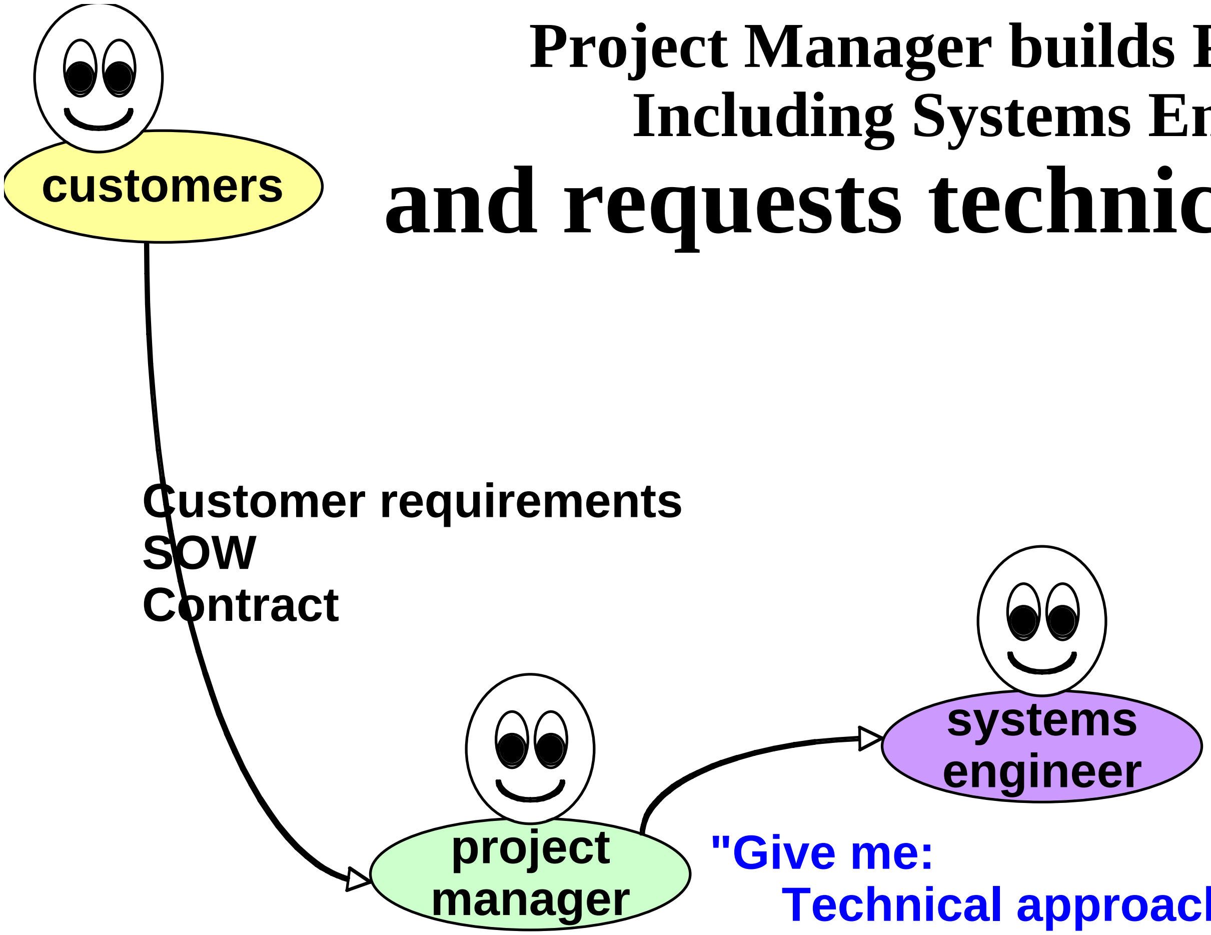
Customer requirements
SOW
Contract

project manager

systems engineer

Project Manager builds Project Team Including Systems Engineer ...

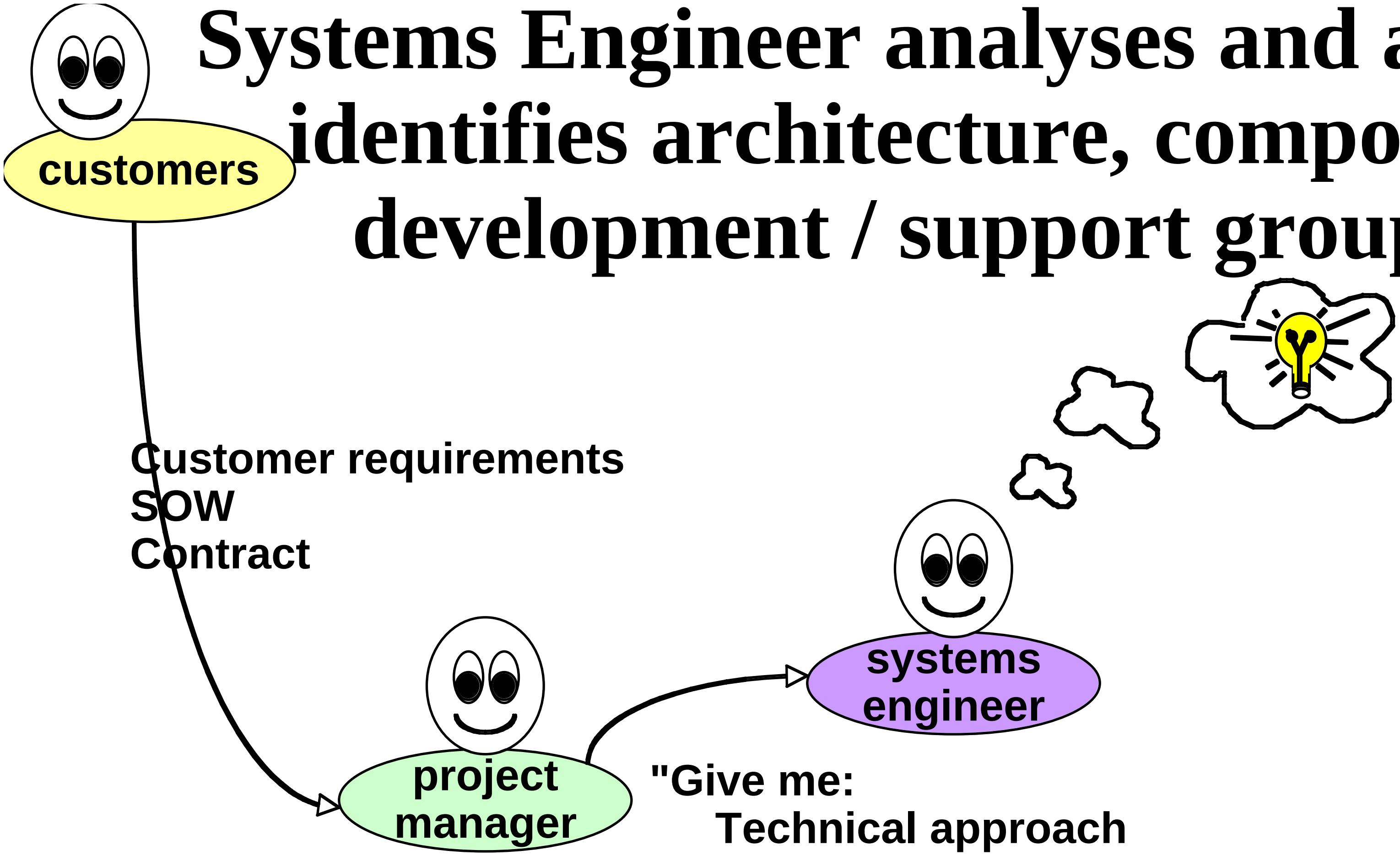
and requests technical approach



"Give me:

Technical approach
Estimates
Assumptions, risks, constraints"

Systems Engineer analyses and analyses, identifies architecture, components, development / support groups ...

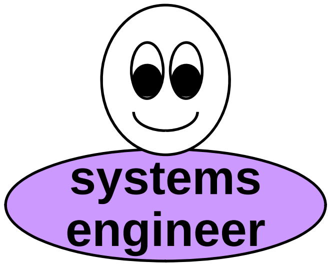


Customer requirements
SOW
Contract

"Give me:
- Technical approach
- Estimates
- Assumptions, risks, constraints"

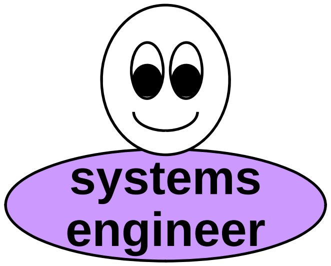
Project Initiation: Key Responsibility

- Translate customer requirements into technical requirements
  - Architecture
  - Components
  - Development
  - Integration
  - Verification
  - Validation
- With appropriate quality (acceptance) criteria
- And with intent to deliver a product that satisfies the technical requirements and customer requirements

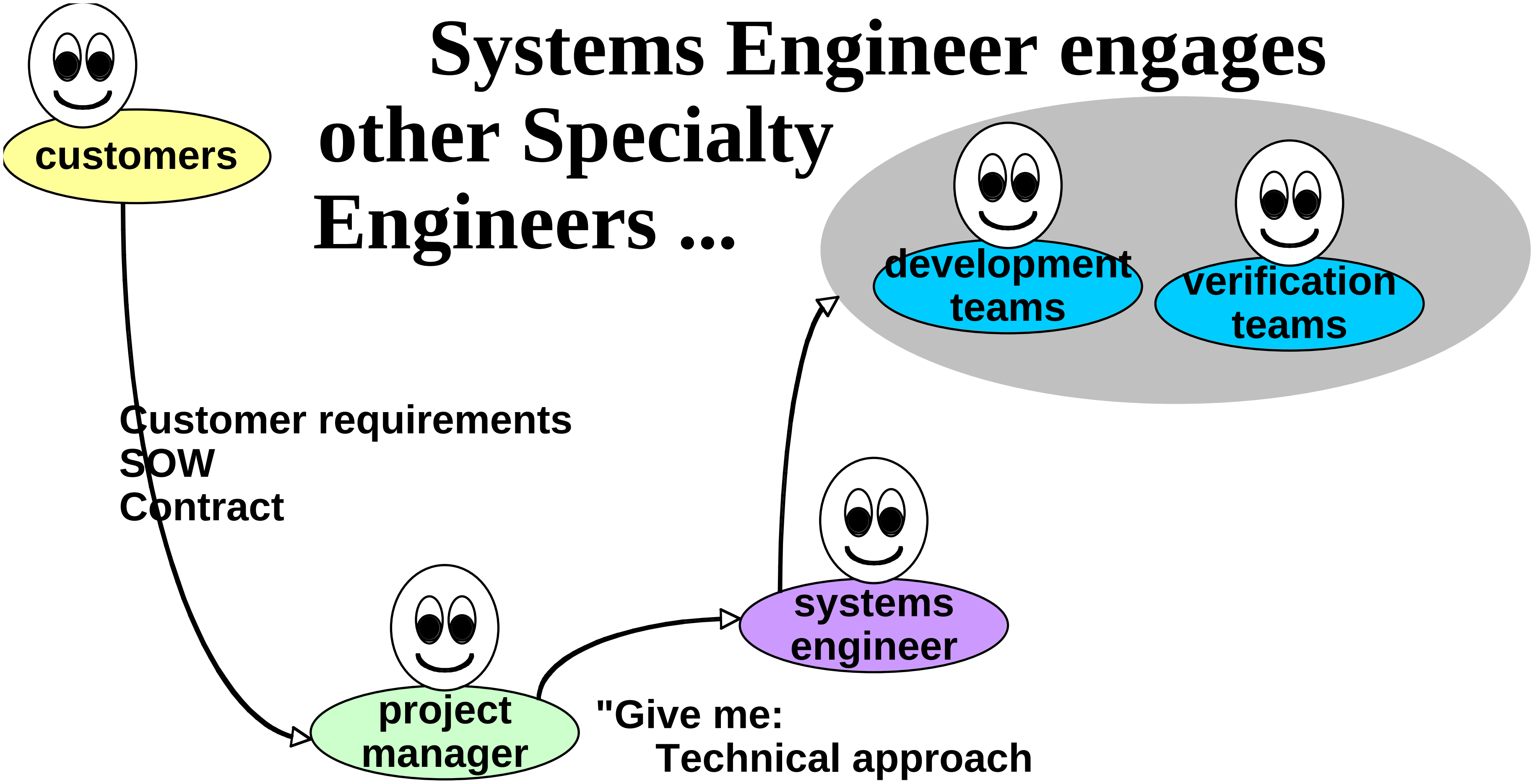


Systems Engineer:
Key Skills, Knowledge Required

- Domain
- Technical
- Negotiating
- Planning
- Managing
- Organising
- Coordinating
- Leading
- Encouraging
- Celebrating
- Following-through



Systems Engineer engages other Specialty Engineers ...



customers

Customer requirements
SOW
Contract

project manager

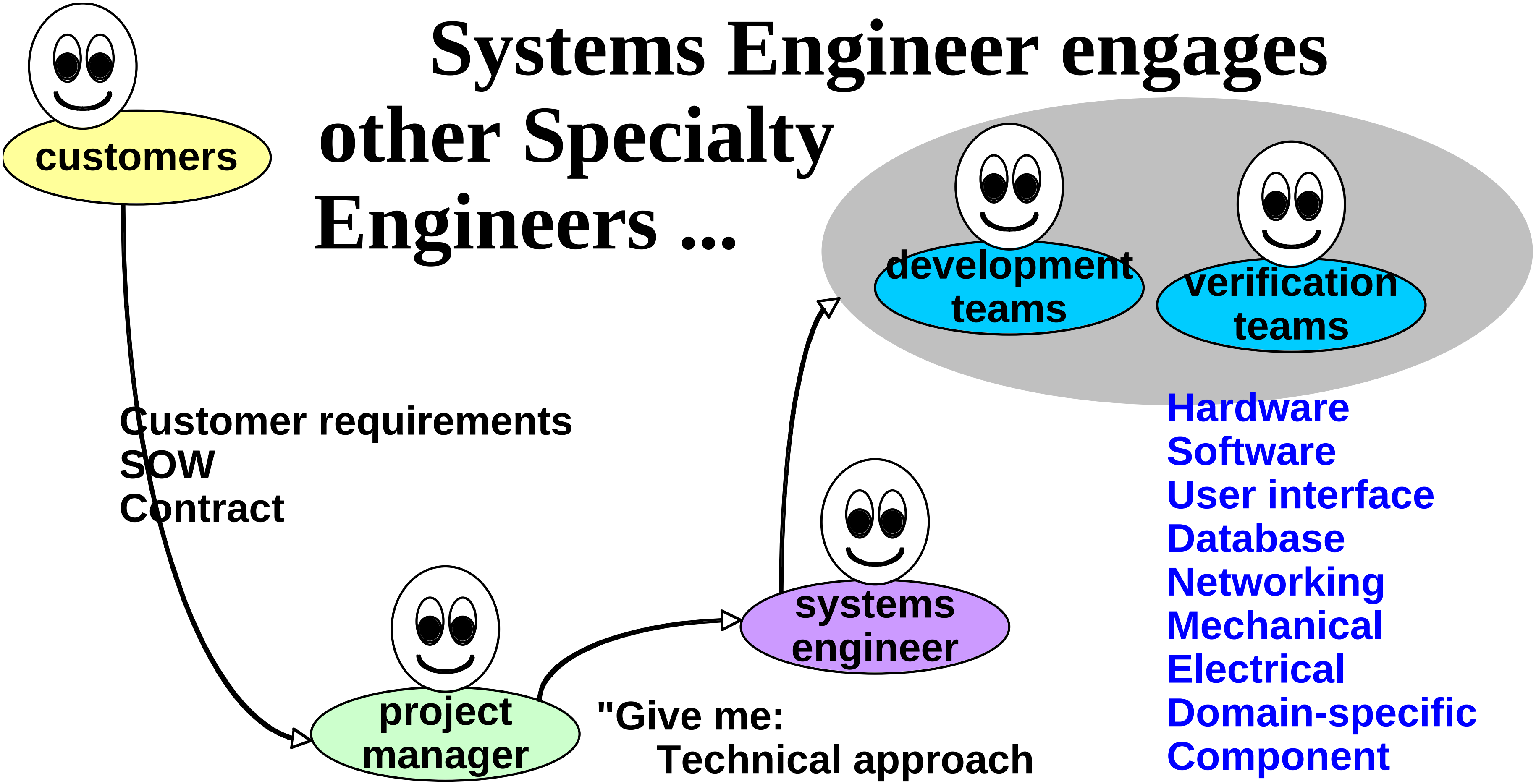
systems engineer

development teams

verification teams

"Give me:
Technical approach
Estimates
Assumptions, risks, constraints"

Systems Engineer engages other Specialty Engineers ...



customers

Customer requirements
SOW
Contract

project manager

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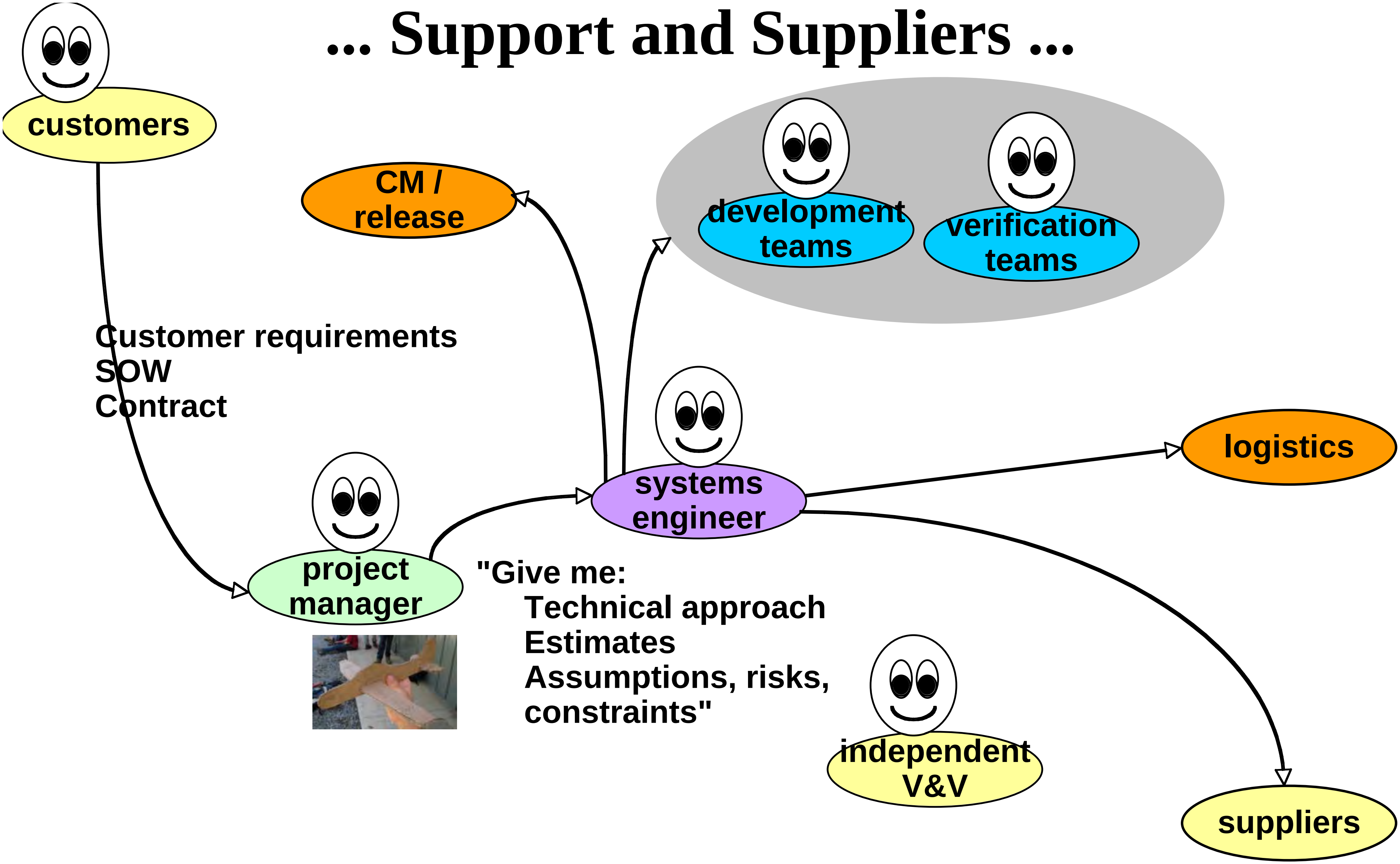
development teams

verification teams

"Give me:
Technical approach
Estimates
Assumptions, risks,
constraints"

Hardware
Software
User interface
Database
Networking
Mechanical
Electrical
Domain-specific
Component
Integrated teams
Single discipline teams

... Support and Suppliers ...



customers

CM / release

development teams

verification teams

Customer requirements
SOW
Contract

systems engineer

logistics

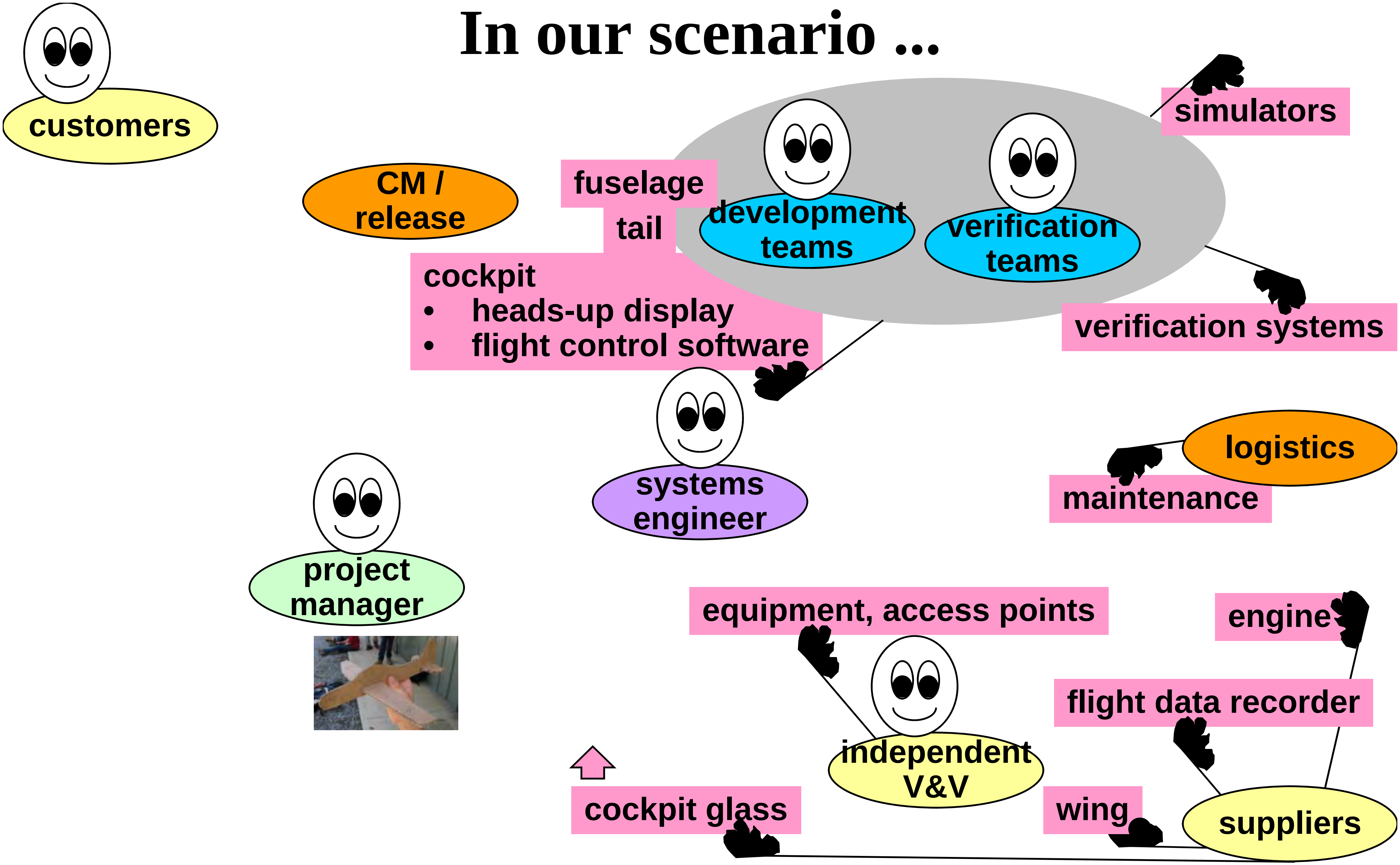
project manager

"Give me:
Technical approach
Estimates
Assumptions, risks, constraints"

independent V&V

suppliers

In our scenario ...



customers

CM / release

fuselage

tail

development teams

verification teams

simulators

cockpit
- heads-up display
- flight control software

verification systems

systems engineer

logistics

maintenance

project manager

equipment, access points

engine

flight data recorder

independent V&V

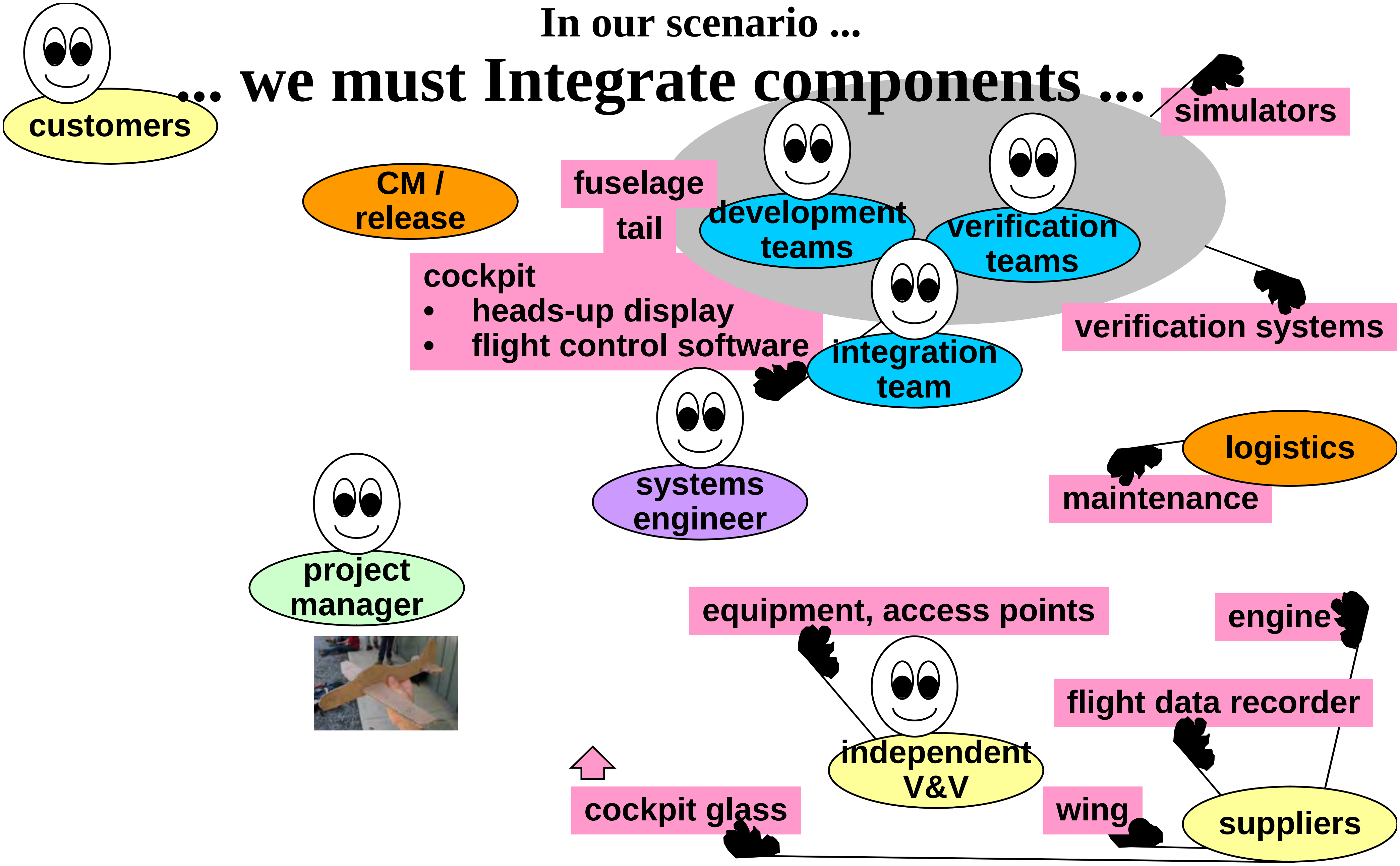
cockpit glass

wing

suppliers

In our scenario …

… we must Integrate components …



customers

CM / release

fuselage

tail

cockpit
- heads-up display
- flight control software

development teams

verification teams

integration team

simulators

verification systems

systems engineer

logistics

maintenance

project manager

equipment, access points

engine

flight data recorder

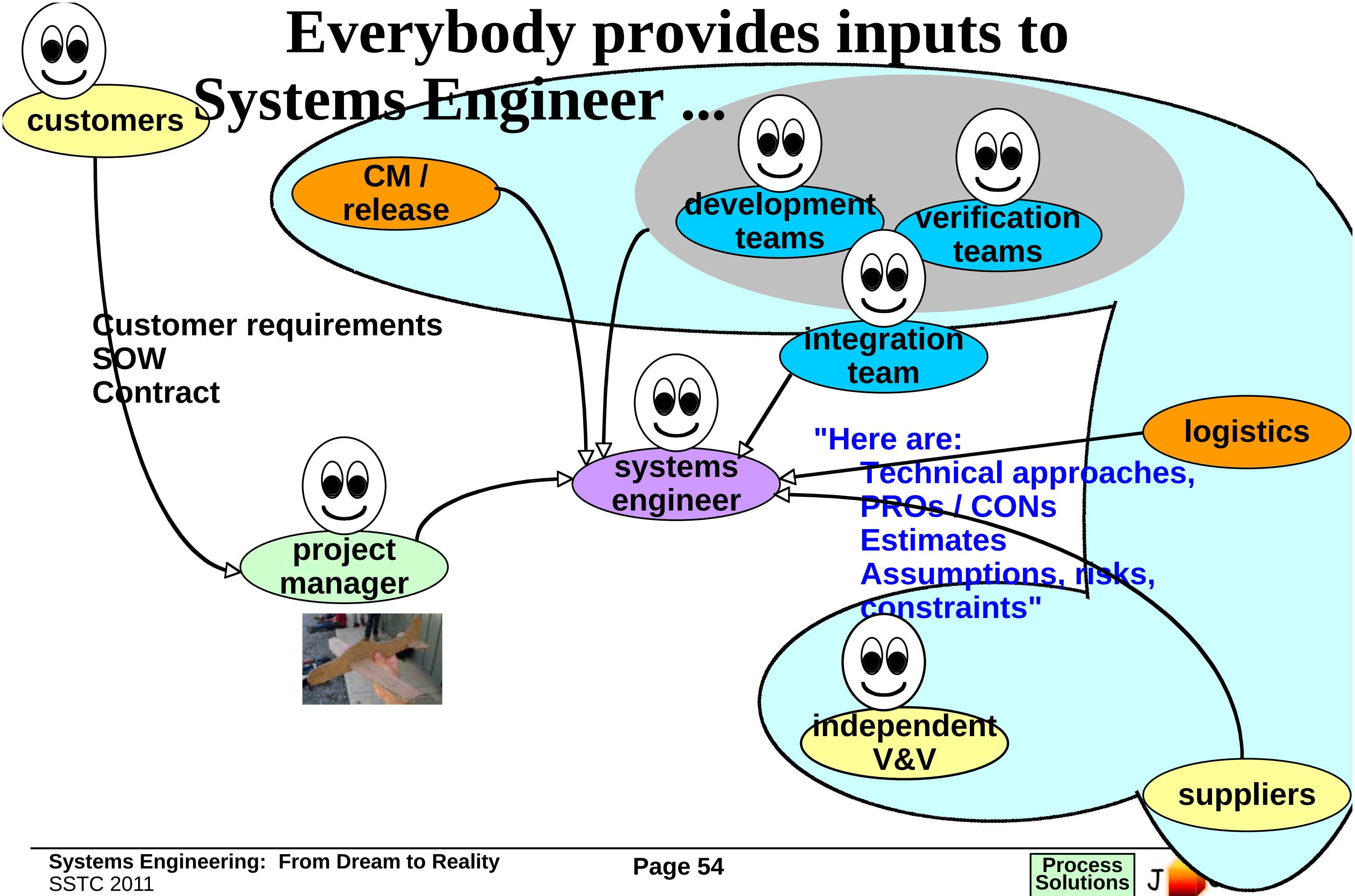
independent V&V

cockpit glass

wing

suppliers

Everybody provides inputs to Systems Engineer ...



customers

CM / release

development teams

verification teams

integration team

Customer requirements
SOW
Contract

systems engineer

project manager

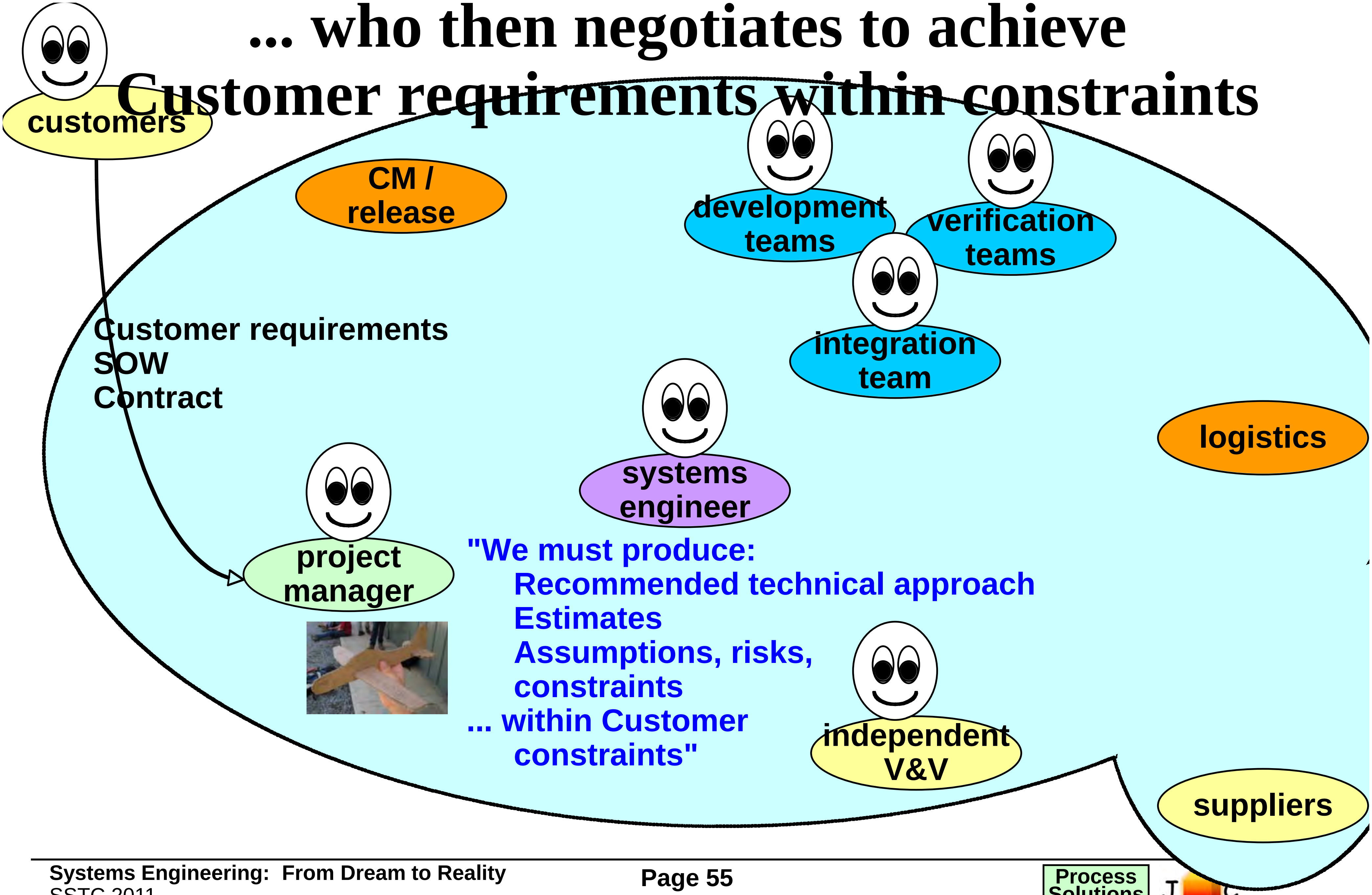
logistics

"Here are:
Technical approaches,
PROs / CONs
Estimates
Assumptions, risks,
constraints"

independent V&V

suppliers

... who then negotiates to achieve Customer requirements within constraints



customers

CM / release

development teams

verification teams

integration team

logistics

systems engineer

project manager

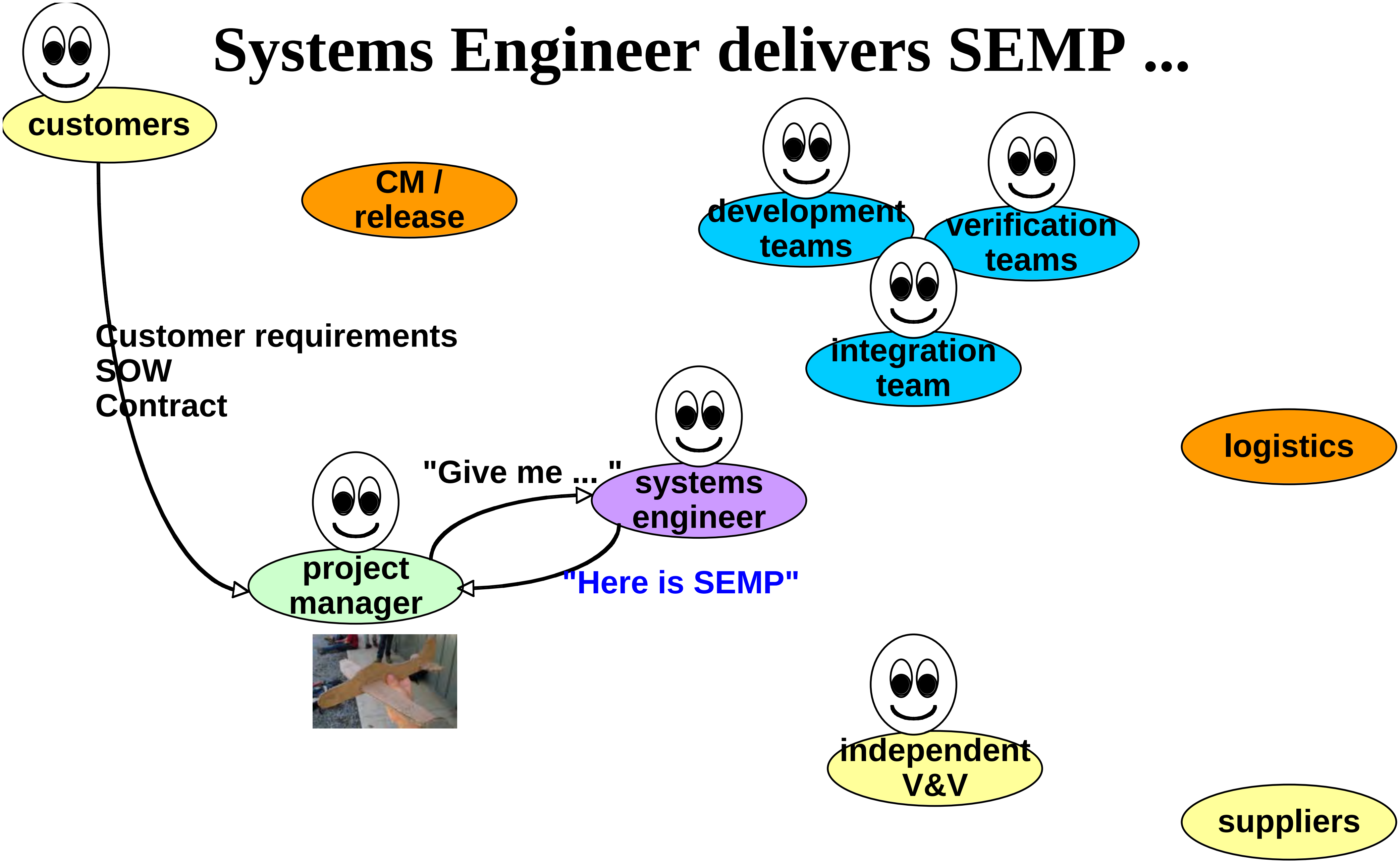
independent V&V

suppliers

Customer requirements
SOW
Contract

"We must produce:
Recommended technical approach
Estimates
Assumptions, risks, constraints
... within Customer constraints"

Systems Engineer delivers SEMP ...



customers

CM / release

development teams

verification teams

integration team

Customer requirements
SOW
Contract

"Give me ... "

systems engineer

project manager

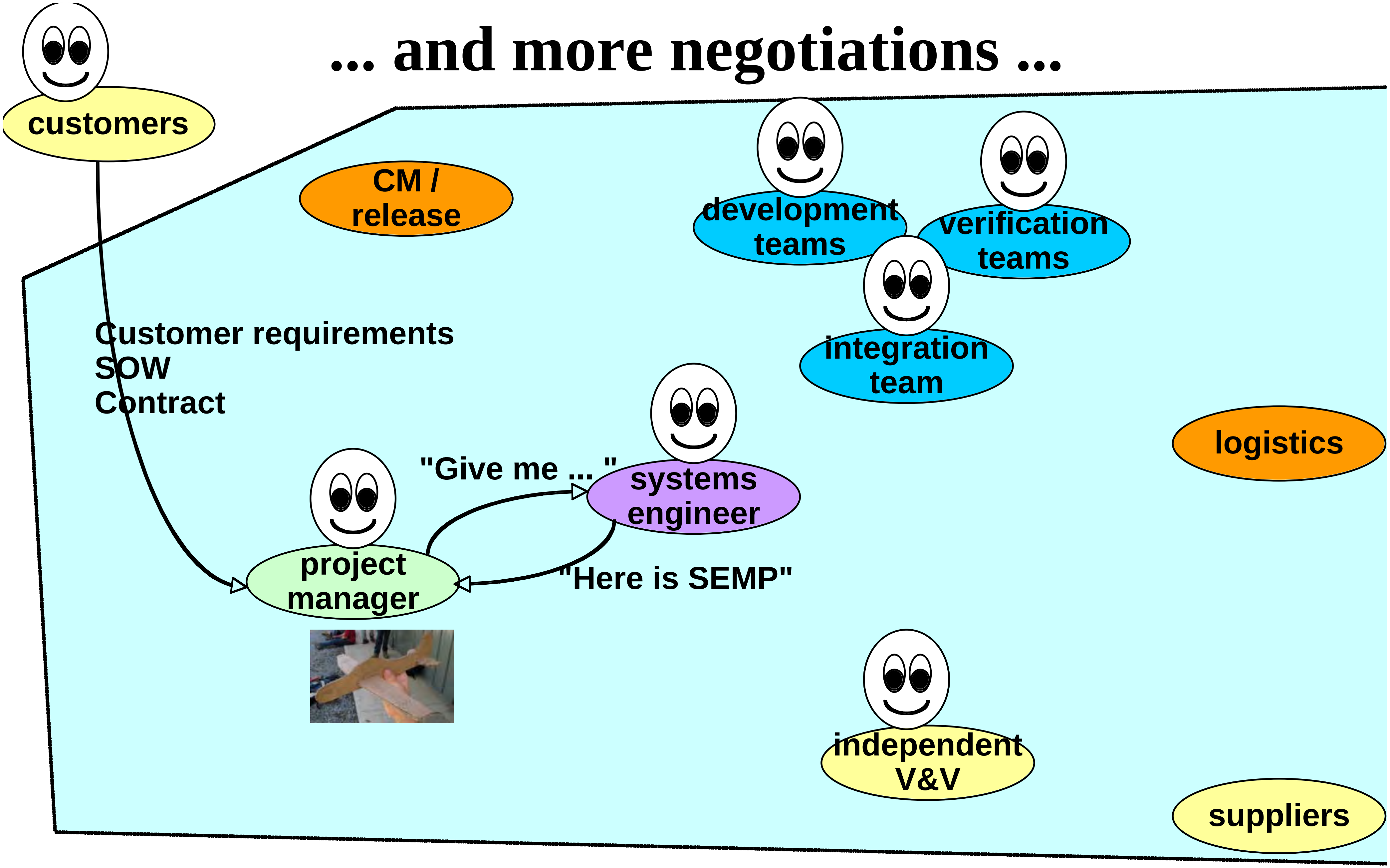
"Here is SEMP"

logistics

independent V&V

suppliers

… and more negotiations …



customers

CM / release

development teams

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integration team

Customer requirements
SOW
Contract

"Give me … "

systems engineer

project manager

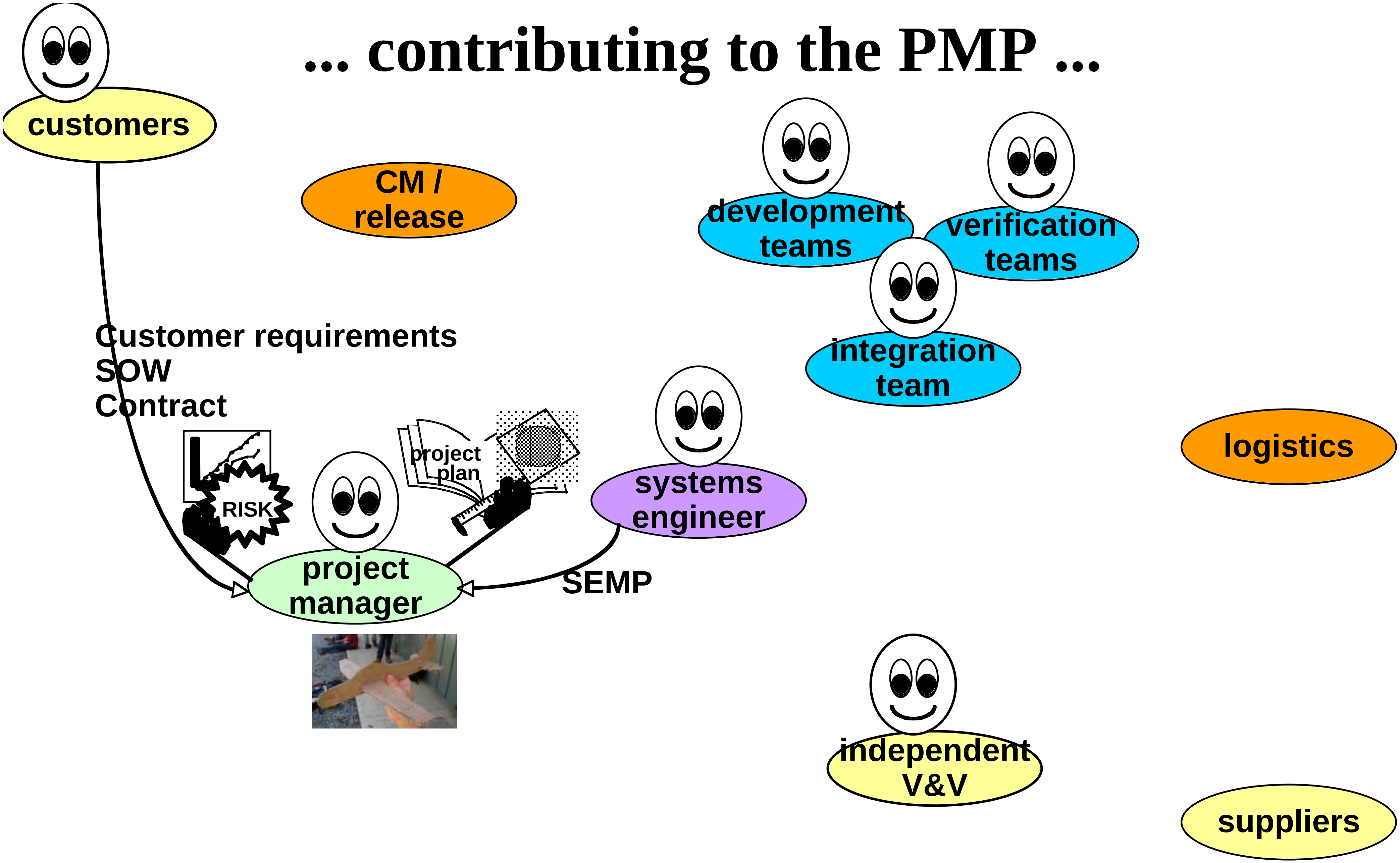
"Here is SEMP"

logistics

independent V&V

suppliers

... contributing to the PMP ...



customers

CM / release

development teams

verification teams

integration team

Customer requirements
SOW
Contract

project manager

systems engineer

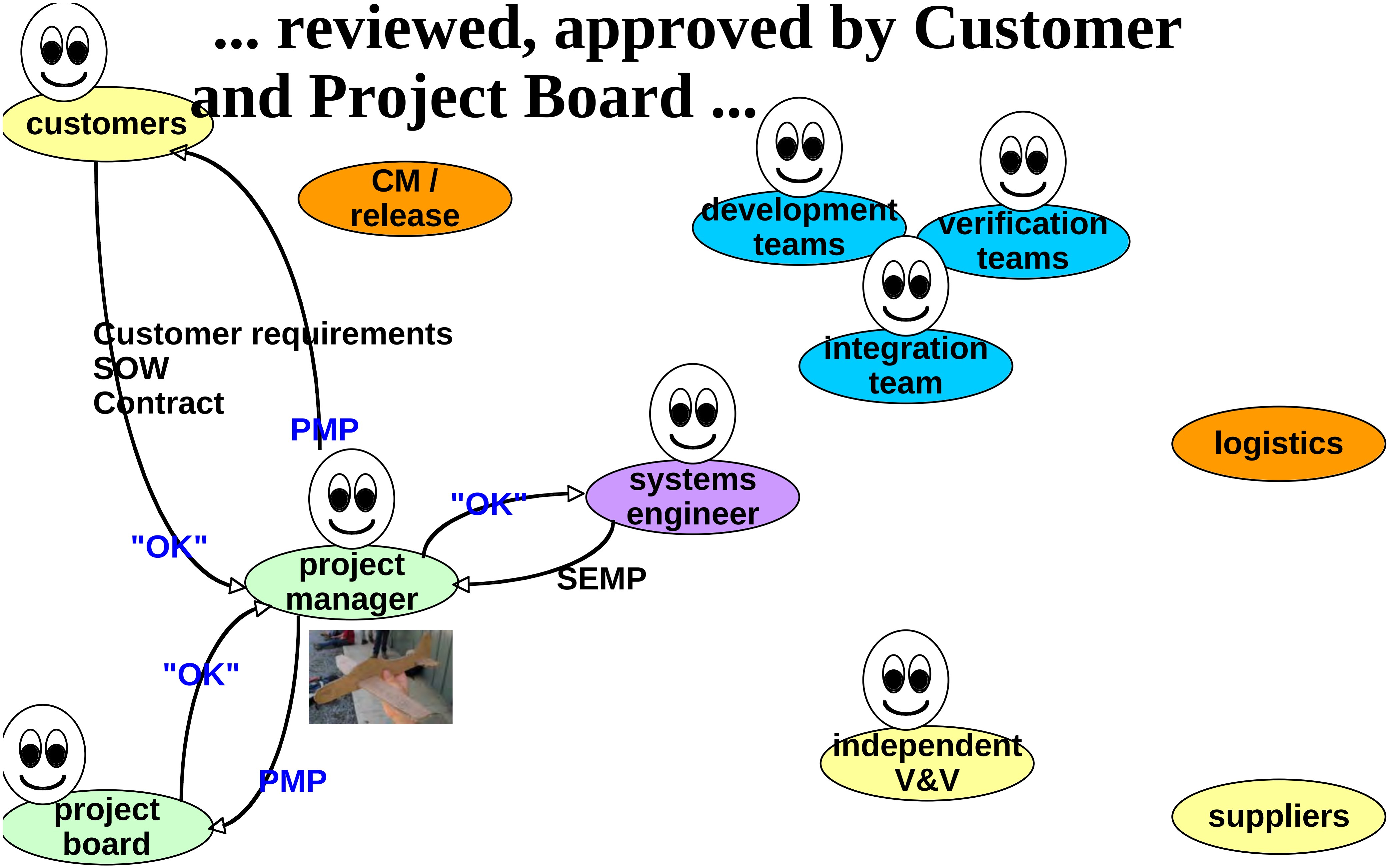
SEMP

logistics

independent V&V

suppliers

... reviewed, approved by Customer and Project Board ...



customers

CM / release

development teams

verification teams

integration team

logistics

Customer requirements
SOW
Contract

PMP

"OK"

systems engineer

"OK"

project manager

SEMP

"OK"

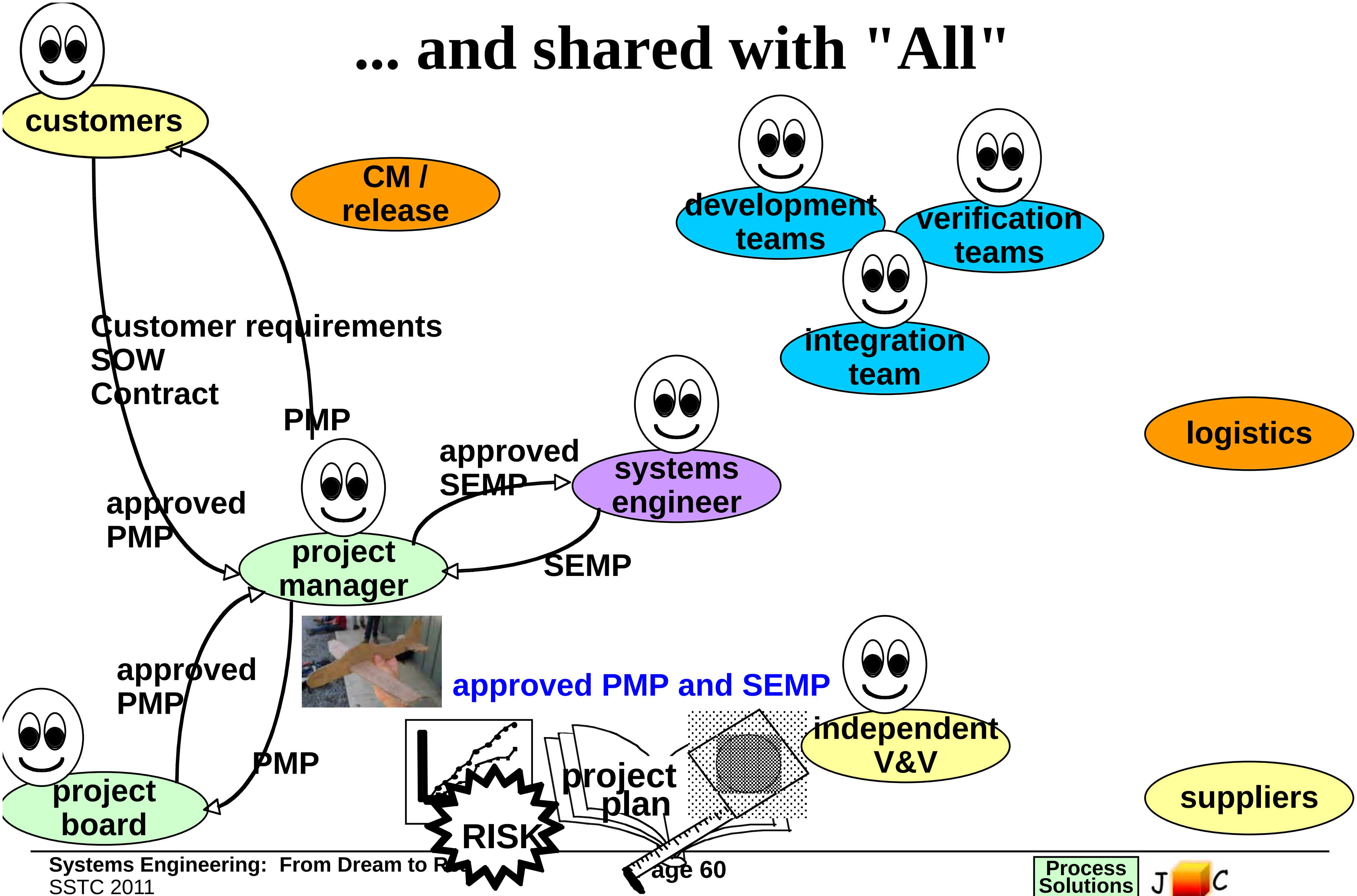
PMP

project board

independent V&V

suppliers

... and shared with "All"



customers

CM / release

development teams

verification teams

integration team

Customer requirements
SOW
Contract

PMP

approved SEMP

systems engineer

logistics

approved PMP

project manager

SEMP

approved PMP

PMP

project board

approved PMP and SEMP

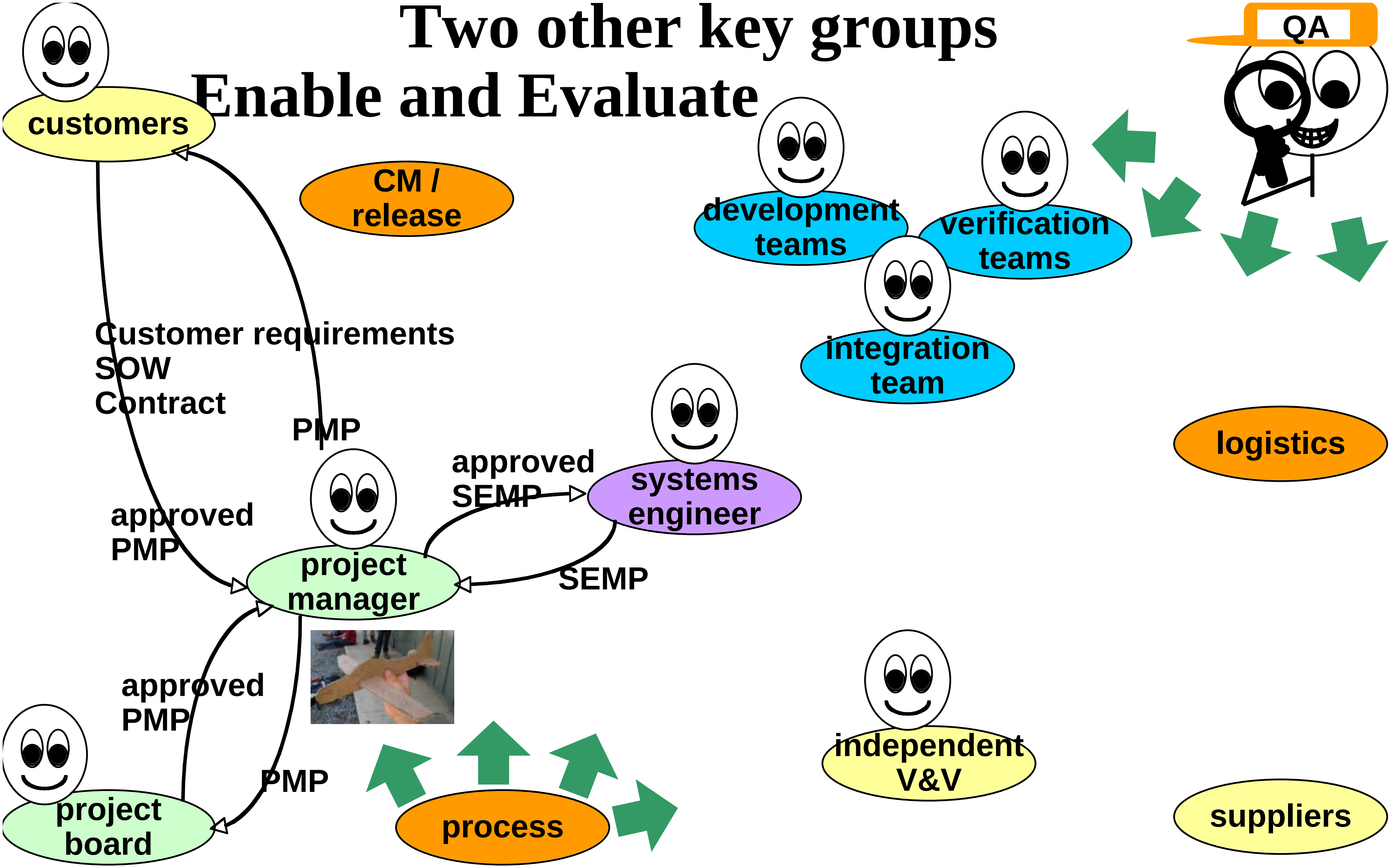
independent V&V

project plan

RISK

suppliers

Two other key groups Enable and Evaluate



customers

CM / release

development teams

verification teams

integration team

QA

Customer requirements
SOW
Contract

PMP

approved PMP

approved SEMP

systems engineer

SEMP

project manager

logistics

approved PMP

PMP

project board

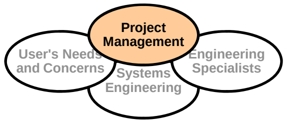
process

independent V&V

suppliers

Systems Engineer:
Key Processes

- Project management - technical aspects
- Project governance - technical aspects
  - Technical reviews
  - Technical / quality measures
- Requirements management
  - Change / configuration management
- Engineering
- Verification
- Validation
- Risk / issue management
- Quality assurance



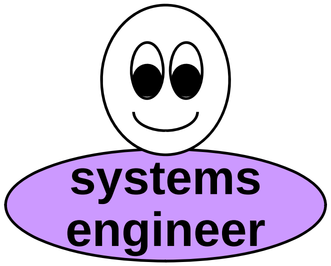
Systems Engineer and Project Execution

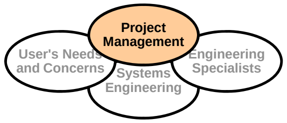
During Project Execution ...

- PMP and SEMP establish:
  - Approach (technical, governance, quality)
  - Stakeholders
  - Roles and responsibilities, authority and accountability
  - References to applicable standards, processes
  - (and lots, lots more!)
- The following threads illustrate some "typical" roles and interactions
  - Your reality may differ ... and ...
  - ... whatever happens should be consistent with PMP and SEMP and all other plans

Project Execution:
Key Responsibility

- Deliver a product that satisfies the technical requirements and customer requirements
- Ensure achievement of appropriate quality (acceptance) criteria
- Ensure integrity and consistency of engineering / technical artefacts



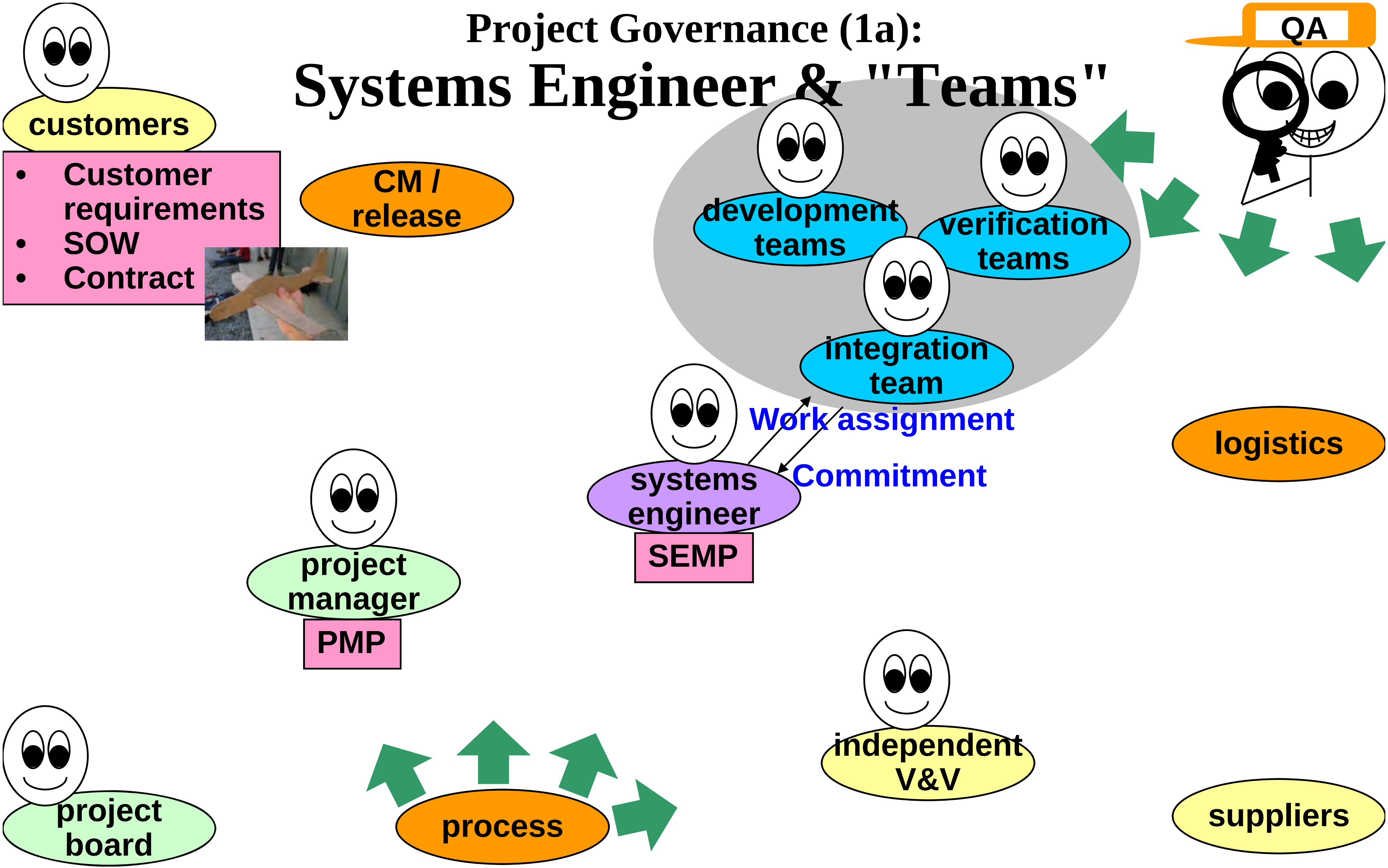


Systems Engineer
and
Project Execution:

Thread: Project Governance

This describes the "form" of the interaction

Project Governance (1a):
Systems Engineer & "Teams"



customers

- Customer requirements
- SOW
- Contract

CM / release

development teams

verification teams

integration team

QA

Work assignment

Commitment

systems engineer

SEMP

project manager

PMP

logistics

independent V&V

project board

process

suppliers

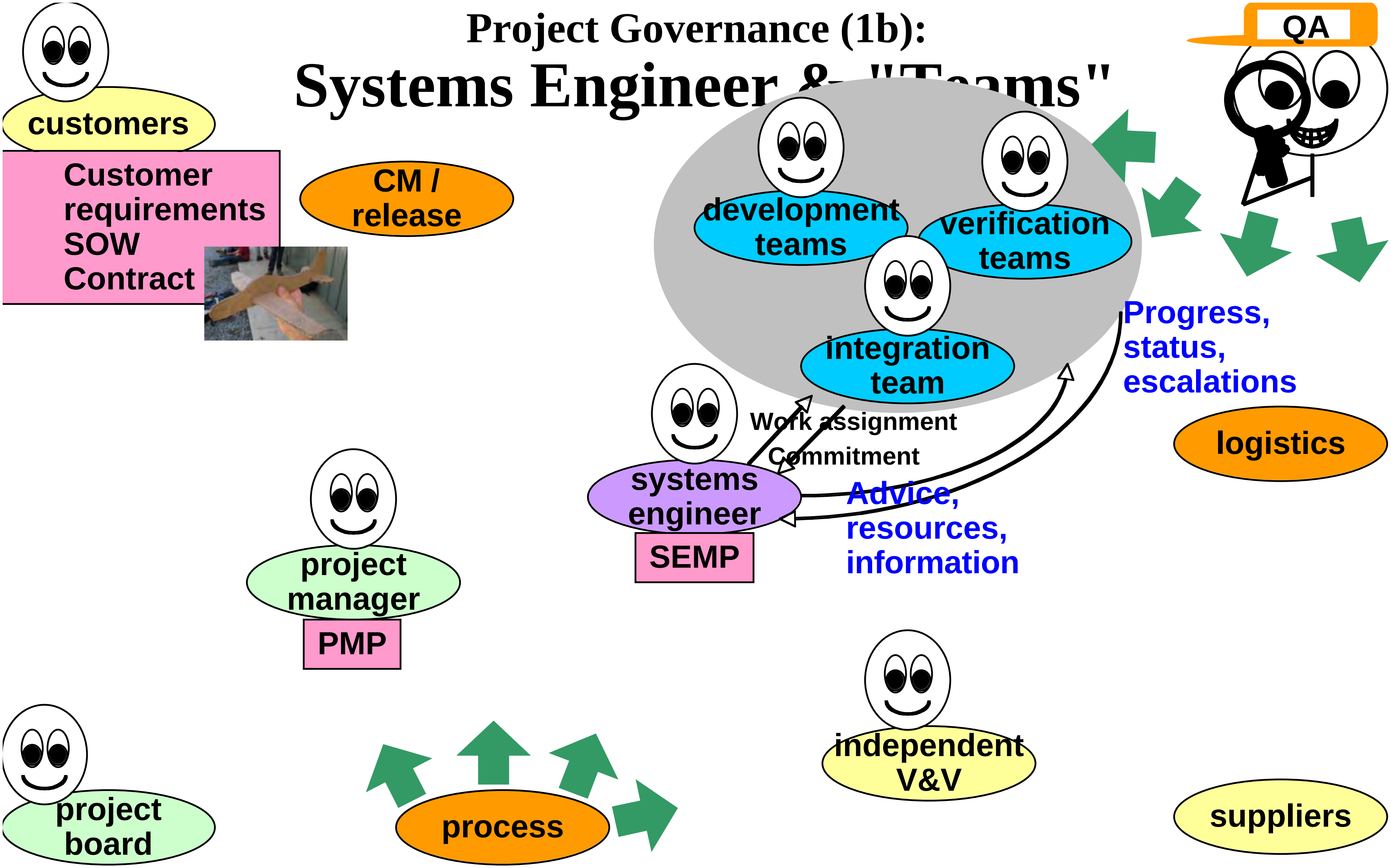
Project Governance (1a): Systems Engineer & "Teams": Notes (1)

- Work assignment ("work package," "task order") =
  - Cost centre (charge number)
    - Legal entity authorising work
  - Outcomes
    - I.e., things that are "measurable" and "demonstrable"
    - Deliverables - external, internal; tangible; functionality; components
    - Quality objectives
  - Resources
    - Including: schedule, effort, budget, staffing, facilities, tools, equipment, etc
  - Other
    - ARCs, dependencies, predecessor products, training
  - "Where these outcomes fit into the big picture"

Project Governance (1a): Systems Engineer & "Teams": Notes (2)

- **Commitment =**
  - **Agreement to perform the work assignment within the designated constraints**
  - **"Pact, freely assumed, visible, expected to be kept by all parties, within the context known at the time, to be reviewed regularly and re-negotiated if the context changes significantly"**
    - * **Often involves negotiation**

Project Governance (1b):
Systems Engineer & "Teams"



customers

Customer requirements SOW Contract

CM / release

development teams

verification teams

integration team

QA

systems engineer

SEMP

Work assignment

Commitment

Progress, status, escalations

Advice, resources, information

logistics

project manager

PMP

independent V&V

project board

process

suppliers

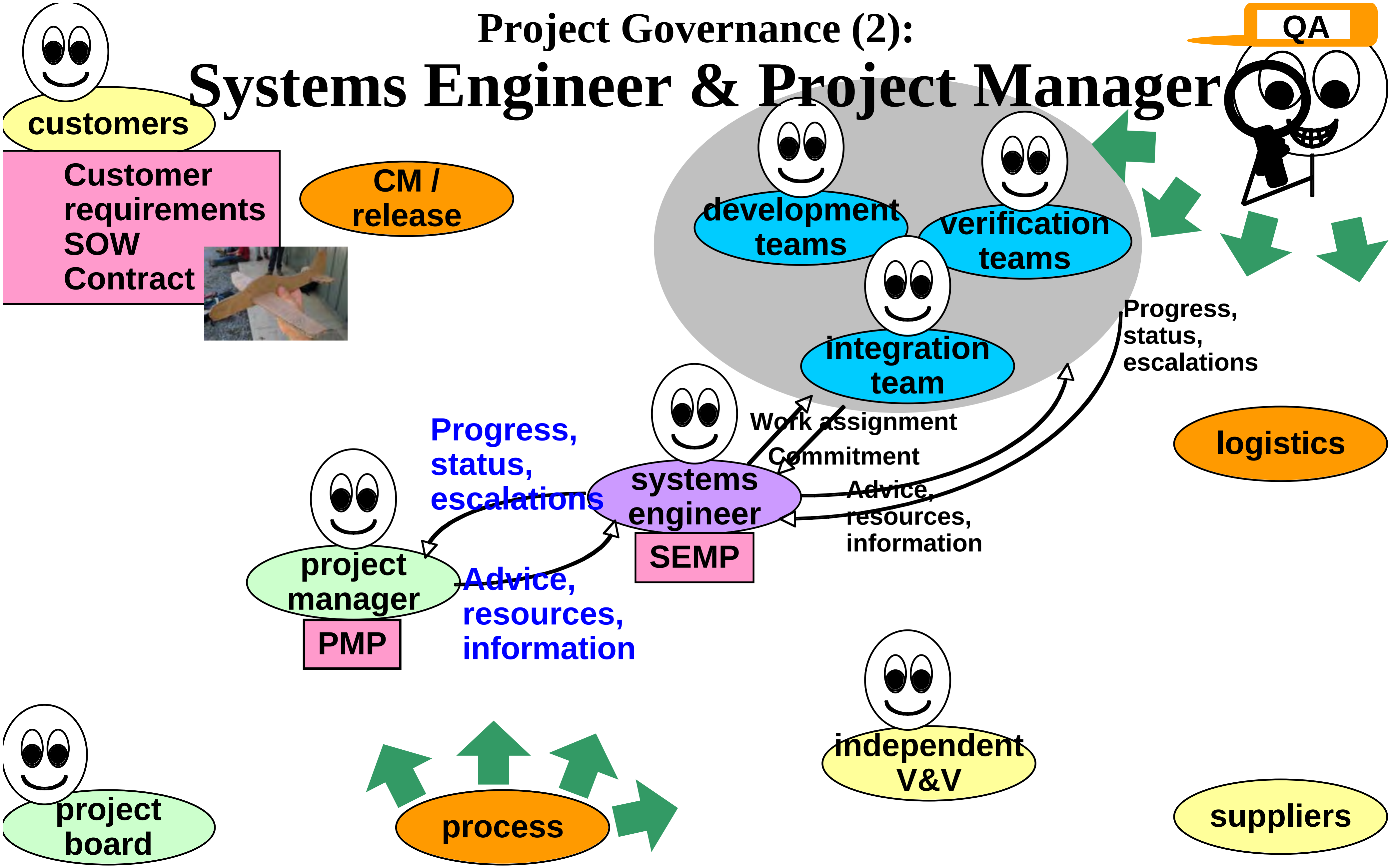
Project Governance (1b): Systems Engineer & "Teams": Notes (1)

- Progress, status, escalations =
  - Progress
    - * Against work assignments: technical, resources (plans), deliverables, quality objectives
  - Plans
    - * For next period (technical, resources, deliverables, quality objectives)
  - Assumptions, Risks, Constraints (ARCs)
    - * So no surprises
    - * Risk management approaches on-going, planned
  - Problems
    - * So no surprises
    - * Remedial action in-place, progress against it to stay in control
  - Escalations
    - * Requests for additional assistance

Project Governance (1b): Systems Engineer & "Teams": Notes (2)

- Advice, resources, information =
  - Advice
    - E.g., in response to escalations
  - Approval
    - As requested
  - Affirmation
    - Achievements against work assignments: progress, plans, ARCs, and approach to managing them, problems and remedial actions
  - Resources
    - E.g., in response to escalations
  - Relevant information from other stakeholders
    - E.g., Project Manager, Project Board, Customer
    - E.g., other Teams, Independent V&V, Suppliers, if separate reporting

Project Governance (2):
Systems Engineer & Project Manager



customers

Customer requirements
SOW
Contract

CM / release

development teams

verification teams

integration team

QA

Progress, status, escalations

logistics

Work assignment

Commitment

Advice, resources, information

systems engineer

SEMP

Progress, status, escalations

Advice, resources, information

project manager

PMP

independent V&V

project board

process

suppliers

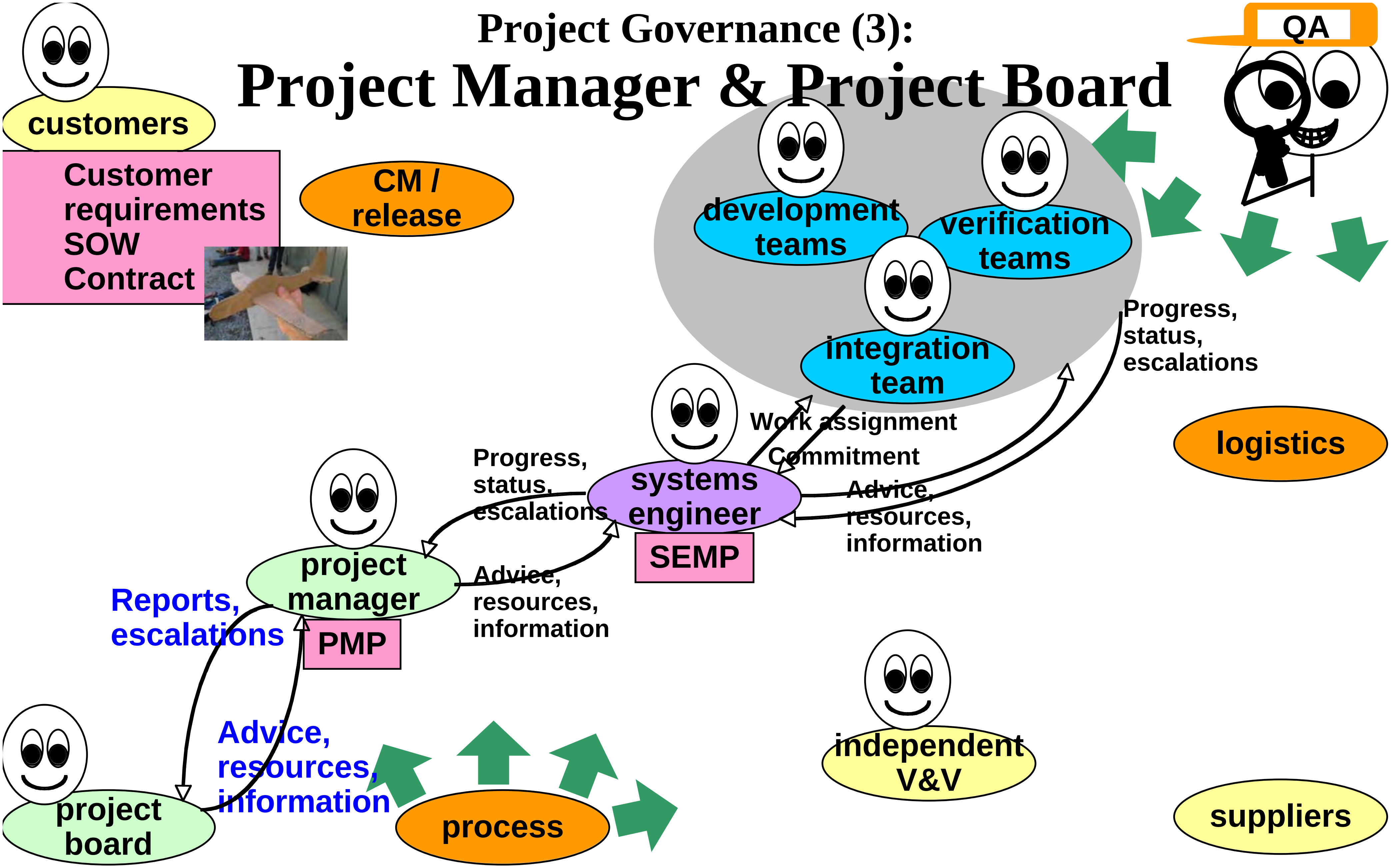
Project Governance (2): Systems Engineer and Project Manager: Notes (1)

- **Progress, status, escalations =**
  - **Progress**
    - * **Against technical, resources (plans), deliverables, quality objectives**
  - **Plans**
    - * **For next period (technical, resources, deliverables, quality objectives)**
  - **Assumptions, Risks, Constraints (ARCs)**
    - * **So no surprises**
    - * **Risk management approaches on-going, planned**
  - **Problems**
    - * **So no surprises**
    - * **Remedial action in-place, progress against it to stay in control**
  - **Escalations**
    - * **Requests for additional assistance**

Project Governance (2): Systems Engineer and Project Manager: Notes (2)

- **Advice, resources, information =**
  - **Advice**
    - * **E.g., in response to escalations**
  - **Approval**
    - * **As requested**
  - **Affirmation**
    - * **Progress, plans, ARCs, and approach to managing them, problems and remedial actions**
  - **Resources**
    - * **E.g., in response to escalations**
  - **Relevant information from other stakeholders**
    - * **E.g., Project Board, Customer**
    - * **E.g., Independent V&V, Suppliers, if separate reporting**

Project Governance (3):
Project Manager & Project Board



QA

customers

Customer
requirements
SOW
Contract

CM /
release

development
teams

verification
teams

integration
team

Progress,
status,
escalations

logistics

Work assignment

Commitment

systems
engineer

SEMP

Advice,
resources,
information

Progress,
status,
escalations

project
manager

PMP

Advice,
resources,
information

Reports,
escalations

Advice,
resources,
information

project
board

process

independent
V&V

suppliers

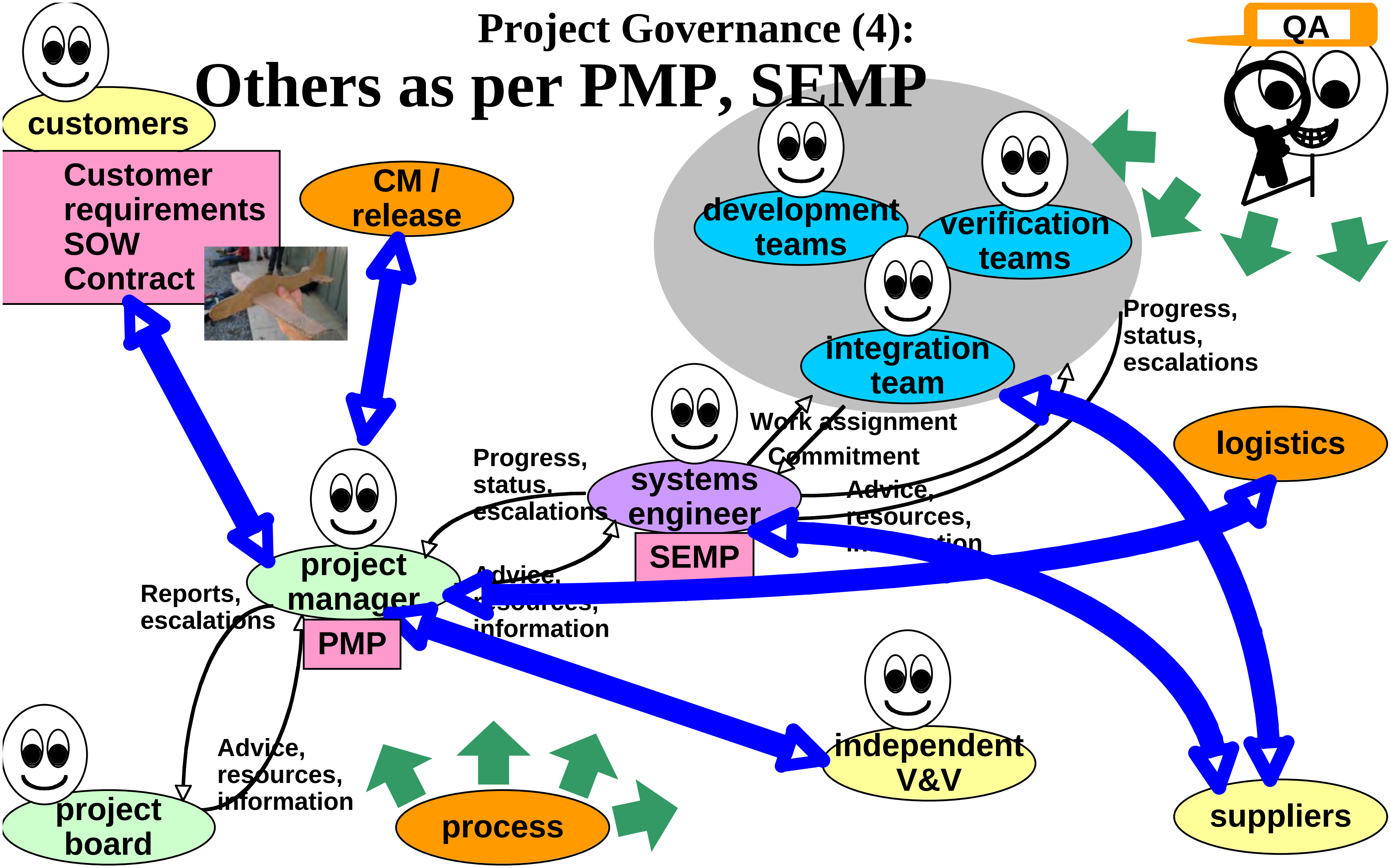
Project Governance (3): Project Manager & Project Board: Notes (1)

- **Progress, status, escalations =**
  - **Reports**
    - * **Against technical, resources (plans), deliverables, quality objectives**
    - * **ARCs that may eventuate and require escalation**
    - * **Problems that may require assistance**
  - **Escalations**
    - * **Requests for additional assistance**
    - * **In response to progress and plans (e.g., if insufficient achievements, insufficient / in appropriate resources, potential missed milestones for deliverables, insufficient progress against or non-achievement of quality objectives)**
    - * **To manage problems**

Project Governance (3): Project Manager & Project Board: Notes (2)

- **Advice, resources, information =**
  - **Advice**
    - * **E.g., in response to escalations**
  - **Approval**
    - * **As requested**
  - **Affirmation**
    - * **As appropriate, to information in Reports**
  - **Resources**
    - * **E.g., in response to escalations**
  - **Relevant information from other stakeholders**
    - * **E.g., other corporate stakeholders**

Project Governance (4):
Others as per PMP, SEMP

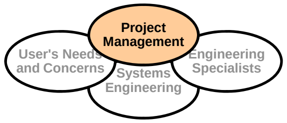


Project Governance (4): Others as per PMP, SEMP:
Notes (1)

- **Process**
  - **Enables effective governance collaboratively**
    - * **Processes, procedures, standards, guidelines, checklists, forms, templates**
    - * **Training, coaching, mentoring**
- **Quality Assurance**
  - **Evaluates effective governance is done collaboratively**
    - * **Measurement - objectively**
    - * **Internal Quality Audits (IQAs) - against agreed-upon processes / etc ...**

Project Governance (4): Others as per PMP, SEMP: Notes (2)

- **The previous are just examples ...**
  - **There is no single right-or-wrong way to organise governance-related communication among stakeholders**
- **The PMP and SEMP describe each project's choices**
- **Systems Engineer focuses on communication about:**
  - **Technical (e.g., functionality, quality)**
- **... and supports:**
  - **Management (e.g., schedule, budget)**
- **Systems Engineer is a negotiator and integrator**

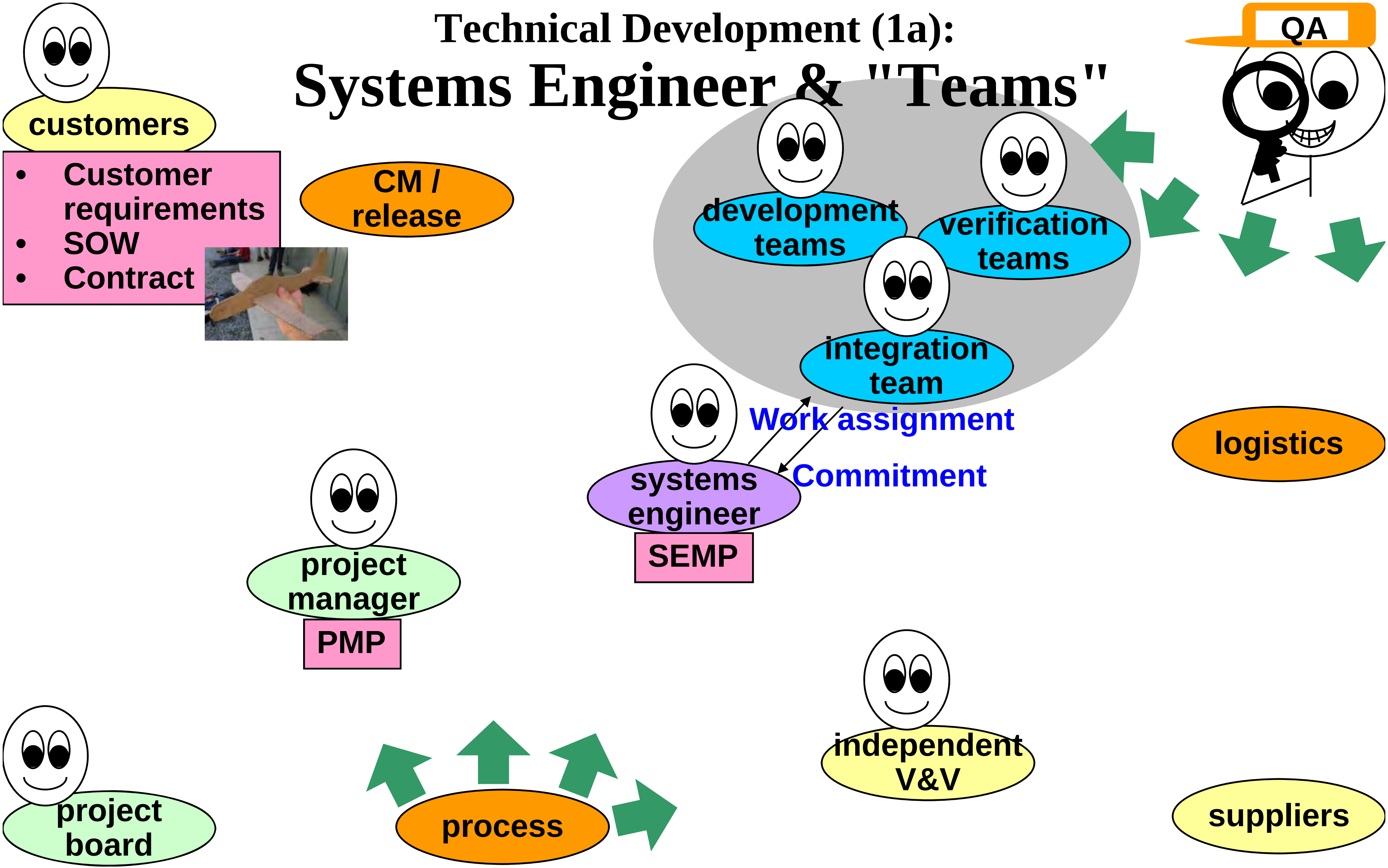


Systems Engineer
and
Project Execution:

Thread: Technical Development

This describes the "content" and "substance" of the interaction

Technical Development (1a): Systems Engineer & "Teams"



customers

- Customer requirements
- SOW
- Contract

CM / release

development teams

verification teams

integration team

QA

Work assignment

Commitment

systems engineer

SEMP

logistics

project manager

PMP

independent V&V

project board

process

suppliers

Technical Development (1a): Systems Engineer & "Teams": Notes (1): Project Manager Focus

- Work assignment ("work package," "task order") =
  - Cost centre (charge number)
    - * Legal entity authorising work
  - Outcomes
    - * I.e., things that are "measurable" and "demonstrable"
    - * Deliverables - external, internal; tangible; functionality; components
    - * Quality objectives
  - Resources
    - * Including: schedule, effort, budget, staffing, facilities, tools, equipment, etc
  - Other
    - * ARCs, dependencies, predecessor products, training
  - "Where these outcomes fit into the big picture"

Technical Development (1a): Systems Engineer & "Teams":
Notes (2): Systems Engineer Focus

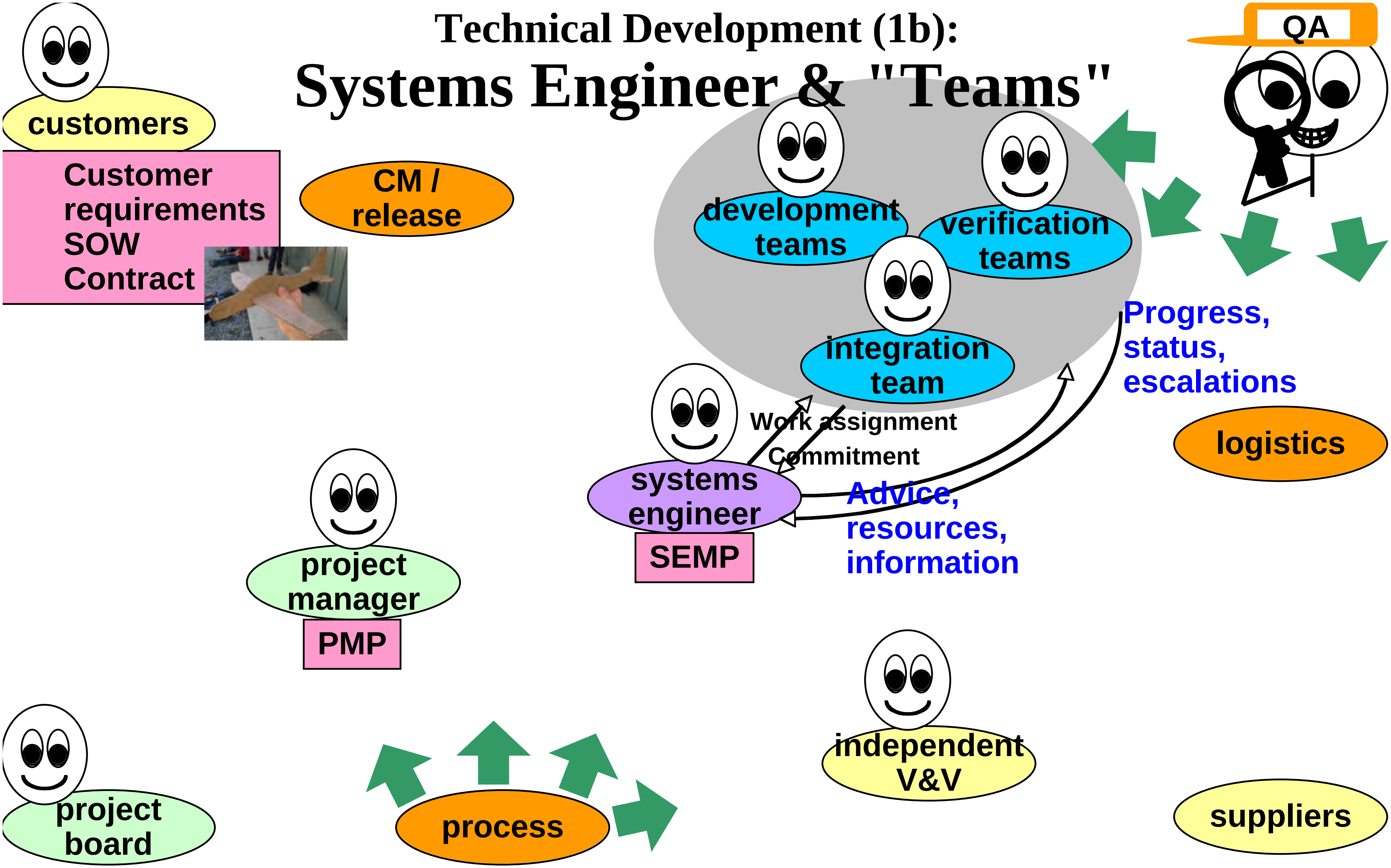
- Work assignment ("work package," "task order") =
  - Cost centre (charge number)
    - * Legal entity authorising work
  - Outcomes
    - * I.e., things that are "measurable" and "demonstrable"
    - * Deliverables - external, internal; tangible; functionality; components
    - * Quality objectives
  - Resources
    - * Including: schedule, effort, budget, staffing, facilities, tools, equipment, etc
  - Other
    - * ARCs, dependencies, predecessor products, training
  - "Where these outcomes fit into the big picture"

Technical Development (1a): Systems Engineer & "Teams": Notes (3)

- Project Manager owns schedule, budget, "governance"
  - And provides support on functionality, quality, "technical" in their contributions to achieving schedule / budget objectives

- Systems Engineer owns functionality, quality, "technical"
  - And provides support on schedule, budget, "governance" in their impact on achieving functionality, quality objectives

Technical Development (1b):
Systems Engineer & "Teams"



QA

customers

Customer requirements
SOW
Contract

CM / release

development teams

verification teams

integration team

Progress, status, escalations

logistics

Work assignment

Commitment

systems engineer

SEMP

Advice, resources, information

project manager

PMP

independent V&V

suppliers

project board

process

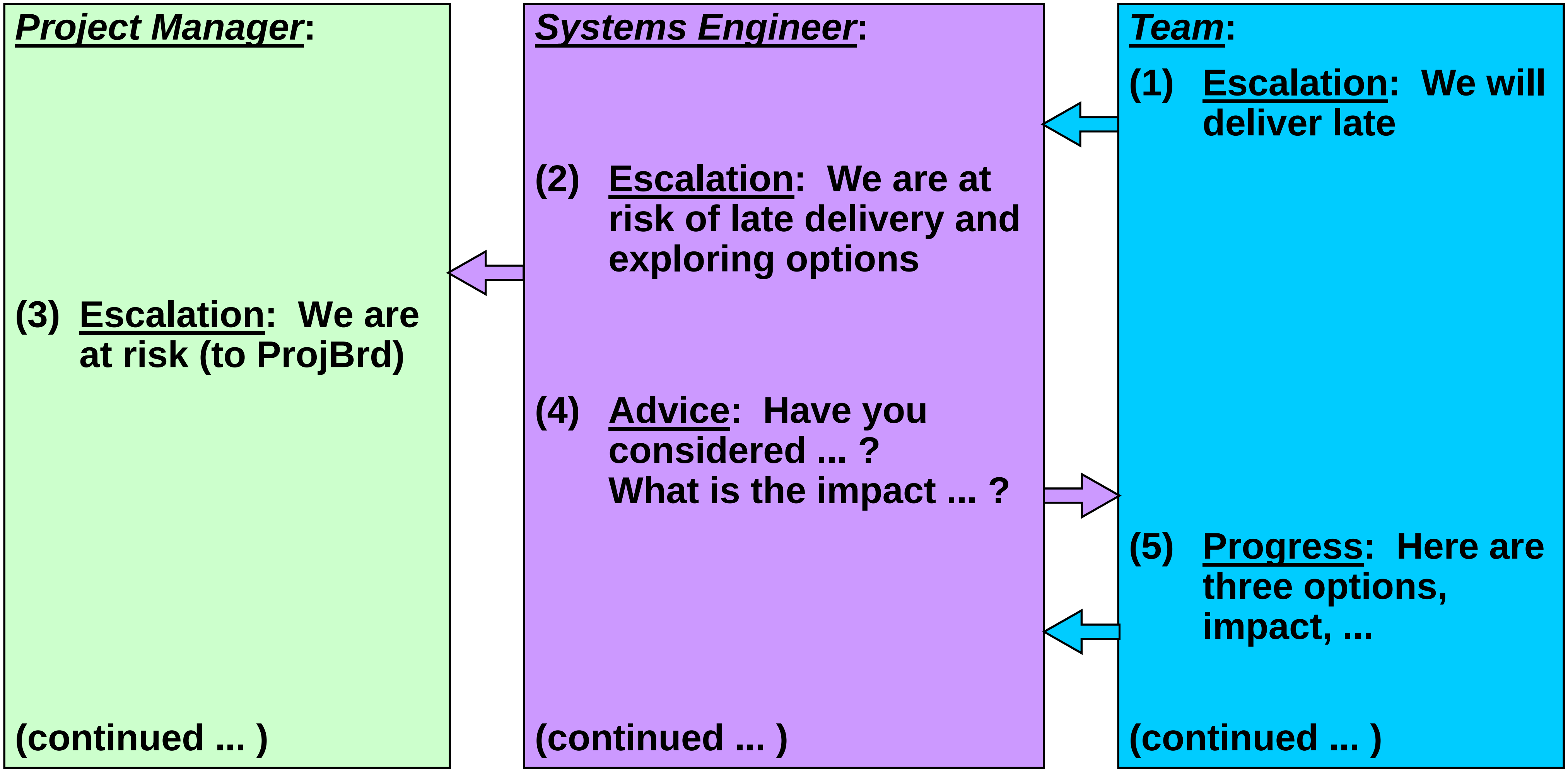
Technical Development (1b): Systems Engineer & "Teams": Notes (1)

- **Project Manager owns Progress, Plans, Problems that are purely schedule, budget**
- **"There is a Risk to this budget because of technology X ... "**
- **"We're Escalating for more resources due to technology problems ... "**

- **Systems Engineer owns _*technical issues*_ related to Progress, Plans, Problems**
- **"There is a Risk in this technology, with budget impacts ... "**
- **"We're Escalating because there are issues with this technology ... "**

☛ The nature / focus of the discourse is different

Technical Development (1b): Systems Engineer & "Teams": Notes (2a)



Project Manager:

(3) **Escalation**: We are at risk (to ProjBrd)

(continued ...)

Systems Engineer:

(2) **Escalation**: We are at risk of late delivery and exploring options

(4) **Advice**: Have you considered ... ?
What is the impact ... ?

(continued ...)

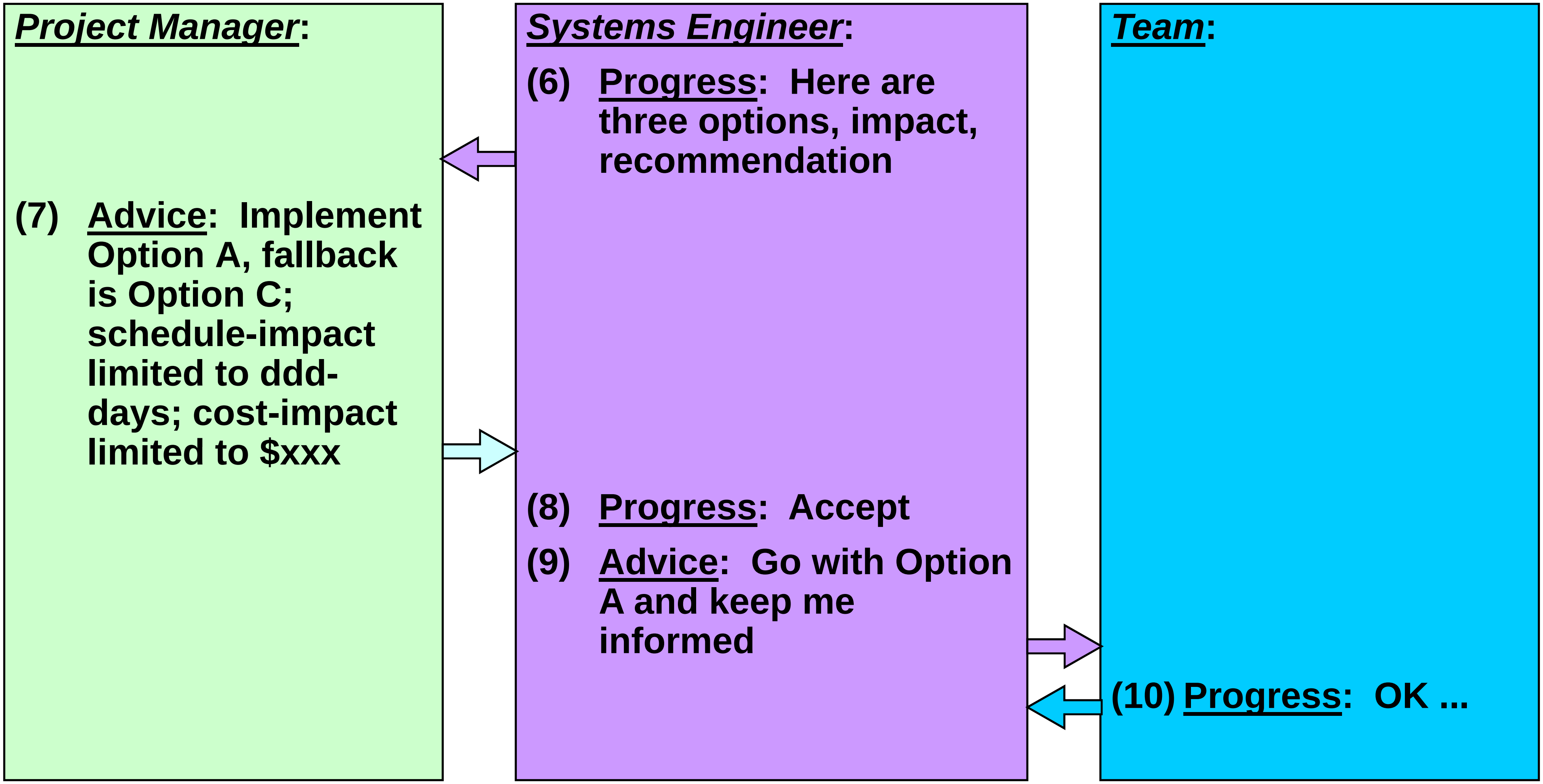
Team:

(1) **Escalation**: We will deliver late

(5) **Progress**: Here are three options, impact, ...

(continued ...)

Technical Development (1b): Systems Engineer & "Teams": Notes (2b)



Project Manager:

(7) **Advice**: Implement Option A, fallback is Option C; schedule-impact limited to ddd-days; cost-impact limited to $xxx

Systems Engineer:

(6) **Progress**: Here are three options, impact, recommendation

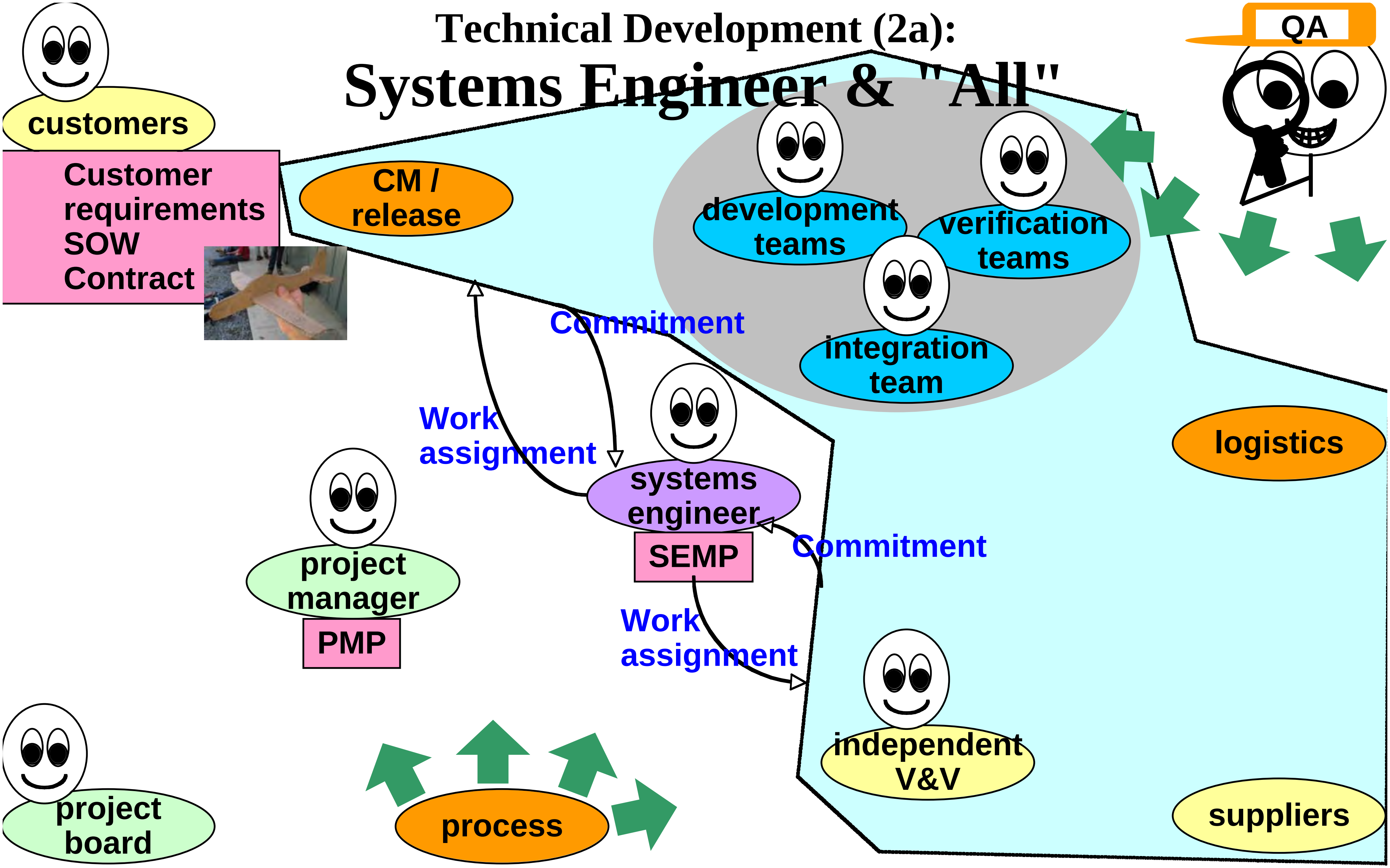
(8) **Progress**: Accept

(9) **Advice**: Go with Option A and keep me informed

Team:

(10) **Progress**: OK ...

Technical Development (2a):
Systems Engineer & "All"



QA

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Commitment

Work assignment

systems engineer

SEMP

Commitment

Work assignment

project manager

PMP

logistics

independent V&V

suppliers

project board

process

Technical Development (2a): Systems Engineer & "All": Notes (1)

- **Work assignment and Commitment**
  - **Similar as before ... and ...**
    - * **If external organisation, may have legally-binding contractual implications enabling / blocking technical accomplishments**
      - + **Fees / awards / progress payments**

        E.g., up-front payments to allow tool purchases
      - + **Penalties, liabilities**
      - + **Customised, shared processes**

        E.g., to ensure technical reviews, test / defect reports are clear and understood by all stakeholders
      - + **(... continued next slide ...)**

Technical Development (2a): Systems Engineer & "All": Notes (2)

- **Work assignment and Commitment**
  - **Similar as before ... and ...**
    - * **If external organisation, may have legally-binding contractual implications enabling / blocking technical accomplishments**
      - + **(... continued from previous slide ...)**
      - + **Proprietary tools / communication**

        E.g., proprietary tools used for development may be required for verification / maintenance
      - + **Specialised needs (e.g., if geographically distributed team)**

        E.g., transportation, logistics, security, networking across sites, development / support tool licensing
      - + **Acceptance criteria**

Technical Development (2a): Systems Engineer & "All": Notes (3)

- **Systems Engineer plays a key negotiation and integration role among *all* development-related stakeholders**
  - **Case study: Logistics may need some additional wiring to the engine for maintenance measurements**

    ⇒ Requirements on engine supplier
  - **Case study: Supplier may produce cockpit glass with specialised fasteners**

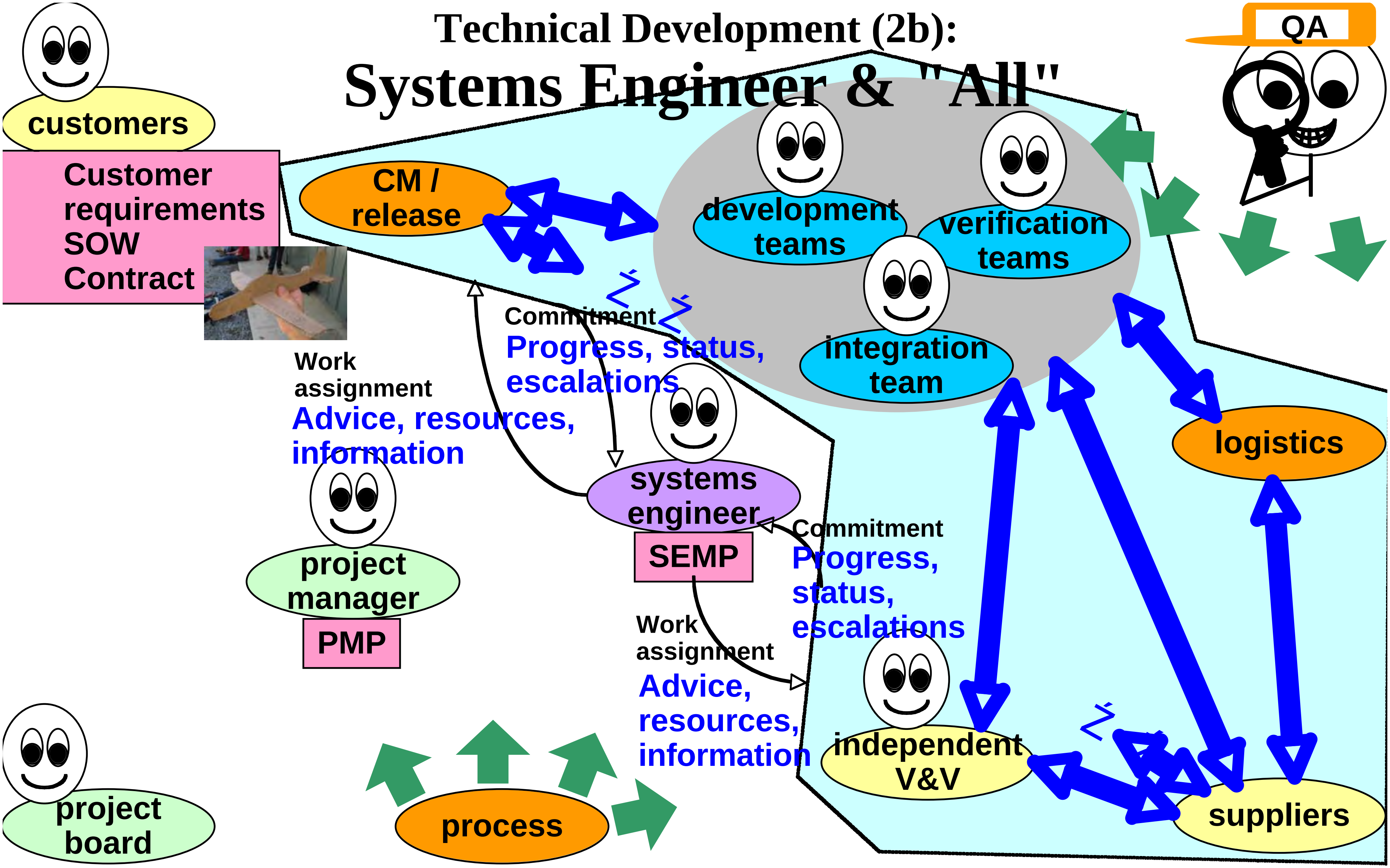
    ⇒ Requirements on cockpit producer (integrator)
  - **Case study: Software team developing flight control software needs to interface with flight data recorder**

    ⇒ Requirements on software team and flight data recorder team

Technical Development (2a): Systems Engineer & "All":
Notes (3)

- Key technical artefacts:
  - Scope definition
  - Systems requirements specification
  - Systems design specification
    - * Including architecture
  - Interface control document
  - Validation approach
  - Verification approach
  - Integration approach
  - Other (e.g., trade studies, build / buy, alternatives, ...)
  - Products / components to deliver
  - Traceability, traceability, traceability ...

Technical Development (2b):
Systems Engineer & "All"



customers

Customer requirements SOW Contract

QA

CM / release

development teams

verification teams

integration team

Commitment
Progress, status, escalations

Work assignment
Advice, resources, information

systems engineer

SEMP

project manager

PMP

Commitment
Progress, status, escalations

Work assignment
Advice, resources, information

logistics

independent V&V

suppliers

project board

process

Technical Development (2b): Systems Engineer & "All": Notes (1)

- **There is a constant, structured, timely, clear information flow among all stakeholders:**
  - **Systems Engineer designs and allocates *work assignments***
  - **"All" acknowledge with *commitment***
    - * **With changes, caveats as appropriate**
  - **"All" perform work**
  - **"All" provide *progress, status, escalations* of work**
  - **Systems Engineer evaluates *progress, status, escalations* and reports to Project Manager**
  - **Systems Engineer responds with *advice, resources, information***

Technical Development (2b): Systems Engineer & "All": Notes (2)

- Work assignments focus on implementing:
  - Scope definition
  - Systems requirements specification
  - Systems design specification
    - * Including architecture
  - Interface control document
  - Validation approach
  - Verification approach
  - Integration approach
  - Other (etc ...)
  - Products / components to deliver
  - Traceability, traceability, traceability ...

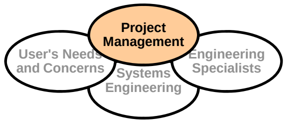
Key technical artefacts

- Commitments are made to deliver:
  - Key technical artefacts within plans and constraints
- Progress, status are reported against:
  - Key technical artefacts, plans, ARCs, etc
- Escalation (technical) occurs when delivering:
  - Key technical artefacts

  ... requires anything beyond team's ability or resources
- Advice, resources,information are provided about and to achieve:
  - Key technical artefacts

Technical Development (2b): Systems Engineer & "All": Notes (3)

- Once again we see that the Systems Engineer is "the person in the middle" - a negotiator and integrator
  - Technical
  - Management

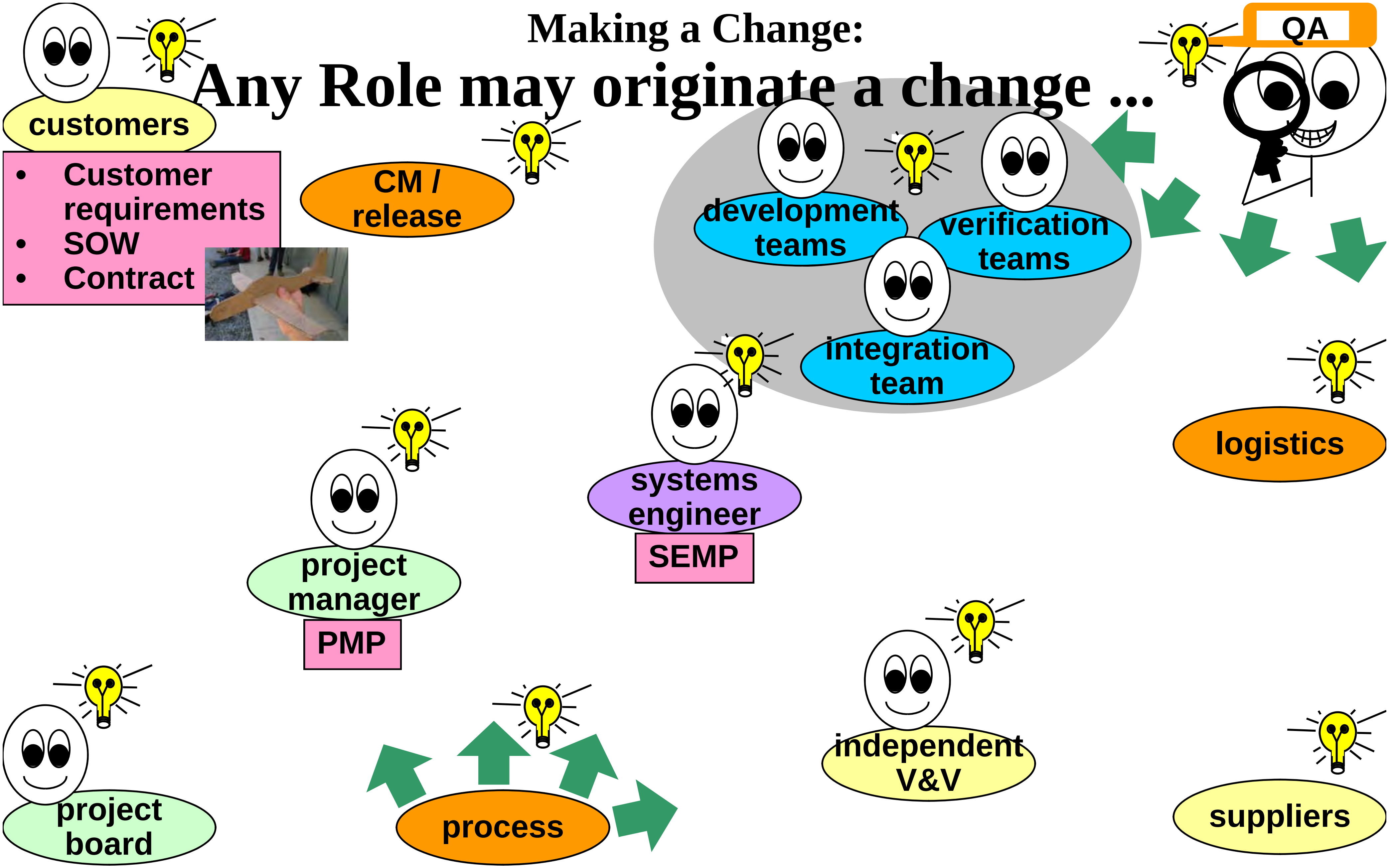


Systems Engineer
and
Project Execution:

Thread: Making a Change

This describes the "content" and "substance" of the interaction

Making a Change:
Any Role may originate a change ...



QA

customers

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project board

process

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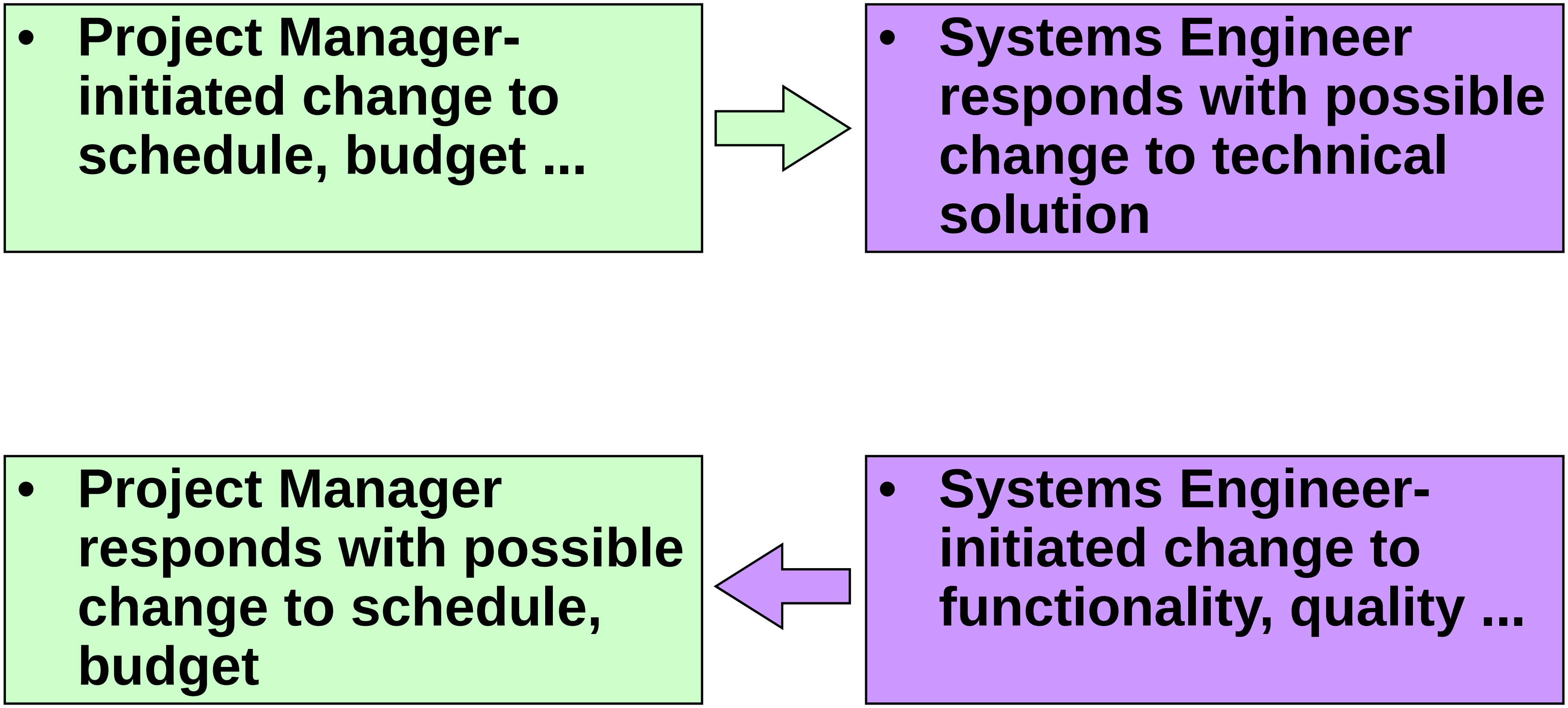
suppliers

Making a Change: Any Role may originate a change: Notes (1)

- Technical
- Managerial
- Not achieving quality objectives
- Not achieving performance / productivity goals
- Exceeding plans
- Not achieving plans
- Market / mission shift
- Improvement, opportunity, corrective action ...
- Etc etc etc ...

Making a Change: Any Role may originate a change:
Notes (2)



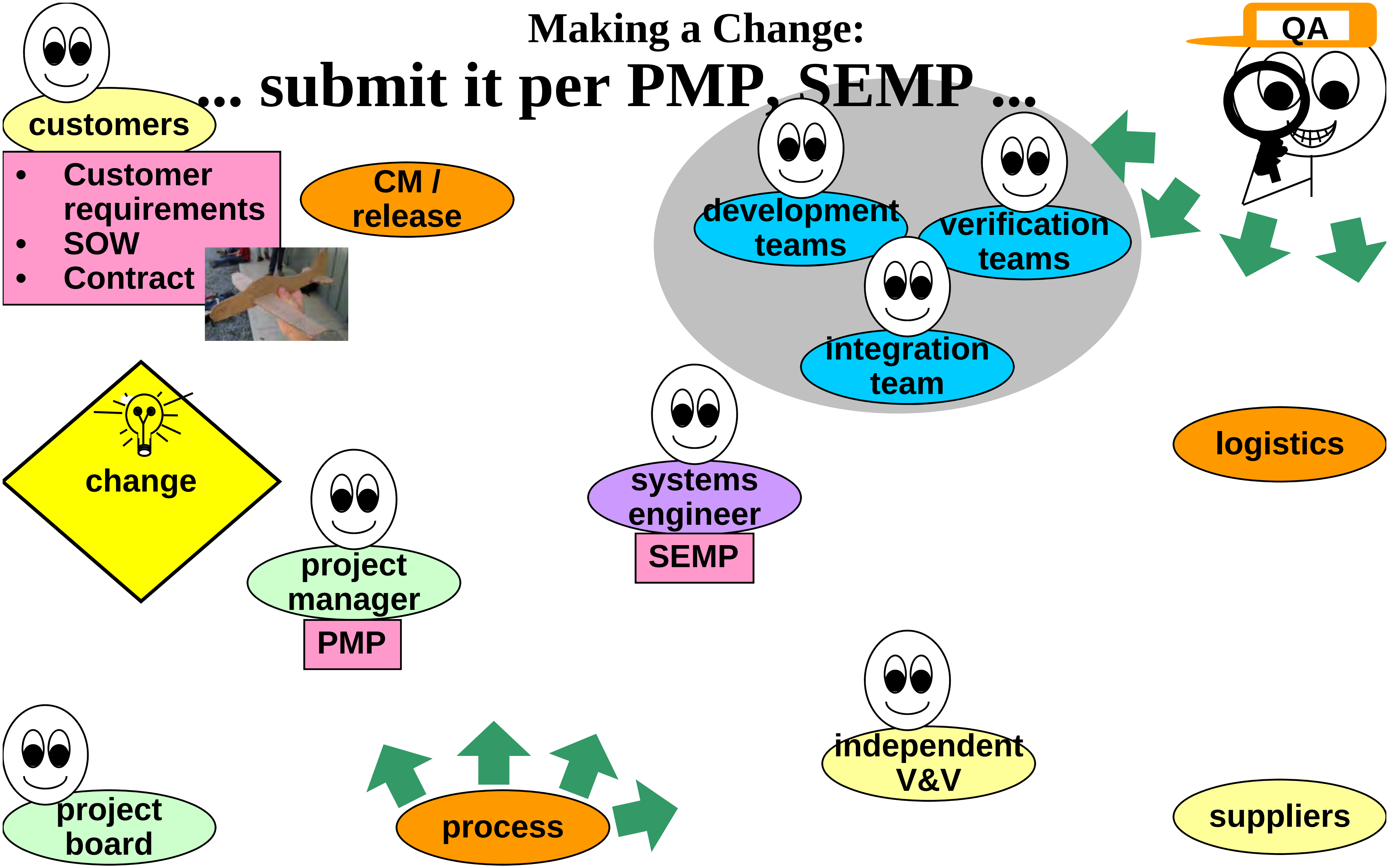
- Project Manager-initiated change to schedule, budget ...

- Systems Engineer responds with possible change to technical solution

- Project Manager responds with possible change to schedule, budget

- Systems Engineer-initiated change to functionality, quality ...

Making a Change:
... submit it per PMP, SEMP ...



customers

- Customer requirements
- SOW
- Contract

CM / release

change

project manager

PMP

systems engineer

SEMP

development teams

verification teams

integration team

QA

logistics

independent V&V

project board

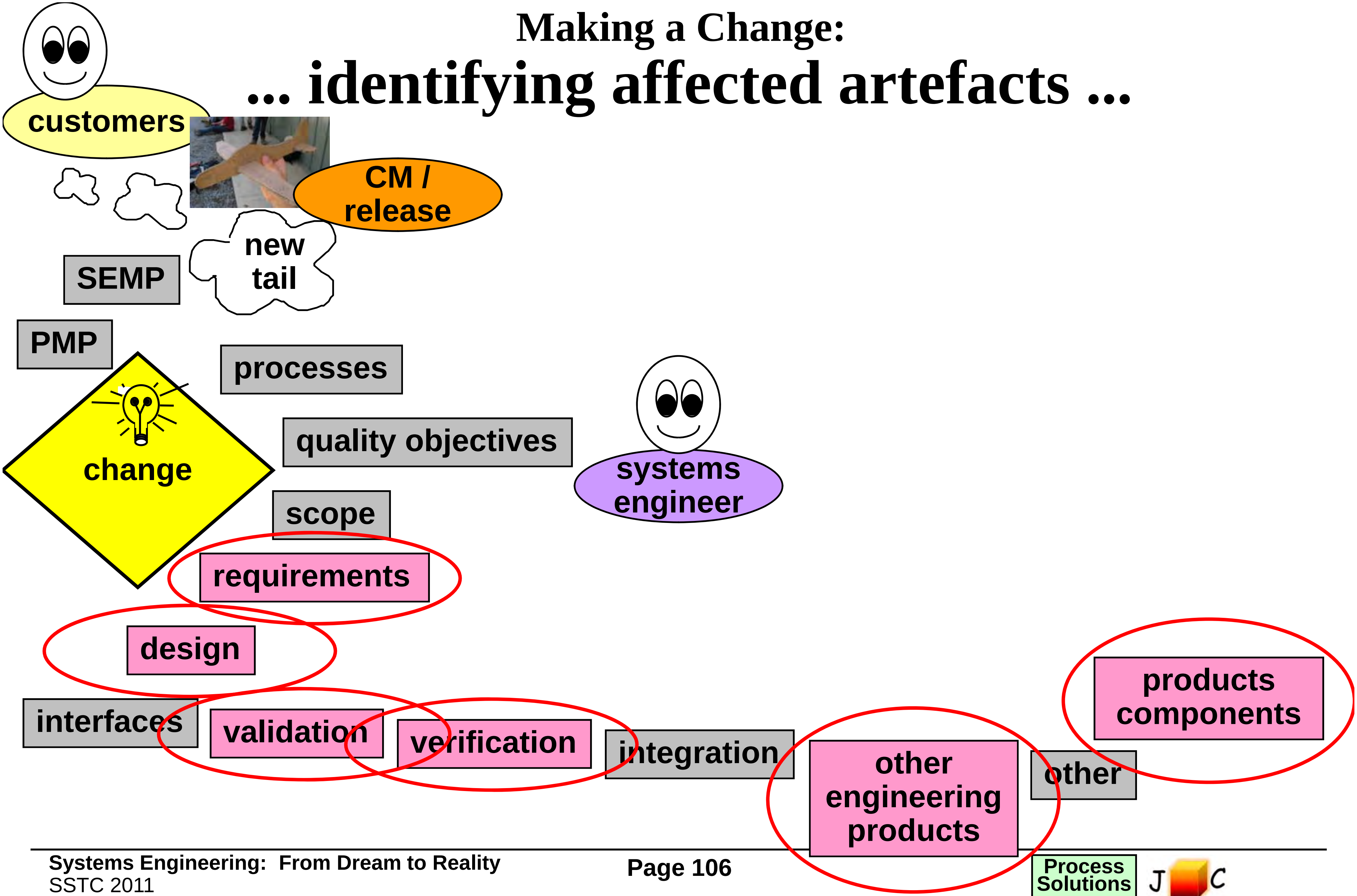
process

suppliers

Making a Change: ... submit it per PMP, SEMP ... : Notes

- **For this example, consider our case study, where Customer requires a new tail configuration**
  - **... and I will make some simplifying assumptions**
    - **(Perhaps not-quite-real-world!)**

Making a Change:
... identifying affected artefacts ...

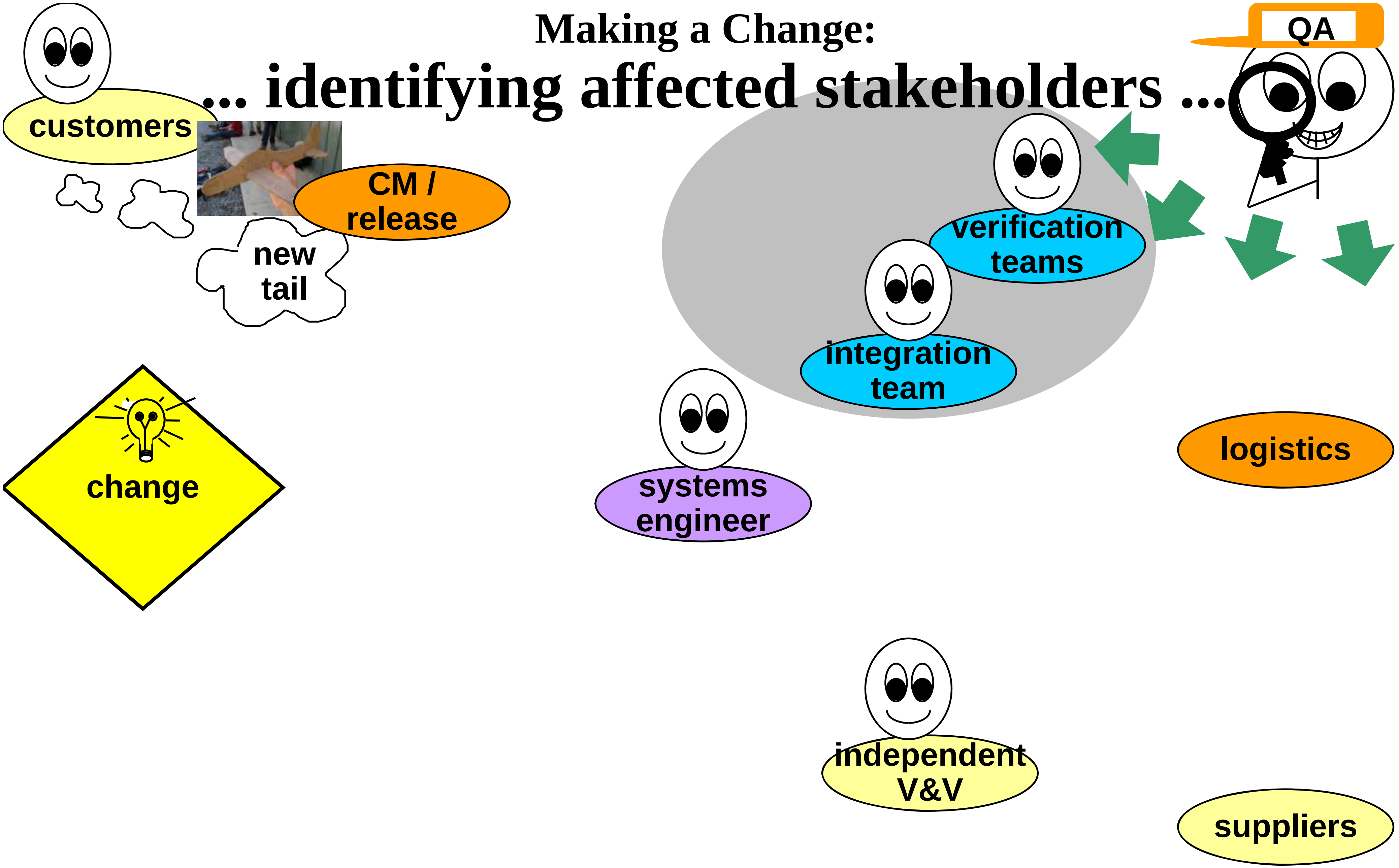


Making a Change: Identifying affected artefacts ... : Notes

- **Traceability, traceability, traceability !!!**
  - **Scope:** **Paragraph 1.13 ...**
  - **Requirements:** **Sections 3.4, 12.7, 13.6 ...**
  - **Design:** **Volume 3, Chapter 7**
Volume 5, Chapter 2 - 4 ...
  - **Components:** **Tail**
Fuselage
Flight control software ...
  - **Other:** **Test equipment ABC**
Test software XYZ ...

Making a Change:

... identifying affected stakeholders ...



customers

CM / release

new tail

change

verification teams

integration team

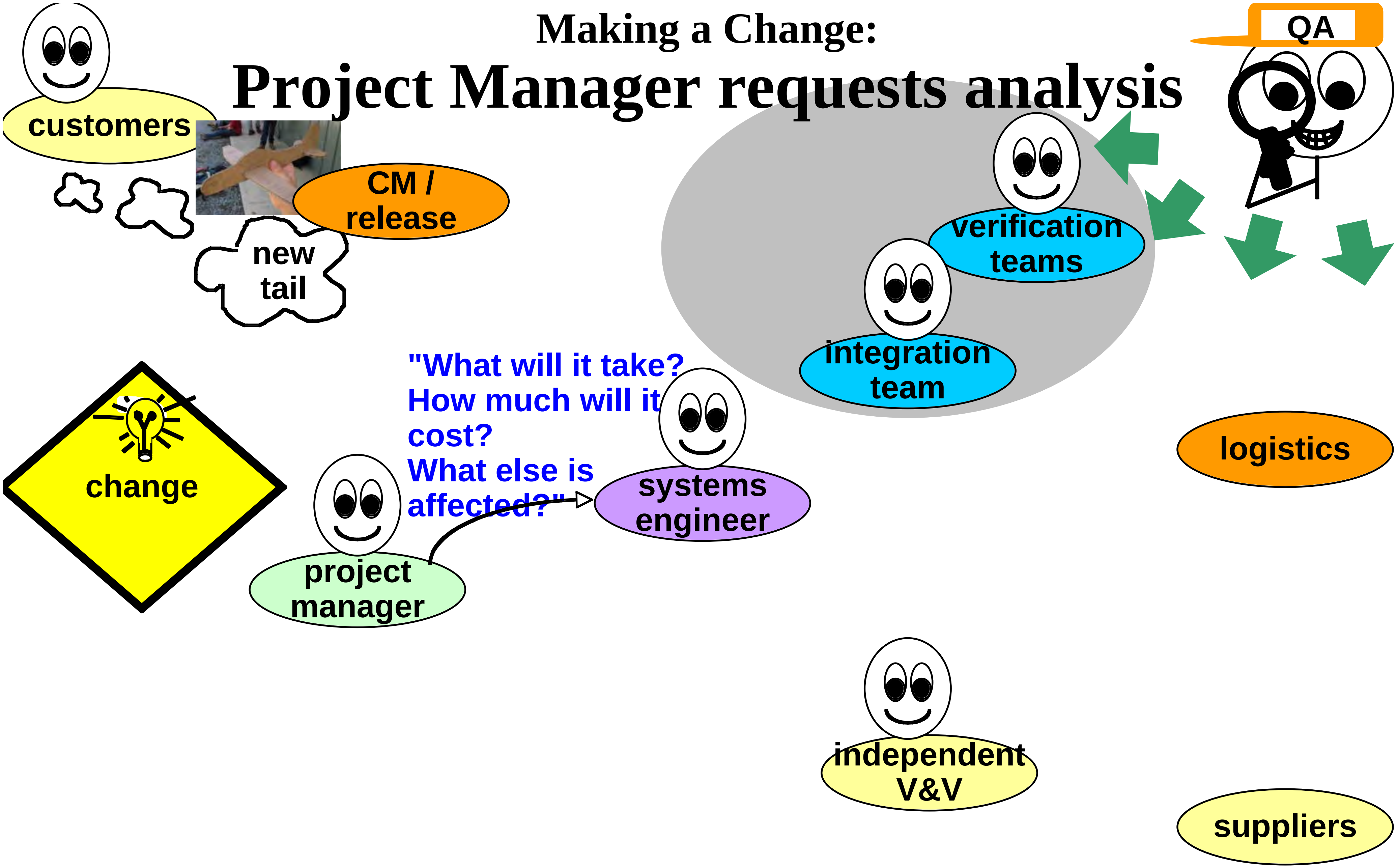
systems engineer

logistics

independent V&V

suppliers

Making a Change:
Project Manager requests analysis



customers

CM / release

new tail

QA

verification teams

integration team

change

"What will it take? How much will it cost? What else is affected?"

project manager

systems engineer

logistics

independent V&V

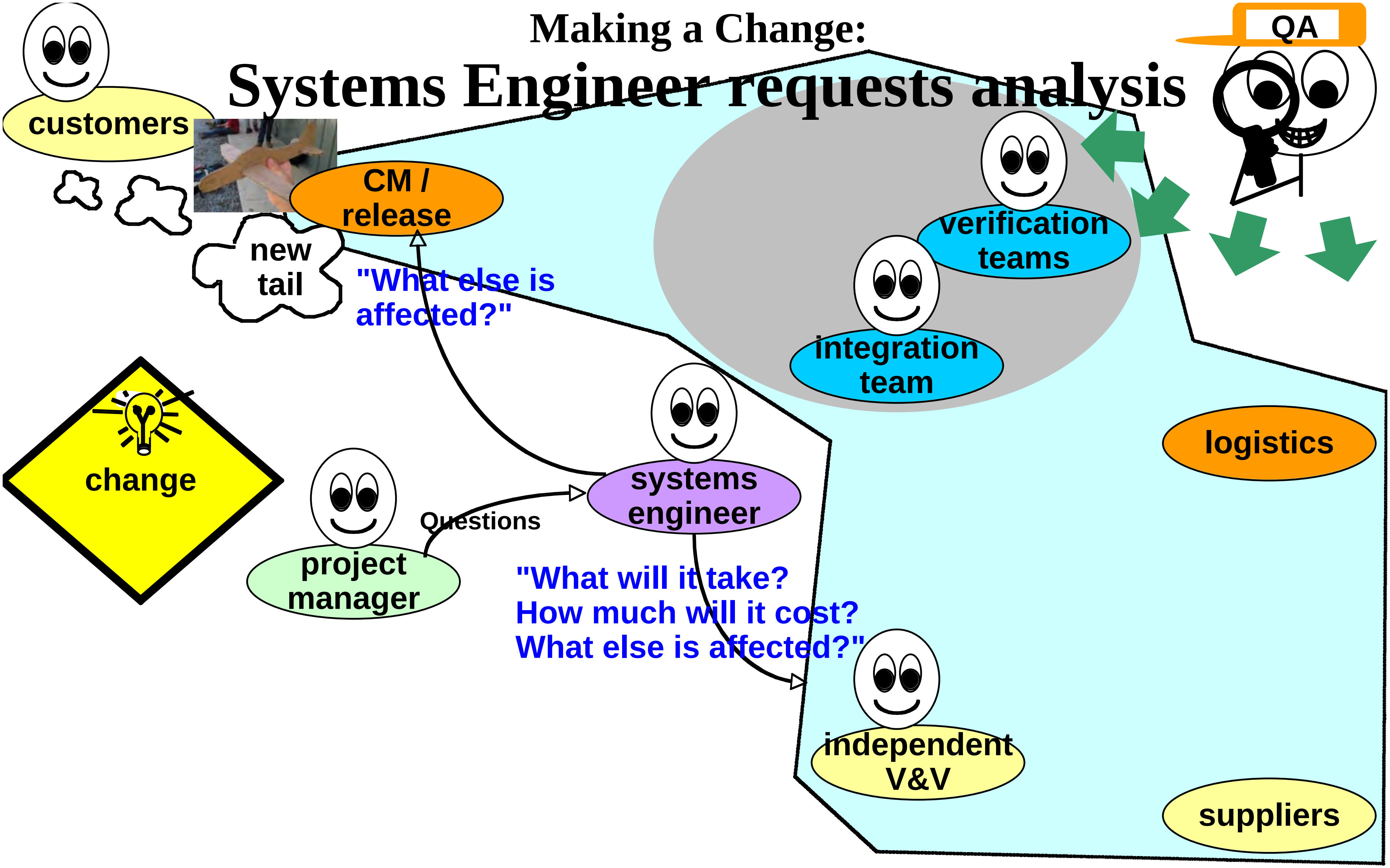
suppliers

Making a Change: Project Manager requests analysis: Notes

- Project Manager needs to understand "governance" impacts:
  - Schedule
  - Budget
- For example:
  - What are the issues?
  - What is the impact on: schedule? budget?
  - What alternatives are there?
  - What risks / costs / benefits - to schedule and budget - for each?

Making a Change:

Systems Engineer requests analysis



QA

customers

new tail

CM / release

"What else is affected?"

verification teams

integration team

change

project manager

Questions

systems engineer

"What will it take?
How much will it cost?
What else is affected?"

logistics

independent V&V

suppliers

Making a Change: Systems Engineer requests analysis: Notes (1)

- Systems Engineer needs to understand "technical" impacts:
  - Functionality
  - Quality
- For example:
  - What are the issues?
  - What is the impact on: existing components? architecture? existing artefacts? down-stream activities / products (e.g., verification, validation)?
  - What alternatives are there?
  - What risks / costs / benefits are introduced by delivering this alternative functionality / quality to achieve the required outcome?

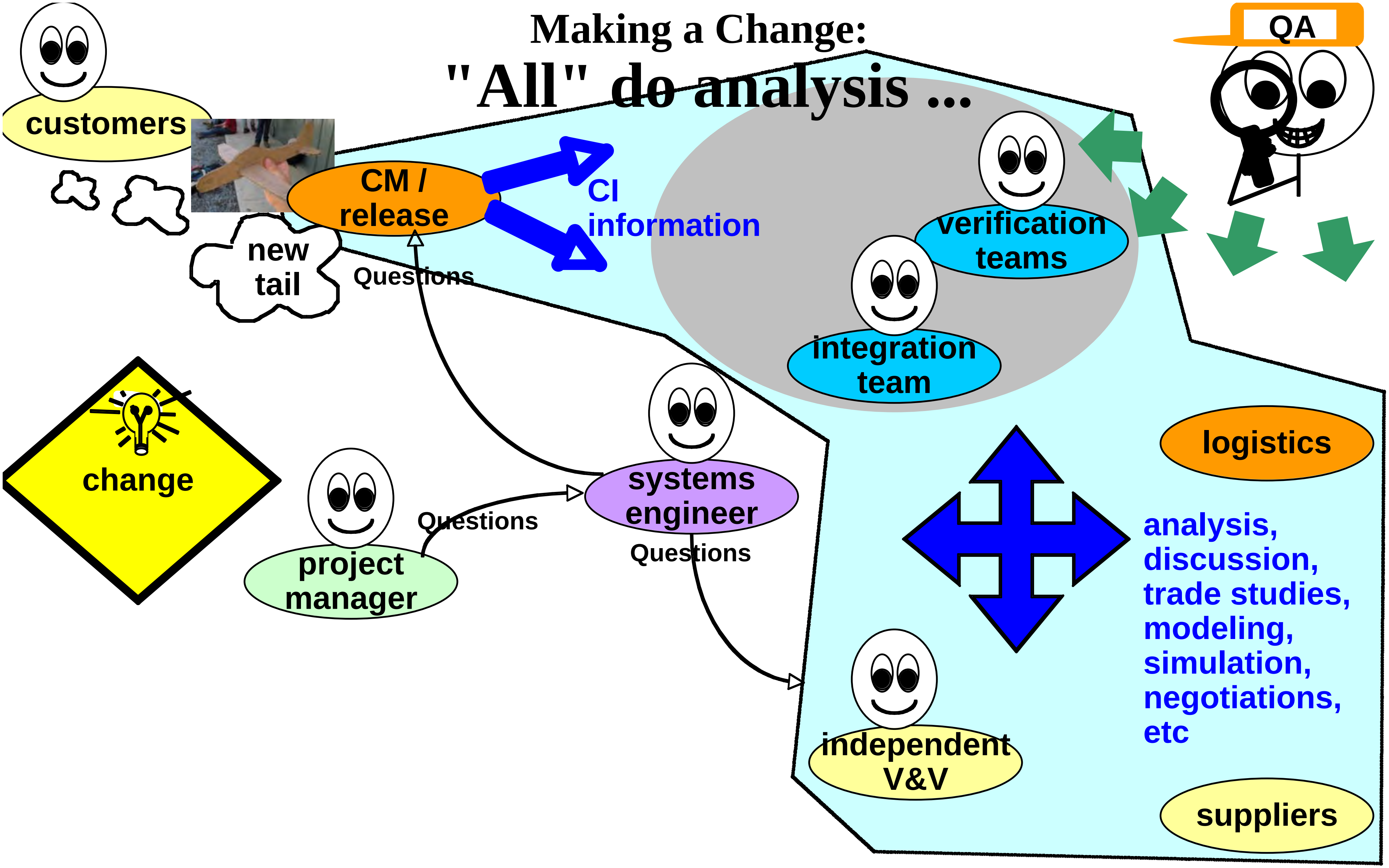
Making a Change: Systems Engineer requests analysis:
Notes (2)

- Project Manager needs to understand "governance" impacts:
  - Schedule
  - Budget
- For example:
  - What are the issues?
  - What is the impact on: schedule? budget?
  - What alternatives are there?
  - What risks / costs / benefits - to schedule and budget - for each?

- Systems Engineer needs to understand "technical" impacts:
  - Functionality
  - Quality
- For example:
  - What are the issues?
  - What is the impact on: existing components? architecture? existing artefacts? downstream activities / products (e.g., verification, validation)?
  - What alternatives are there?
  - What risks / costs / benefits - to functionality and quality - for each?

☛ **Systems Engineer "puts meat on the bones" for Project Manager to take to Project Board and Customer**

Making a Change:
"All" do analysis ...



customers

new tail

CM / release

CI information

Questions

QA

verification teams

integration team

change

project manager

Questions

systems engineer

Questions

logistics

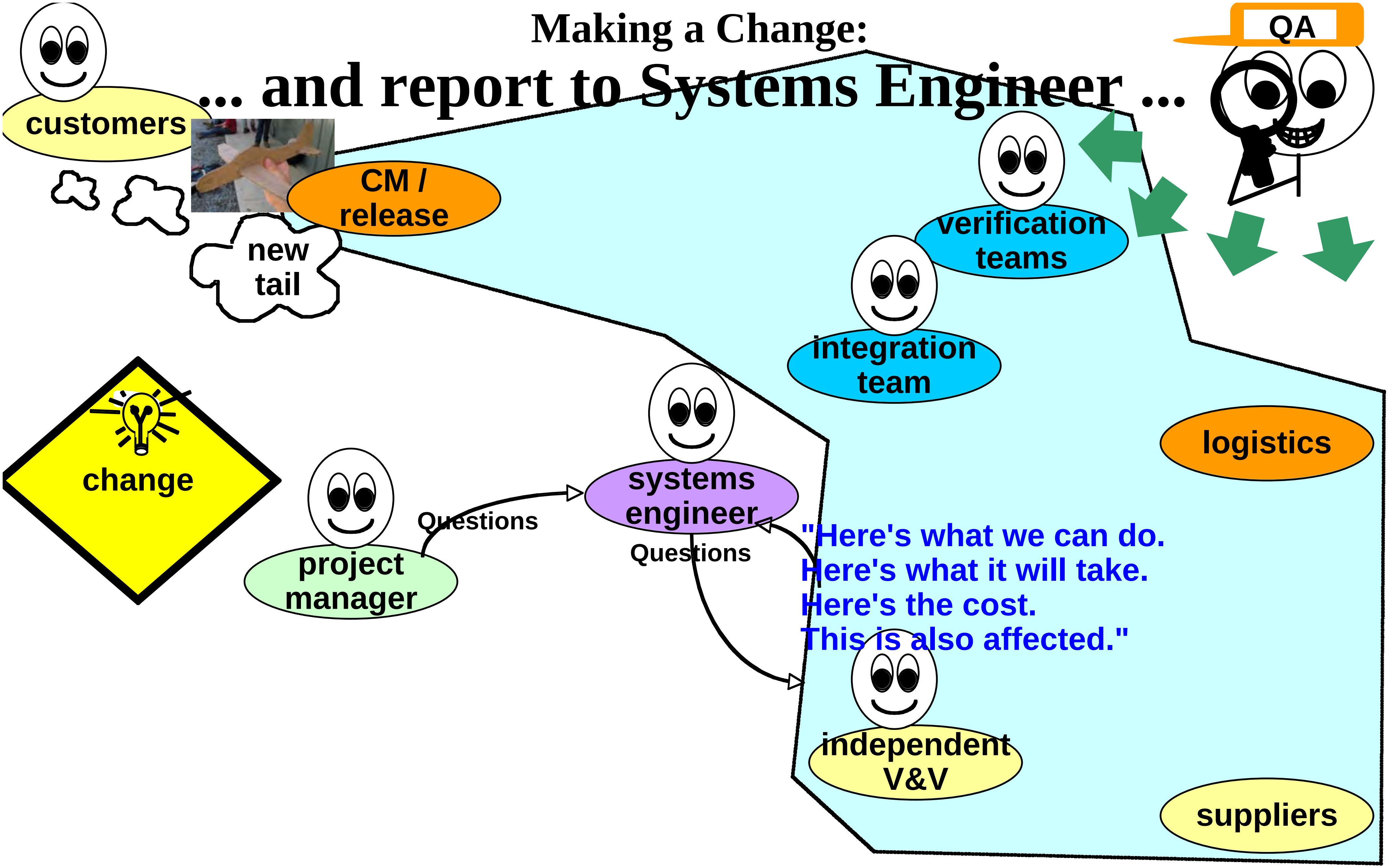
analysis, discussion, trade studies, modeling, simulation, negotiations, etc

independent V&V

suppliers

Making a Change:

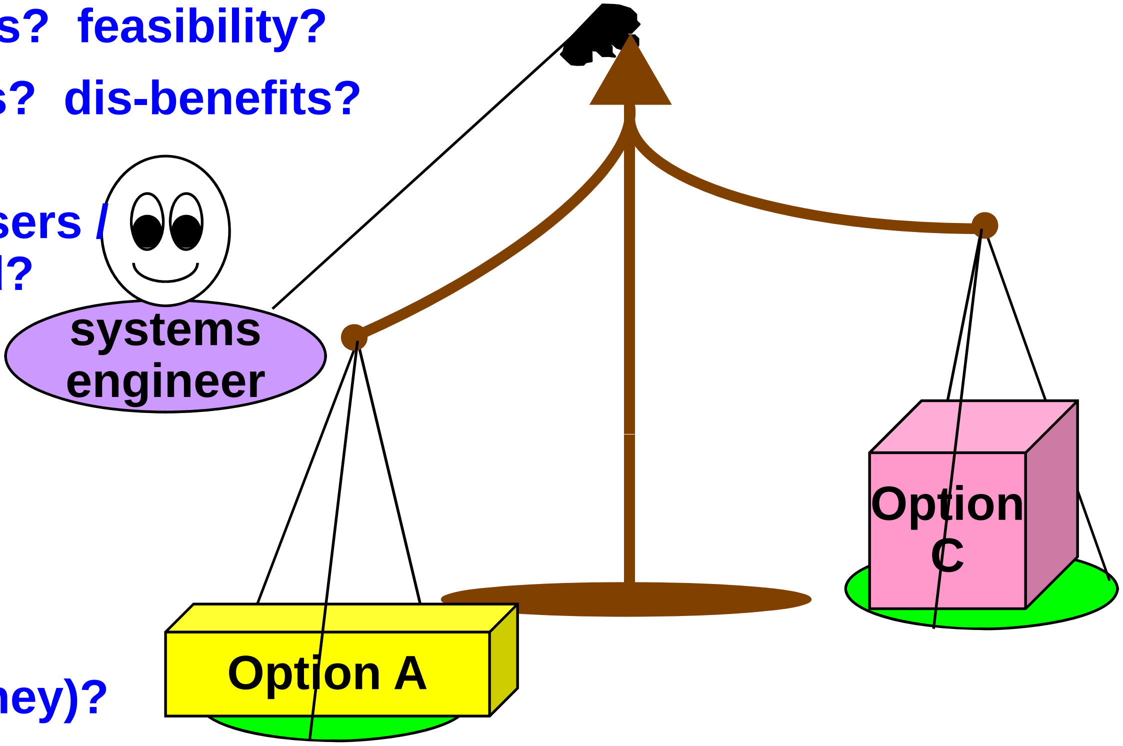
... and report to Systems Engineer ...



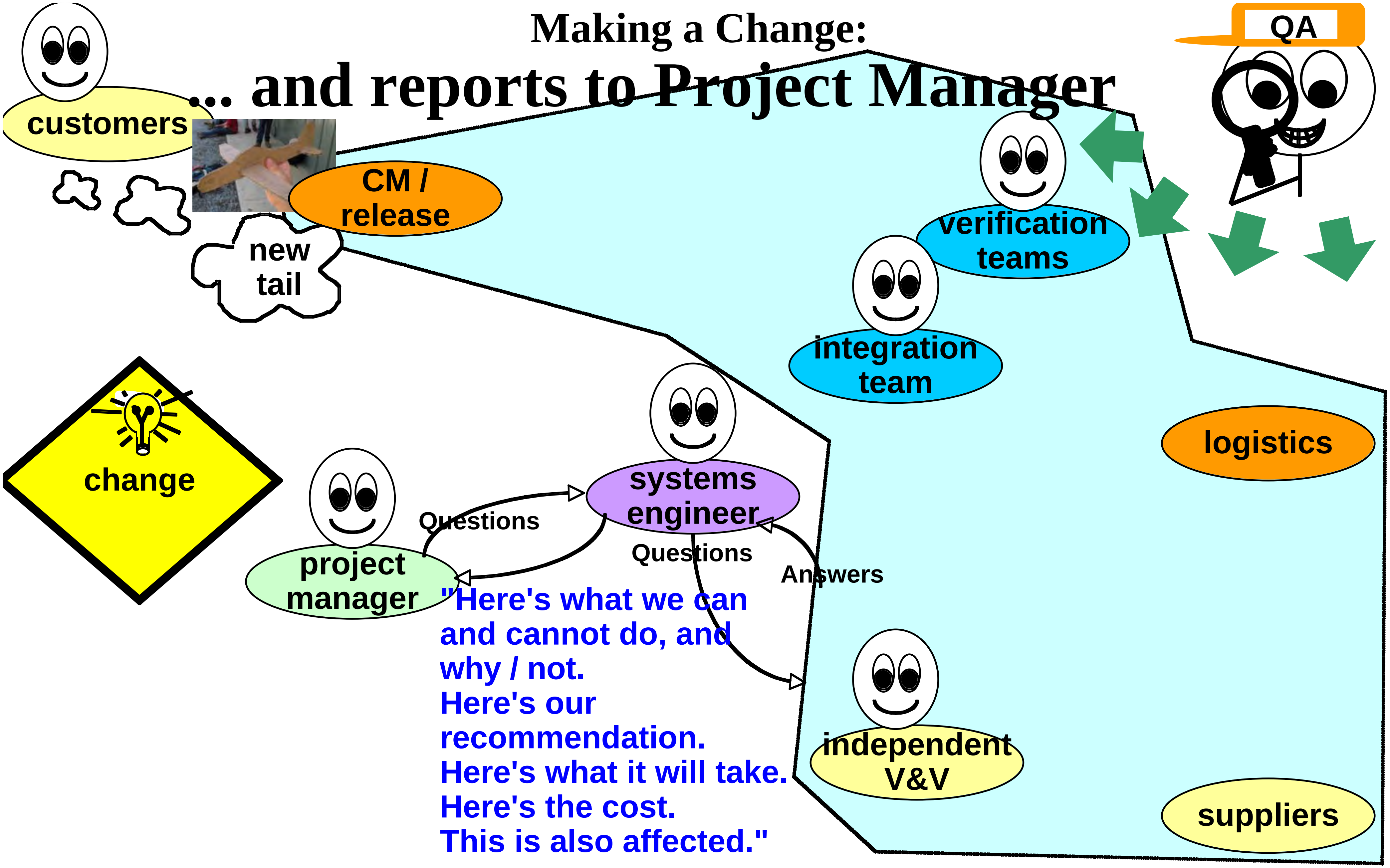
"Here's what we can do.
Here's what it will take.
Here's the cost.
This is also affected."

Making a Change:
... who evaluates options ...

- What functionality is gained? lost? improved? degraded?
- What quality is improved? degraded? at-risk?
- What are the technical risks? feasibility?
- What are technical benefits? dis-benefits?
- What other components / stakeholders / systems / users / artefacts / etc are impacted?
- What else is impacted? (traceability, traceability, traceability !!!)
- Who else is impacted? (traceability, traceability, traceability !!!)
- What is the cost (time, money)?
- Can we do it (capacity, capability; internal, supplier)?
- How does this impact Customer's big picture?



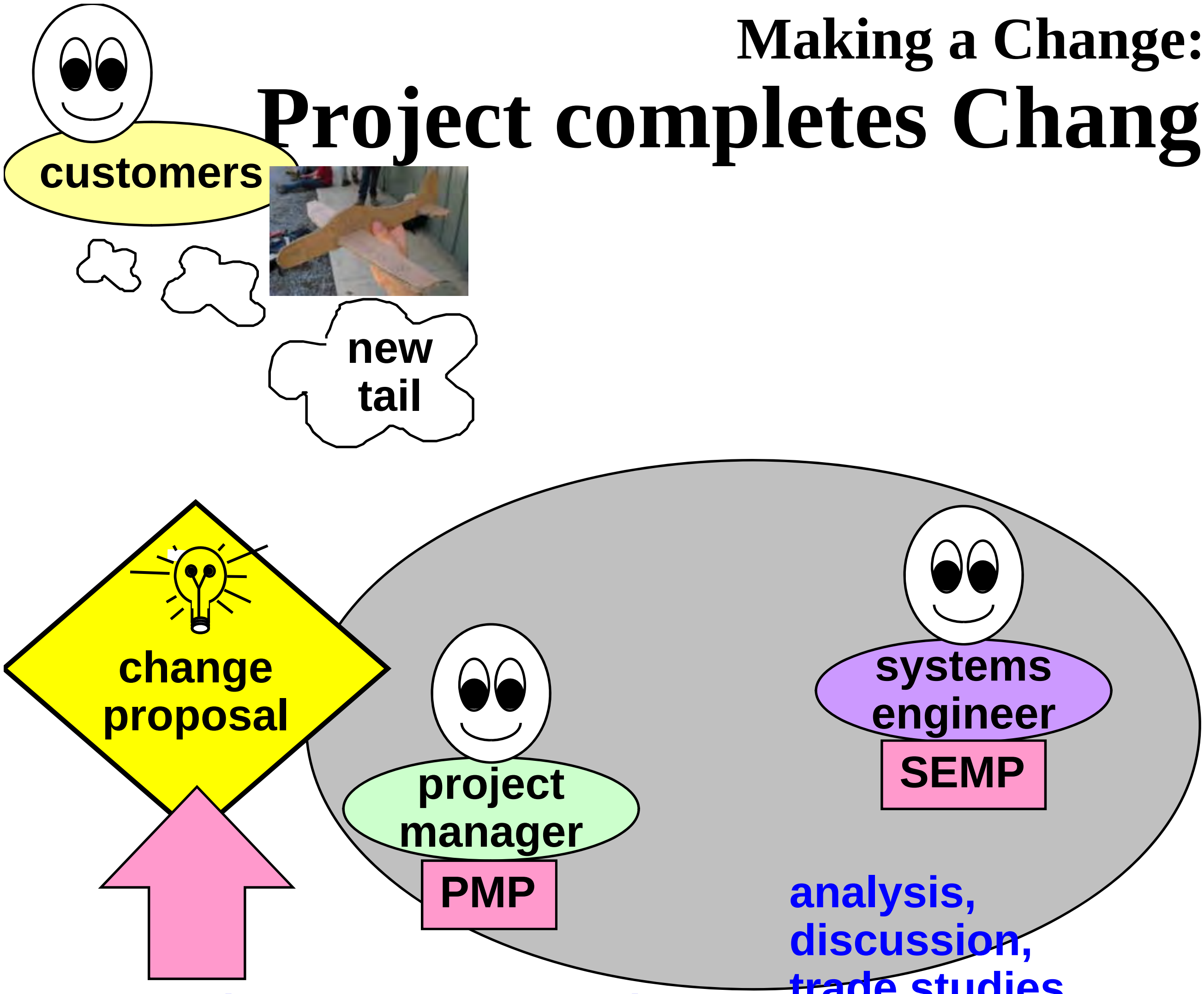
Making a Change:
... and reports to Project Manager



"Here's what we can and cannot do, and why / not.
Here's our recommendation.
Here's what it will take.
Here's the cost.
This is also affected."

Making a Change:

Project completes Change Proposal ...



customers

new tail

change proposal

project manager

PMP

systems engineer

SEMP

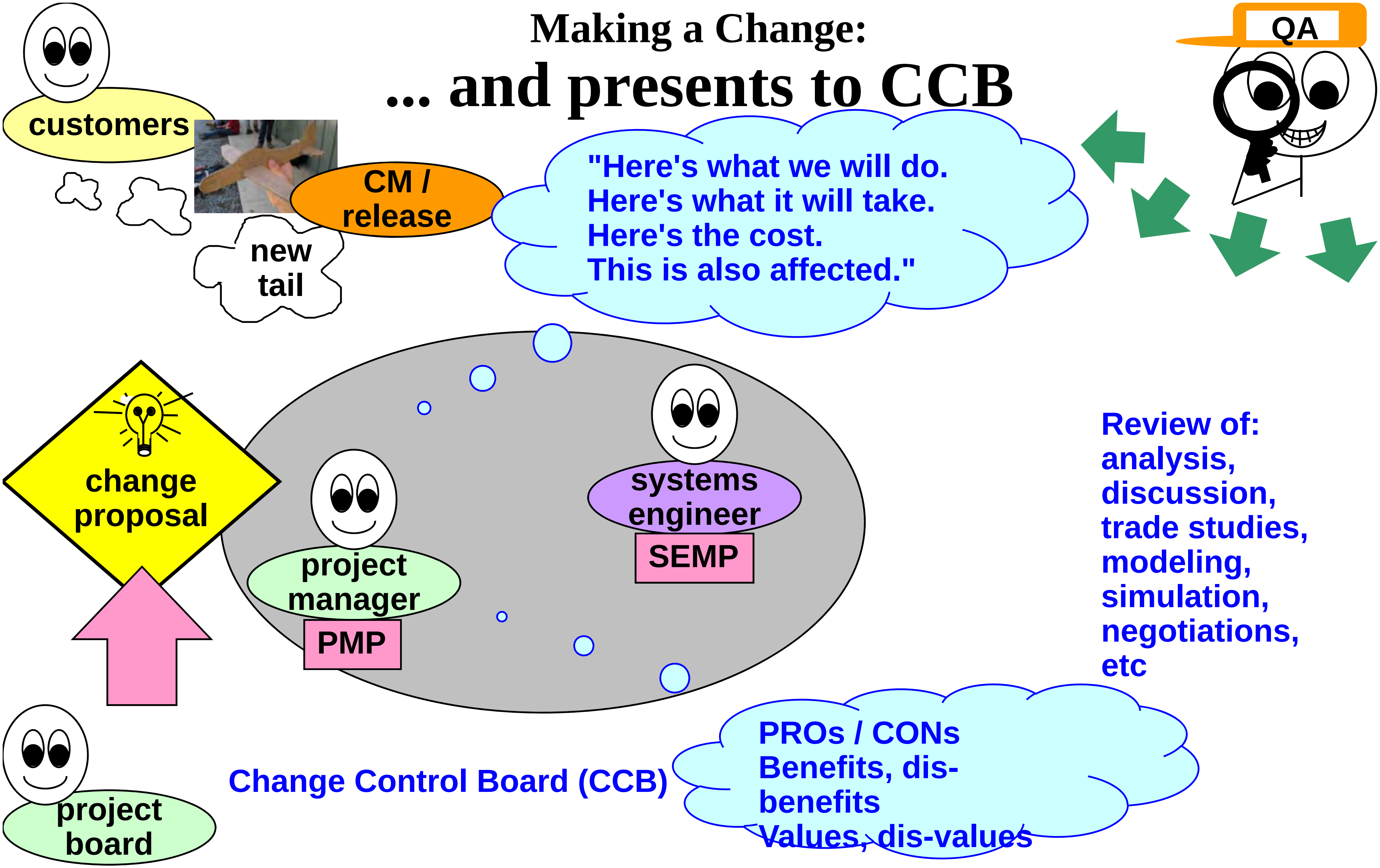
"Here's what we propose to do.
Here's what it will take.
Here's the cost.
This is also affected."

analysis,
discussion,
trade studies,
modeling,
simulation,
negotiations,
etc

Making a Change: Project completes Change Proposal ... : Notes

- System Engineer
  - Formalises the Change Proposal
  - Prepares a convincing argument
    - * Recommendations
    - * Alternatives
    - * PROs / CONs
  - Convinces / aligns internal stakeholders (e.g., Project Manager, Project Board)
  - Prepares the case - technically - functionality / quality - for Customer

Making a Change:
… and presents to CCB



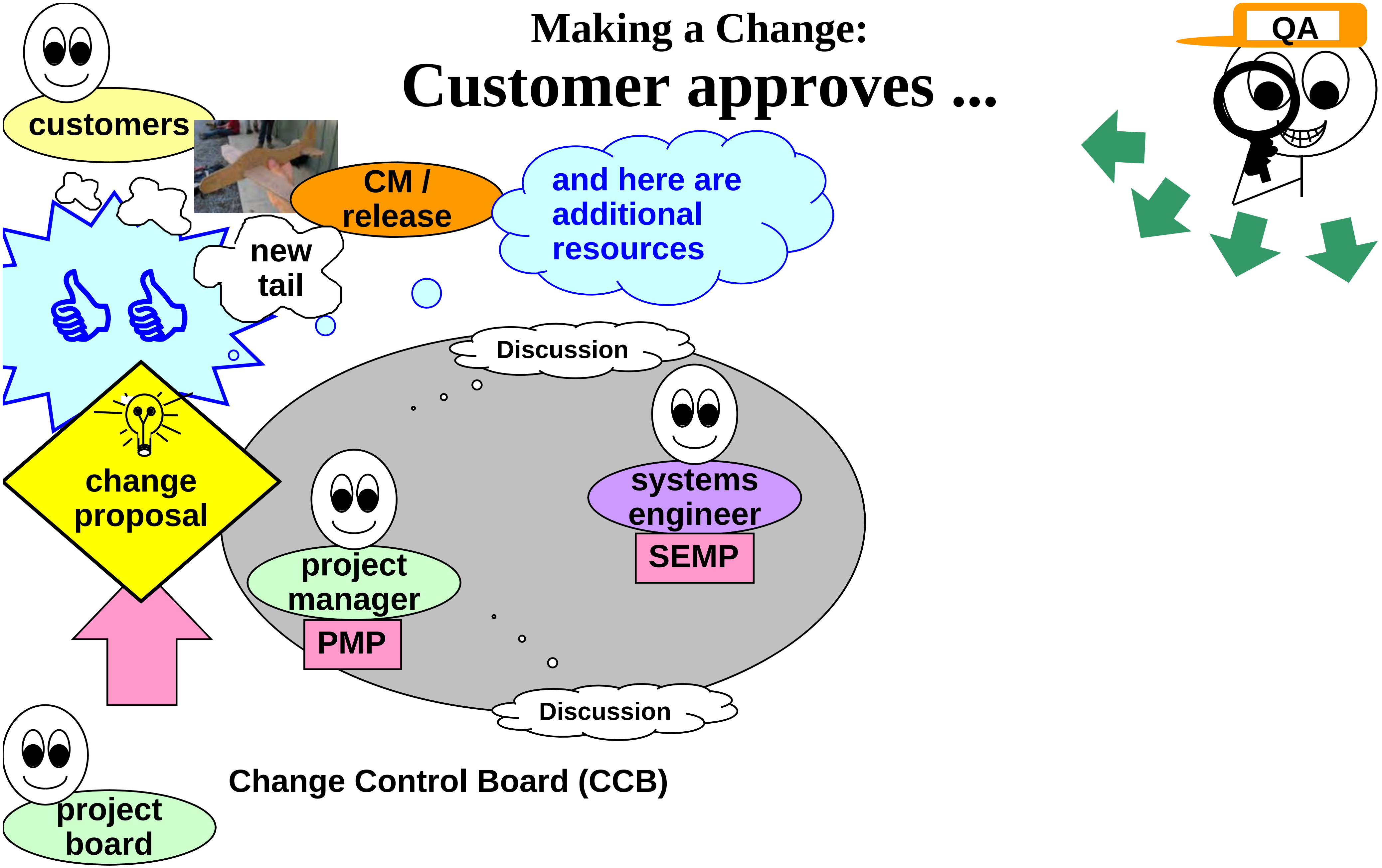
"Here's what we will do.
Here's what it will take.
Here's the cost.
This is also affected."

Review of:
analysis,
discussion,
trade studies,
modeling,
simulation,
negotiations,
etc

Change Control Board (CCB)

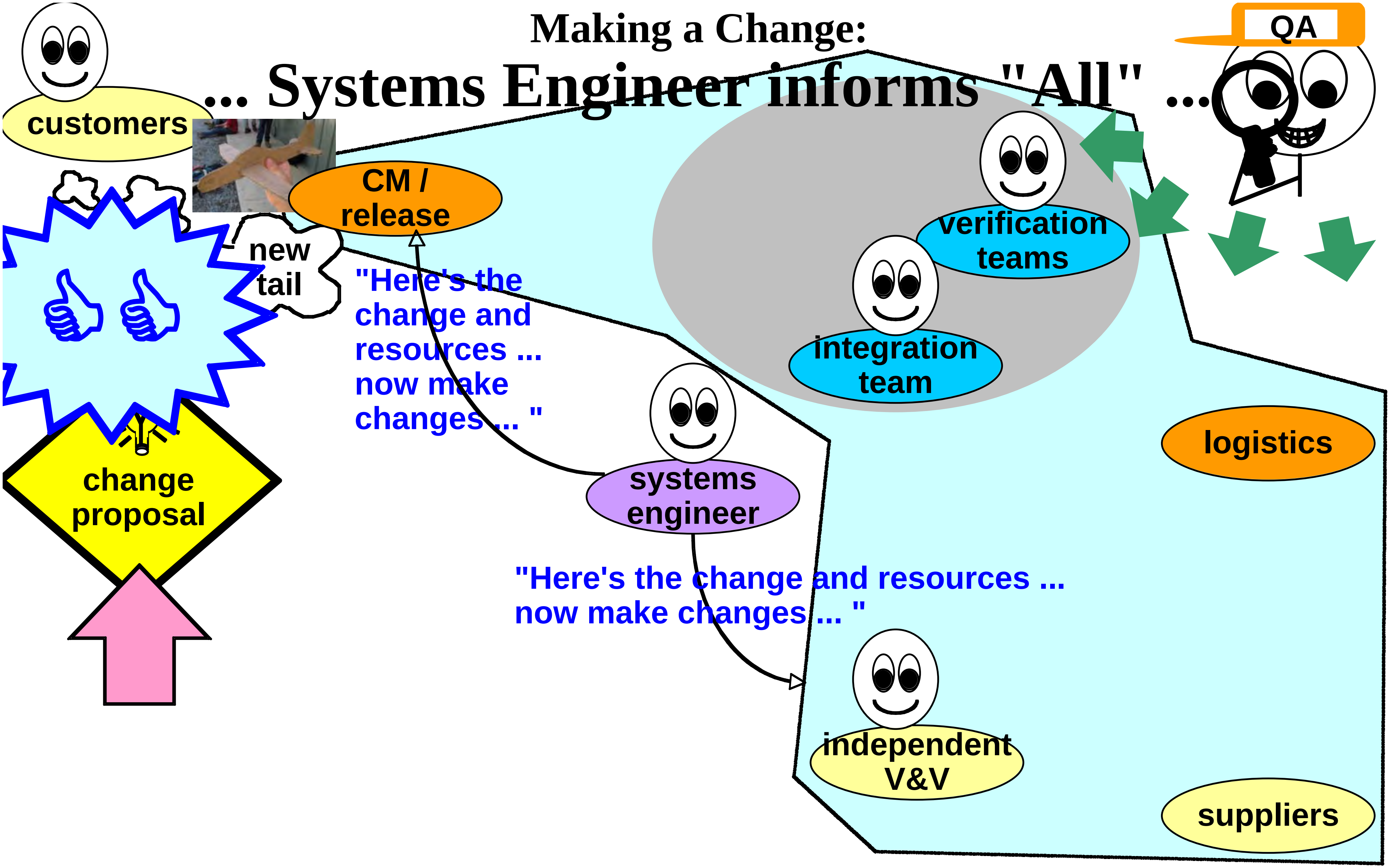
PROs / CONs
Benefits, dis-benefits
Values, dis-values

Making a Change:
Customer approves ...



Making a Change:

... Systems Engineer informs "All" ...



customers

new tail

CM / release

"Here's the change and resources ... now make changes ... "

change proposal

systems engineer

"Here's the change and resources ... now make changes ... "

QA

verification teams

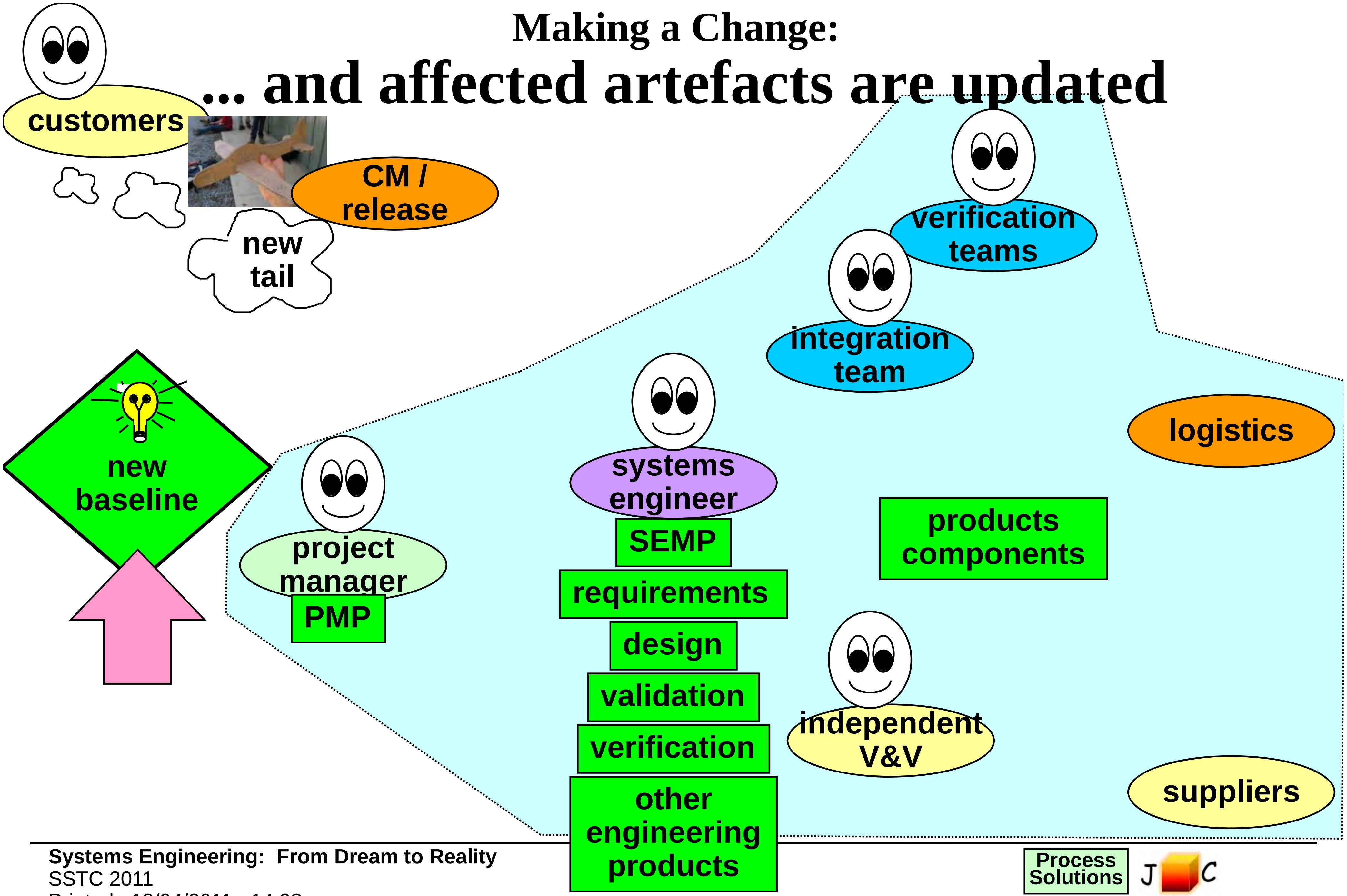
integration team

logistics

independent V&V

suppliers

Making a Change:
... and affected artefacts are updated



customers

new tail

CM / release

new baseline

project manager

PMP

systems engineer

SEMP

requirements

design

validation

verification

other engineering products

integration team

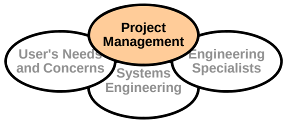
verification teams

products components

independent V&V

logistics

suppliers

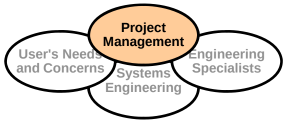


Summary

- **Systems Engineers require expertise in multiple disciplines**
- **Systems Engineers focus primarily on *<u>technical</u>***
  - **Functionality**
  - **Quality**
- **Systems Engineers collaborate with / supports Project Manager on *<u>governance</u>***
  - **Schedule**
  - **Budget**
- **Systems Engineers use their expertise to:**
  - **Integrate expertise of others**
  - **Negotiate with others**
- **Good Systems Engineers are rare; take time to develop; and "must-have" for successful projects**

Systems Engineering: From Dream to Reality

Role Play: Session 2



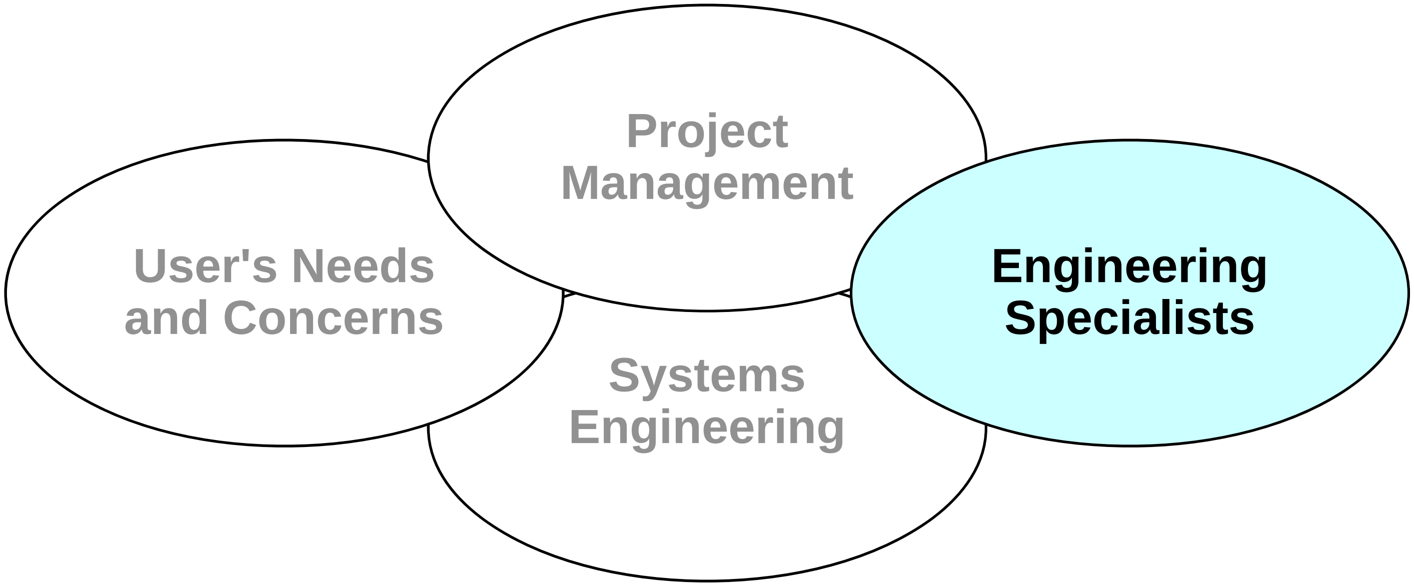
System's User's Needs and Concerns:

Role Play Session 2 Observations

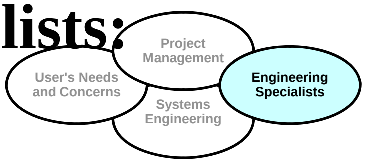
- Were you successful in your effort?
- How hard was it to maintain the projects technical schedule?
- How difficult was it to maintain technical schedule when impacted by overall project schedule?
- Any lessons learned

Systems Engineering: From Dream to Reality

Capabilities and Ambitions of the Engineering Specialists

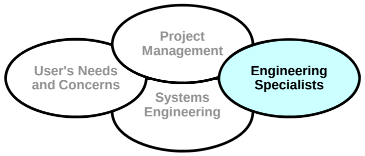


Capabilities and Ambitions of the Engineering Specialists: Agenda



- Where to Start
- The tools that you use
- The knowledge you need
- Your focus
- The canvas that you will create on

Are you a Good Engineer or a Bad Engineer?



Project Management

User's Needs and Concerns

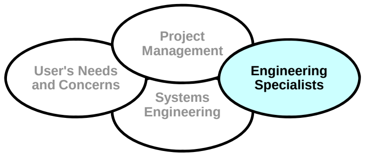
Engineering Specialists

Systems Engineering

- Business Process Engineer - Is your focus on the organization?
- Product Engineer - Is your focus on a product or product line?
- Software Engineer - Is the systems engineering just a new word for software engineering?

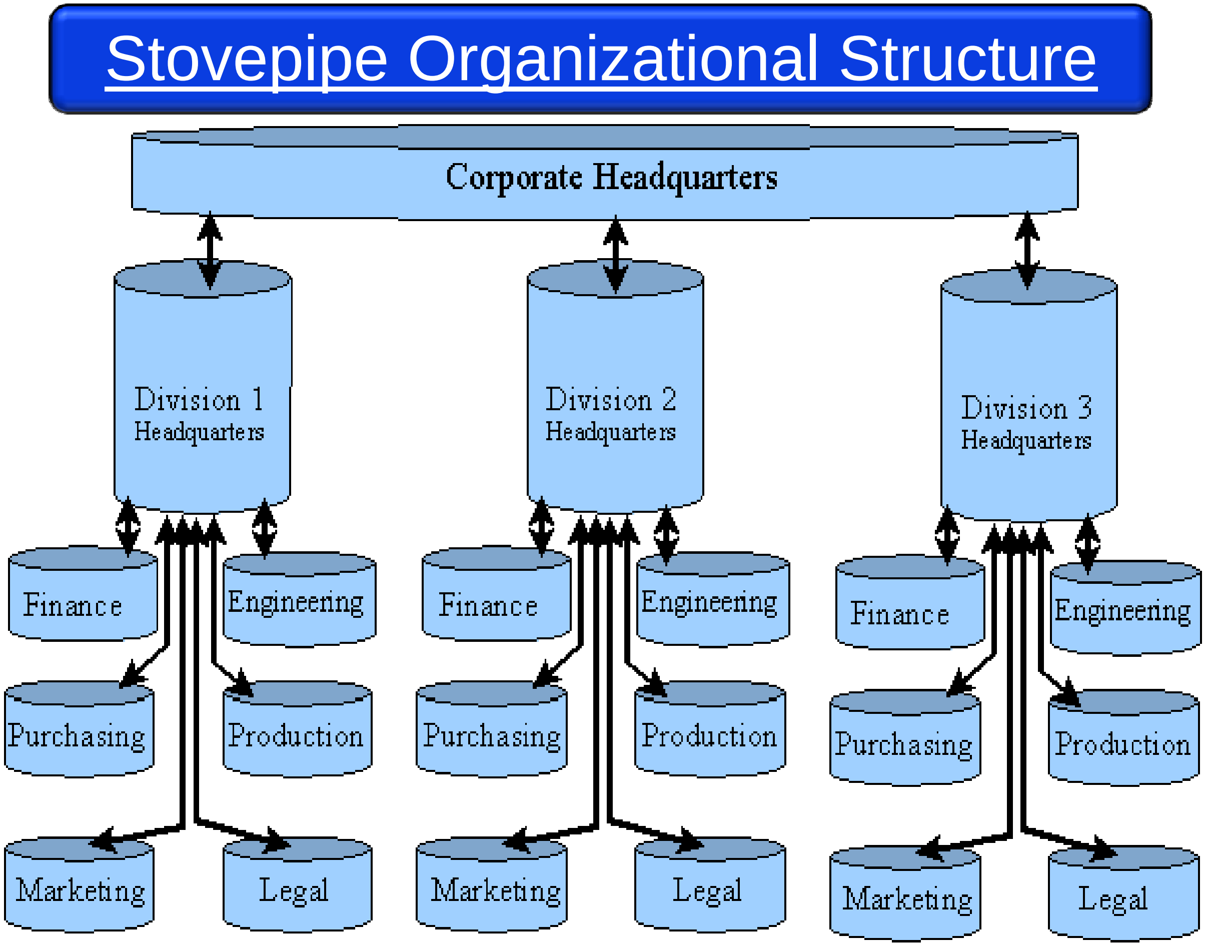
Software too early - "bad"

Systems Engineering first - "good"

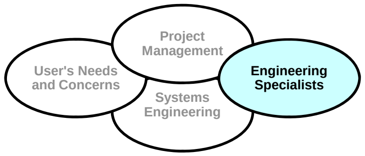


This is what you DON'T want!

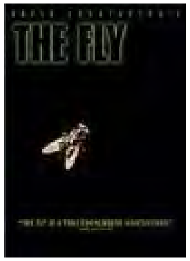
- **All information flows vertically, with no hope of horizontal integration.**
- **Disjoint processes, with no sharing of information.**
- **Cannot do data mining or data warehousing.**
- **No centralized resources to save time and money.**
- **Zero coupling, zero cohesion between applications.**



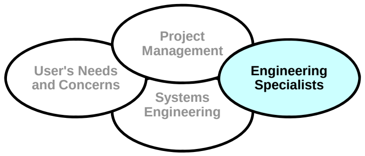
Focus on the organization (when practical!)



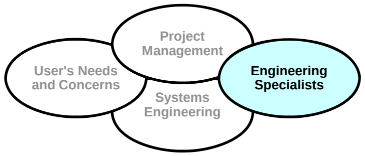
- **The Business Process Engineer works from the top down, focusing on the organizational needs.**
- **The Product engineer works from the bottom up, focusing on the software. Unless you are careful, this leads to stovepiping.**
- **Know what systems (vs. software) engineering is – "The *interdisciplinary* approach governing the total *technical and managerial* effort required to *transform* a set of customer *needs, expectations, and constraints (requirements)* into a product *solution*. It should allow for ease in supporting the solution throughout the product's life cycle."**



Be afraid, be very afraid of software engineering too early



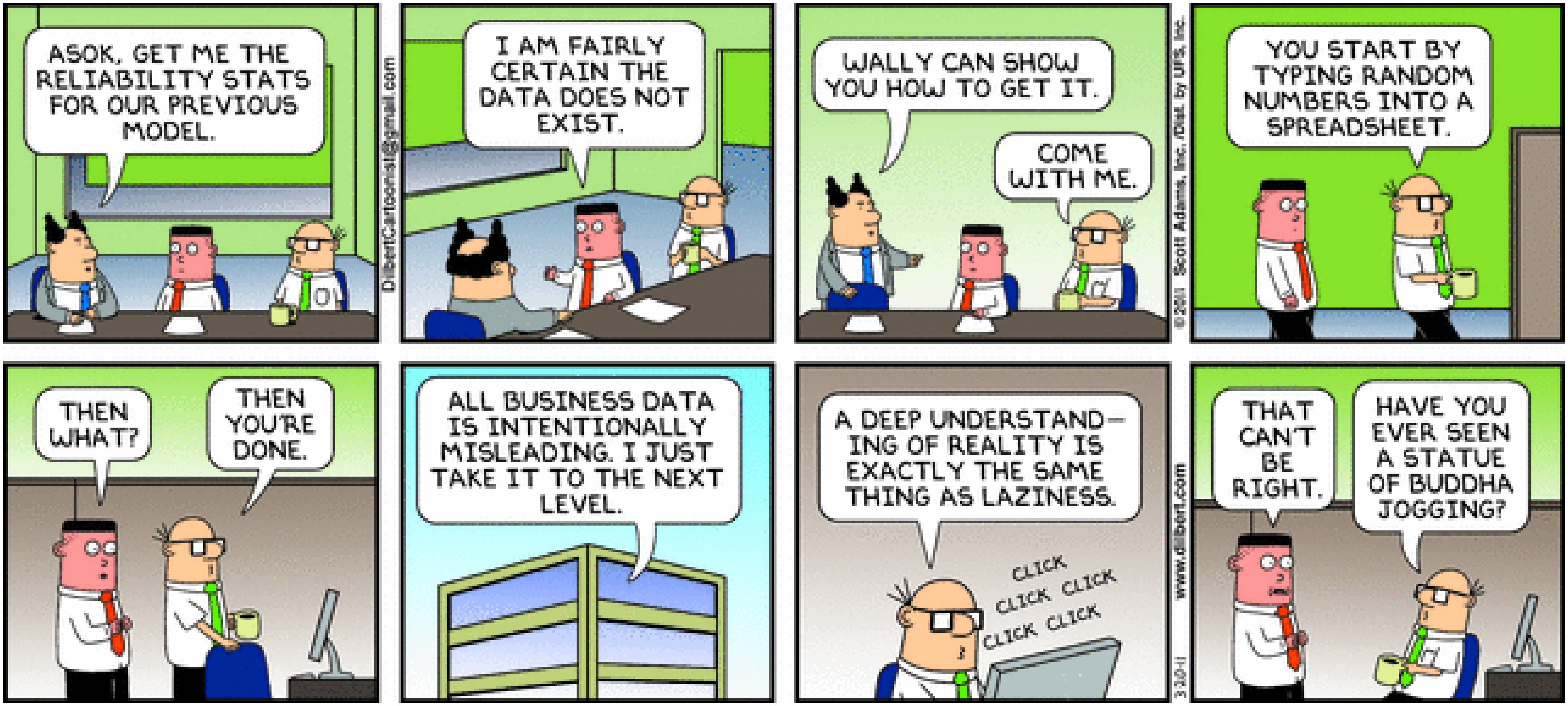
- **Focusing on software too early is bad - be wary of being too software oriented early on.**
- **"If all you have is a hammer, every problem is a nail." Unfortunately, - there are LOTS of different hammers. How do you know you are using the right hammer?**
- **Software is part of the SOLUTION - Make sure you understand the problem first!**



What matters is…

- As a Systems Engineer, you need to work to "reduce clutter" and provide organization
  - You need to practice the "Zen" of Engineering
  - You seek to provide structure and organization
  - Systems Engineering is focused on achieving ***simplicity*** in the midst of chaos
  - Work for a minimal solution - it will grow beyond recognition unless you work to minimize and simplify.

Understand that simplicity is hard work!


ASOK, GET ME THE RELIABILITY STATS FOR OUR PREVIOUS MODEL.
I AM FAIRLY CERTAIN THE DATA DOES NOT EXIST.
WALLY CAN SHOW YOU HOW TO GET IT.
COME WITH ME.
YOU START BY TYPING RANDOM NUMBERS INTO A SPREADSHEET.
THEN WHAT?
THEN YOU'RE DONE.
ALL BUSINESS DATA IS INTENTIONALLY MISLEADING. I JUST TAKE IT TO THE NEXT LEVEL.
A DEEP UNDERSTANDING OF REALITY IS EXACTLY THE SAME THING AS LAZINESS.
CLICK CLICK CLICK CLICK CLICK
THAT CAN'T BE RIGHT.
HAVE YOU EVER SEEN A STATUE OF BUDDHA JOGGING?
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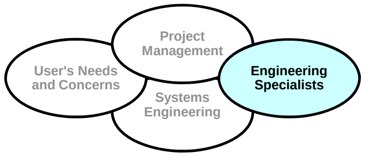
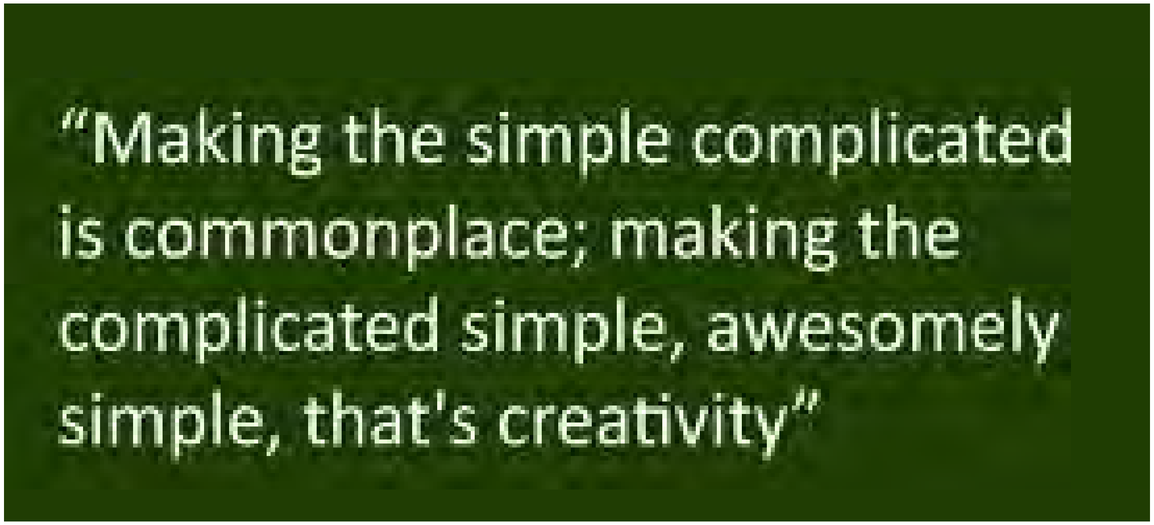


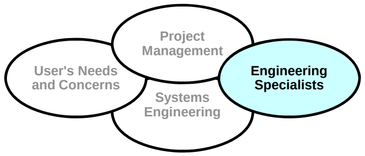
Good Systems Engineering requires vigilance against creeping requirements, solutions "bloat", and overly complex solutions

SIMPLICITY!


"Making the simple complicated is commonplace; making the complicated simple, awesomely simple, that's creativity"

WWWD?

What would Wally do?



Project Management

User's Needs and Concerns

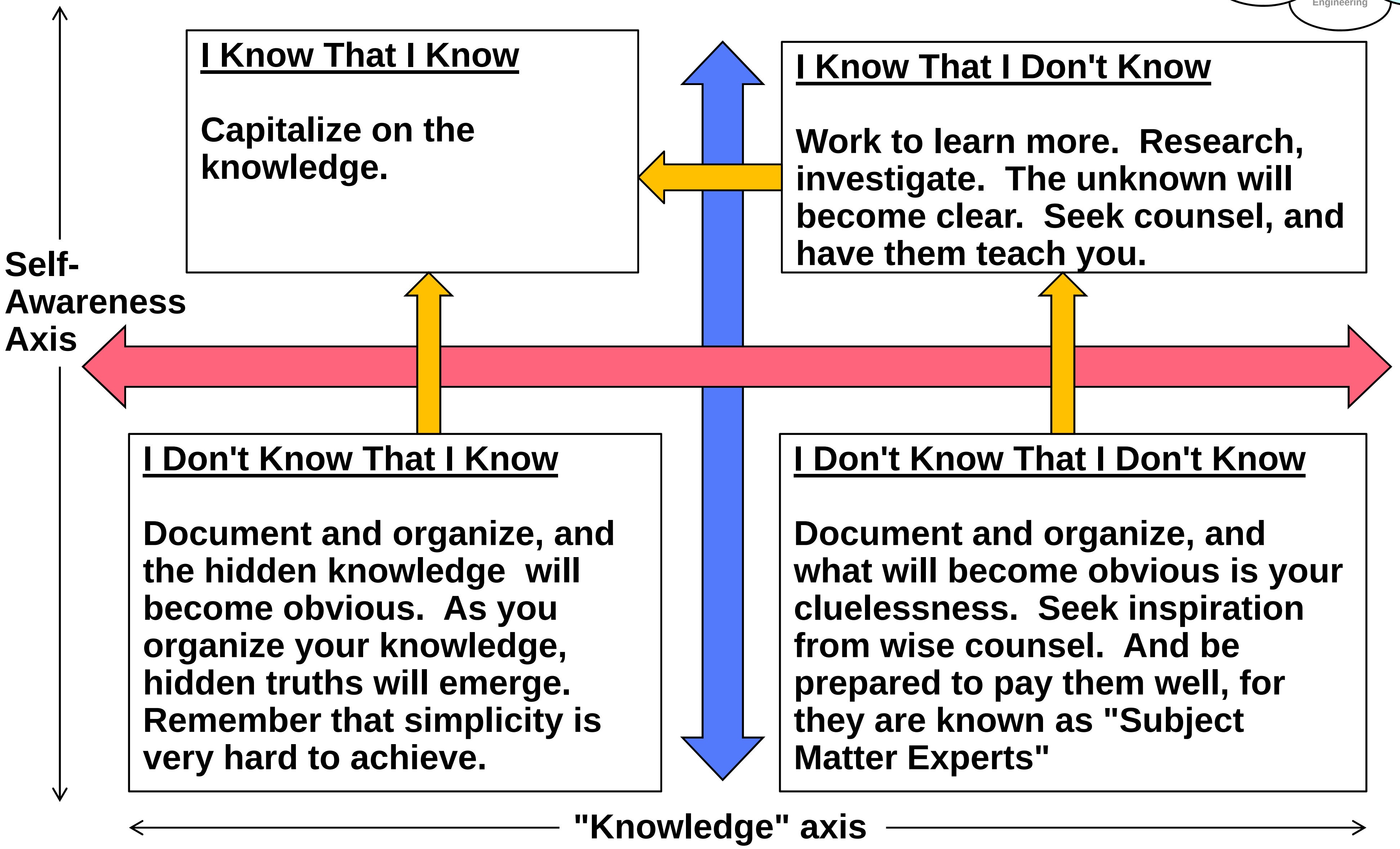
Engineering Specialists

Systems Engineering

Your Tools

- **Assumptions**
  - * **Learn to "Know what you Know" to reduce the number of possible solution**
- **Simplifications (a.k.a. Abstraction)**
  - * **Learn to "Think in the Large" or you will surely spend all of your days doing nothing**
- **Limitations**
  - * **Learn the limits of your system and your ability**
- **Constraints**
  - * **Learn what you have to work with - and "do no more" than necessary**
- **Preferences**
  - * **Know your customers. Know their requirements. Know their preferences for the solution. Know what they really need. Work to meet minimal needs.**

Your Knowledge



I Know That I Know

Capitalize on the knowledge.

I Know That I Don't Know

Work to learn more. Research, investigate. The unknown will become clear. Seek counsel, and have them teach you.

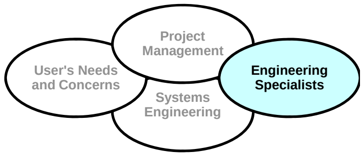
I Don't Know That I Know

Document and organize, and the hidden knowledge will become obvious. As you organize your knowledge, hidden truths will emerge. Remember that simplicity is very hard to achieve.

I Don't Know That I Don't Know

Document and organize, and what will become obvious is your cluelessness. Seek inspiration from wise counsel. And be prepared to pay them well, for they are known as "Subject Matter Experts"

Knowledge

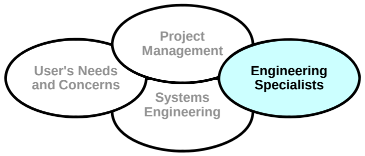

Project Management

User's Needs and Concerns

Engineering Specialists

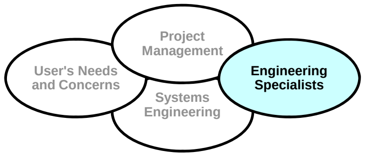
Systems Engineering

- You yourself need "just enough" subject matter knowledge. Find SMEs for what you don't need to know.
- You need to know and understand the tools and techniques you will be using. You don't need to be an tools expert - that's what the new engineers are for!
- You need to be able to think logically.
- You need to be able to discard useless knowledge and save useful knowledge - and the intelligence to discern the difference.



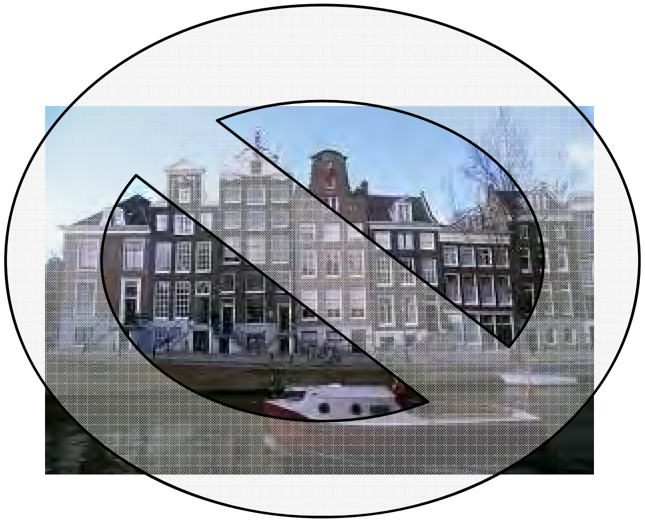
Your Canvas

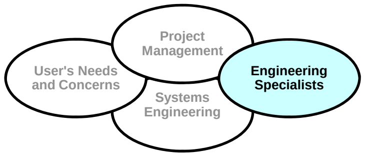
- Architectural Engineering
- Scenario or User-based Viewpoints
- Interface Engineering
- Data Engineering



Architectural Engineering

- **Learn how to soar like an Eagle, and check out the view at 50,000 feet**
- **Use appropriate techniques to effectively organize the system.**
- **Scenarios and use cases provide focus, and allow for different viewpoints**




Project Management

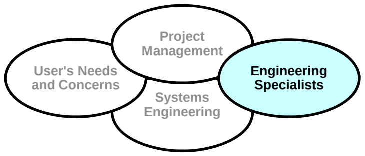
User's Needs and Concerns

Engineering Specialists

Systems Engineering

Viewpoints

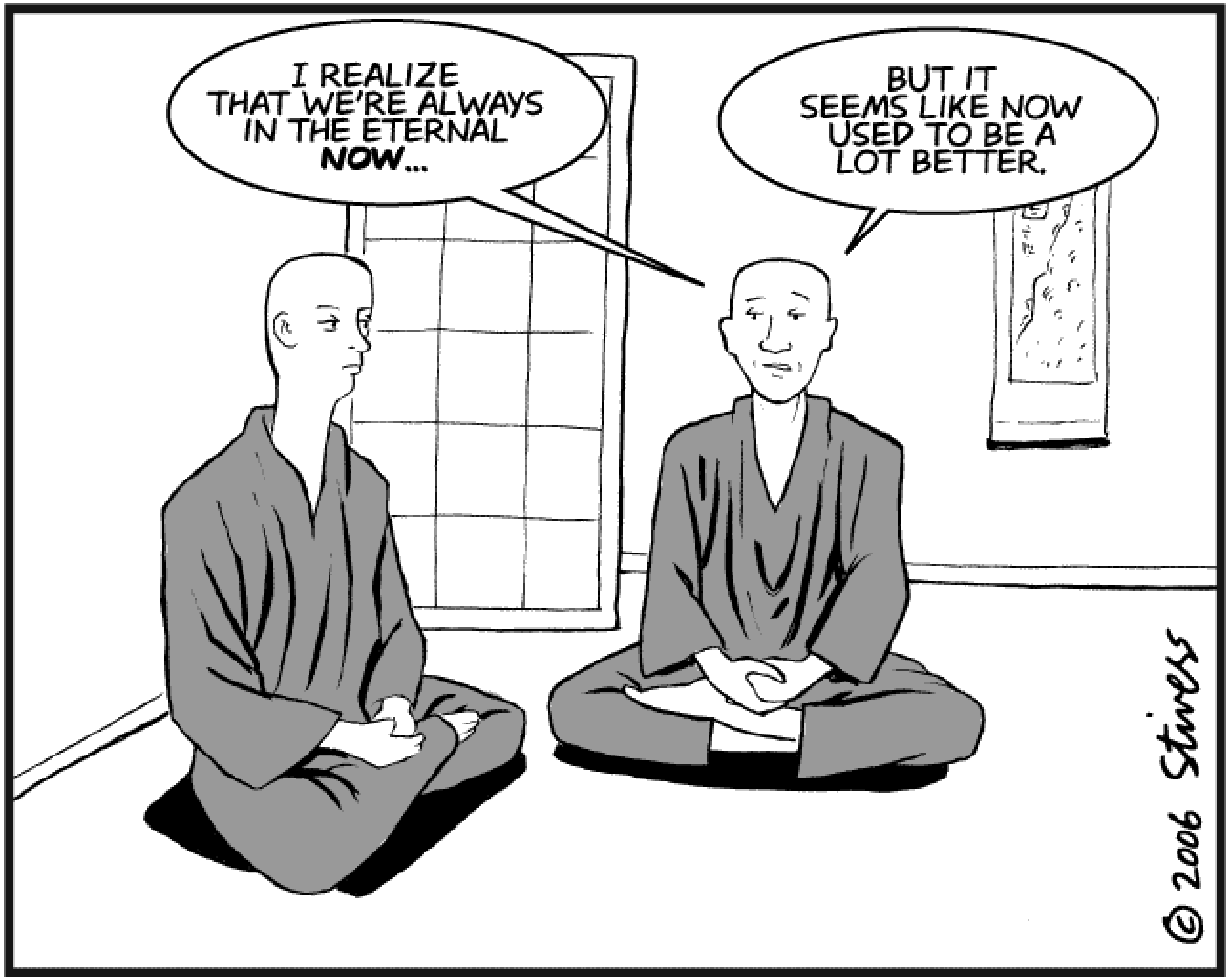
- All systems appear different when viewed from different perspectives.
- Aim to integrate perspectives, so that all viewpoints are correct and consistent (but NOT complete.)
- All viewpoints will be incomplete. This is a limitation of techniques and the understanding of classes of users.
- A "Zen Master" Systems Engineer knows that every viewpoint, while incomplete, is still valid and useful. The totality of all viewpoints represents reality.

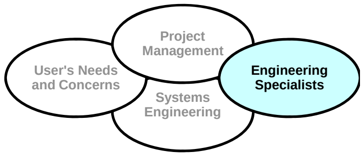


Interface Engineering

- Use the knowledge you have to define how your system will fit into
  - …Other business products
  - …The overall business objectives
  - …Supporting systems - both from an input and output perspective

What does a Zen Master want when he orders a pizza?


I REALIZE THAT WE'RE ALWAYS IN THE ETERNAL NOW...
BUT IT SEEMS LIKE NOW USED TO BE A LOT BETTER.
© 2006 Stivers


Project Management

User's Needs and Concerns

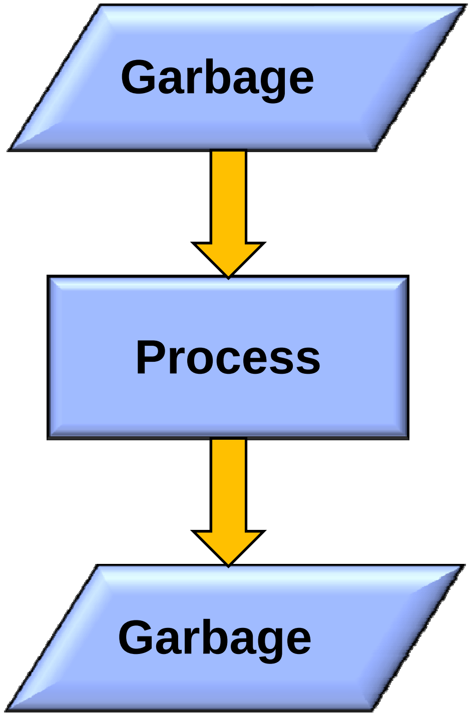
Engineering Specialists

Systems Engineering

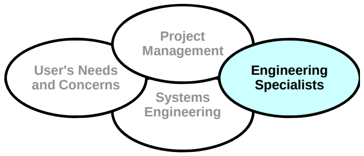
Data ain't what it used to be.

Data Engineering

- The size and complexity of data makes systems engineering hard.
- Know your inputs. Know the provenance of your data. And then assume it has errors anyway.
- "Scrub" your outputs for accuracy.
- Remember the "Data Processing Golden Rule" - ***create output for others as you want input created for you***.



Points to Ponder

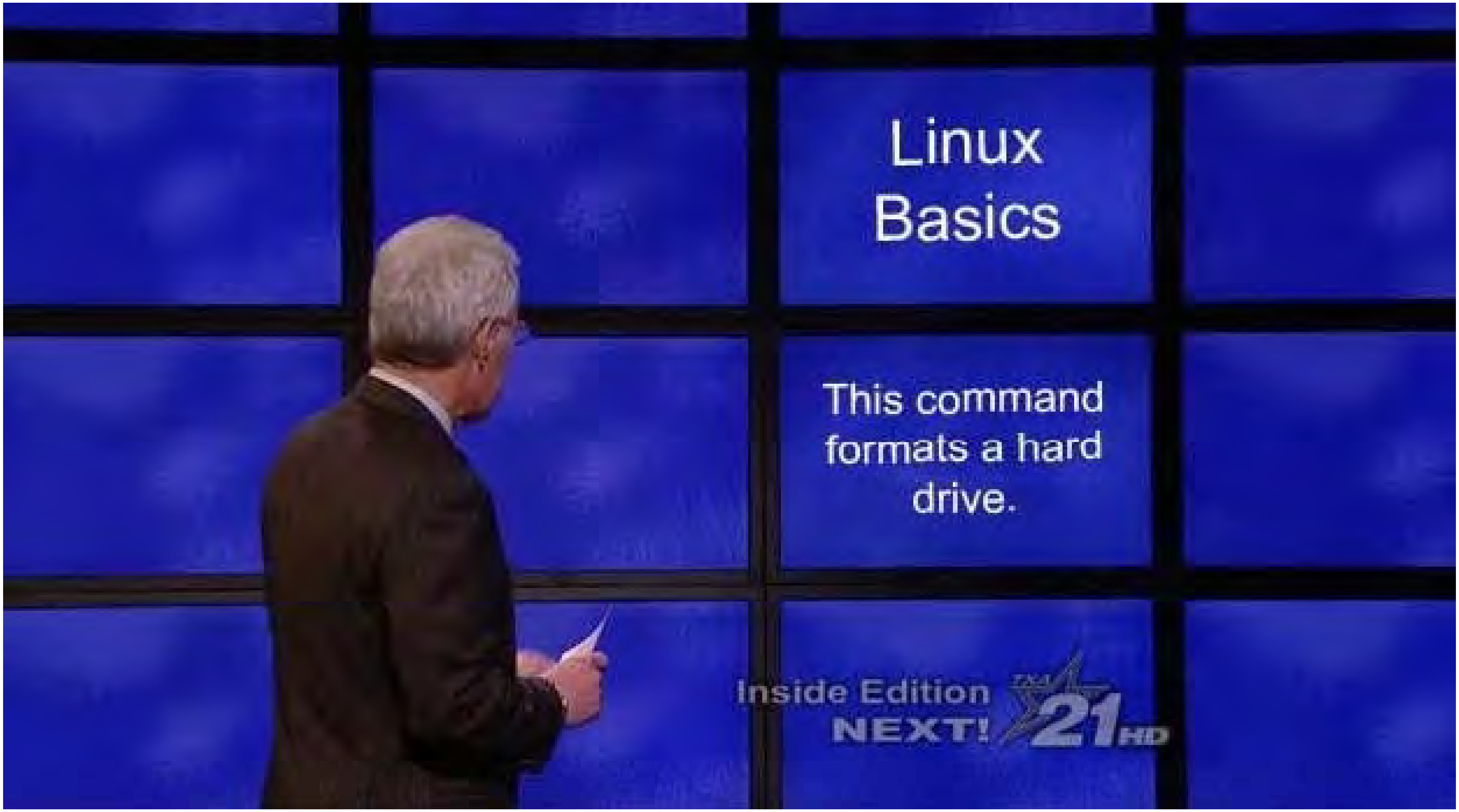


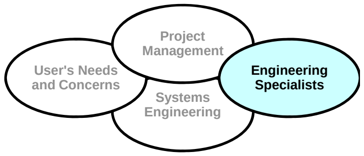
- A "Zen Master Systems Engineer" works first to organize the system structure, and then works to simplify the system and find the "right approach".
- The "right approach" usually comes after multiple "wrong approaches".
- The "right approach" is usually an "Ah Ha!" moment. It will present itself as simple and elegant. It requires you to fully "grok" how everything fits together.

***grok* – to understand so fully that you are "one with the system"**

"Do or do not... *there is no try"*

The "right approach" sometimes means asking "the right question"





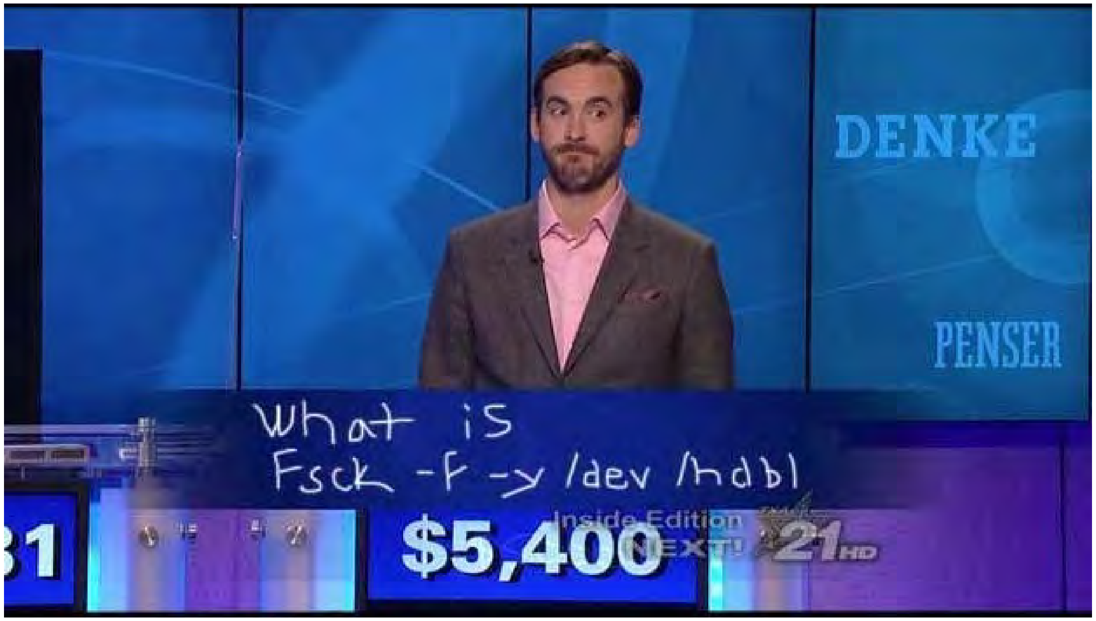
User's Needs and Concerns

Project Management

Engineering Specialists

Systems Engineering

What is
Fsck -f -y /dev/hdbl

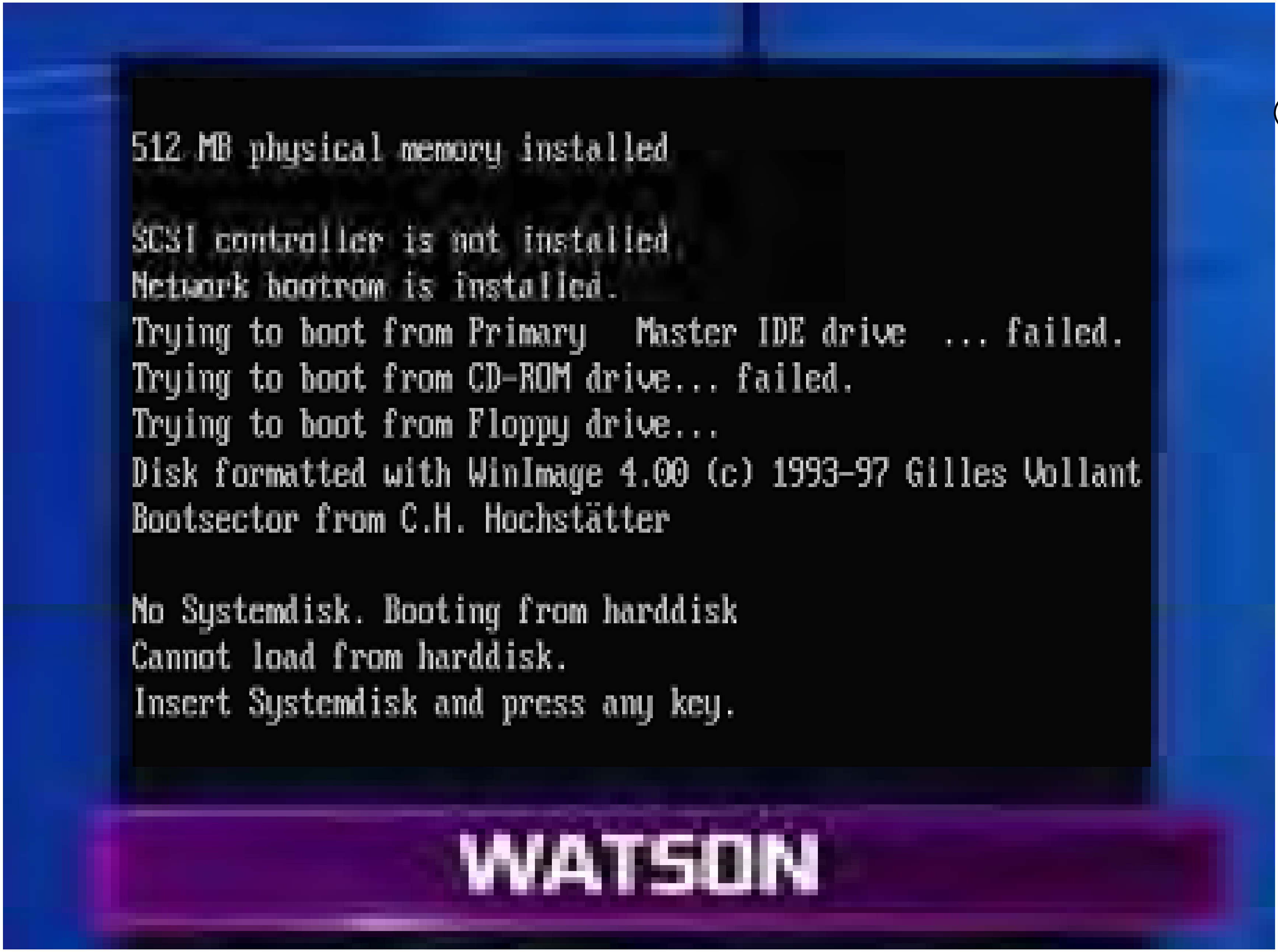


What is
Fsck -f -y /dev /hdbl

```
512 MB physical memory installed

SCSI controller is not installed.
Network bootrom is installed.
Trying to boot from Primary  Master IDE drive  ... failed.
Trying to boot from CD-ROM drive... failed.
Trying to boot from Floppy drive...
Disk formatted with WinImage 4.00 (c) 1993-97 Gilles Vollant
Bootsector from C.H. Hochstätter

No Systemdisk. Booting from harddisk
Cannot load from harddisk.
Insert Systemdisk and press any key.
```



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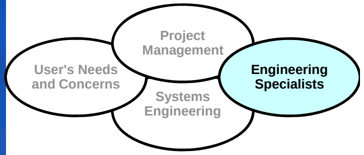


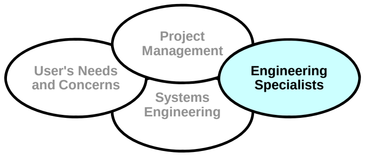
User's Needs and Concerns

Project Management

Engineering Specialists

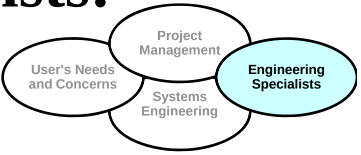
Systems Engineering

Capabilities and Ambitions of the Engineering Specialists:
Summary



- Systems engineers can start from either a product or process perspective – a business process perspective is better and has fewer risks
- The tools used to help in this process are
  - Assumptions
  - Simplifications
  - Limitations
  - Constraints
  - Preferences
- The canvas you have to draw upon are
  - Architectural viewpoints
  - Interface viewpoints
  - Data viewpoints

Capabilities and Ambitions of the Engineering Specialists: Summary



- Above all, be aware of what you know, and of what you do not know.
- Do not be wary of asking for help - that is what Subject Matter Experts are for.
- Use viewpoints - but be aware than each one is a partial solution. It's more important to be able to organize your knowledge than to know everything!
- Realize that the "one true solution" is probably made up of many smaller, incomplete solutions that have to be merged.
- Focus on simplicity - inside of every complex problem, there is an inherently simple solution trying to get out.

KNOWLEDGE + VIEWPOINTS + TOOLS + CANVAS

=

THE SIMPLEST SYSTEM THAT MEETS CRITICAL USER NEEDS

The "Zen" of Systems Engineering

- In Zen Buddhism, students meditate on koans to help focus their mind and encourage "enlightment".
- A koan is a fundamental part of the history and lore of Zen Buddhism. It consists of a story, dialogue, question, or statement, the meaning of which cannot be understood by rational thinking but may be accessible through intuition.
- It is also defined as a nonsensical or paradoxical question or statement to a student, in which process of attempting to understand is often illuminating.

"Two hands clap and there is a sound; what is the sound of one hand clapping?"

Software koans to meditate on

"Make everything as simple as possible, but not simpler" - Albert Einstein

"Simplicity hinges as much on cutting nonessential features as on adding helpful ones." - Walter Bender

"Even for expert users things should be simple" - Jason Fried

"Simplicity and repose are the qualities that measure the true value of any work of art." - Frank Lloyd Wright

"I don't think I've ever seen a piece of commercial software where the next version is simpler rather than more complex." - Walter Bender, Executive Director of the MIT media lab.

THERE'S NO REASON TO BE STRESSED, ALICE.
ALLOW ME TO BE YOUR ROLE MODEL.
I REMAIN CALM DESPITE THE PRESSURE OF IMPOSSIBLE DEADLINES.
THAT'S BECAUSE YOU HAVE NO PRIDE AND NO AMBITION!
I'VE WORKED DAY AND NIGHT TO MAKE THIS DEAD-LINE!
AND WHEN I SUCCEED, THE GLORY WILL BE MINE!
OUR NEW VP JUST CANCELED THE PROJECT SO THE LAST VP WOULD LOOK BAD.
THEY SAY THAT WHEN THE STUDENT IS READY, THE MASTER WILL APPEAR.
© 1999 United Feature Syndicate, Inc.

Simplicity is the ultimate sophistication – Leonardo da Vinci

Systems Engineering: From Dream to Reality

Role Play: Session 3

Systems Engineering:
From Dream to Reality

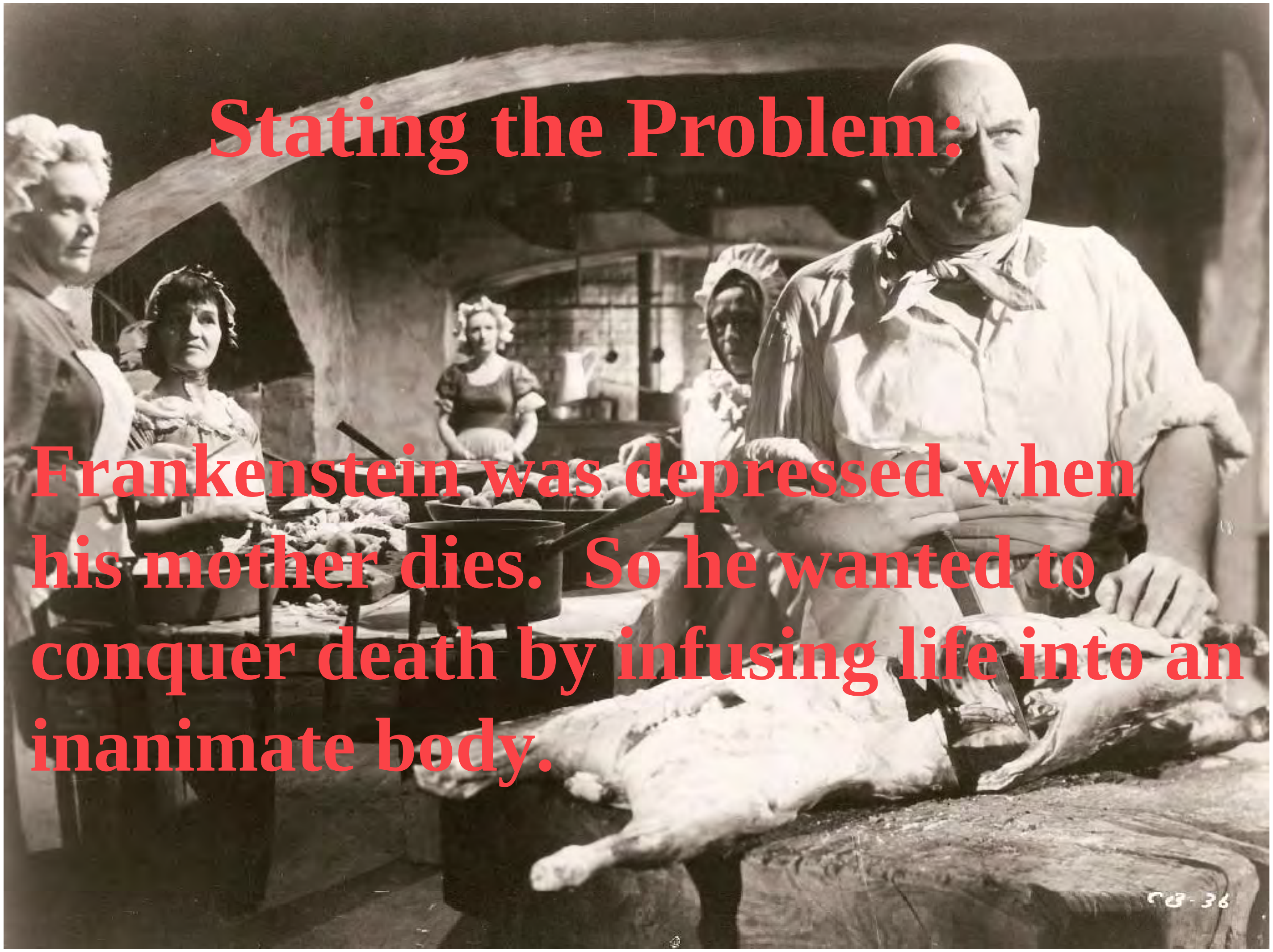
Epilogue, Wrap-Up, and Questions

Epilogue

Was Victor Frankenstein a good systems engineer?

Systems Engineering: From Dream to Reality

Epilogue (2)



Stating the Problem:

Frankenstein was depressed when his mother dies. So he wanted to conquer death by infusing life into an inanimate body.

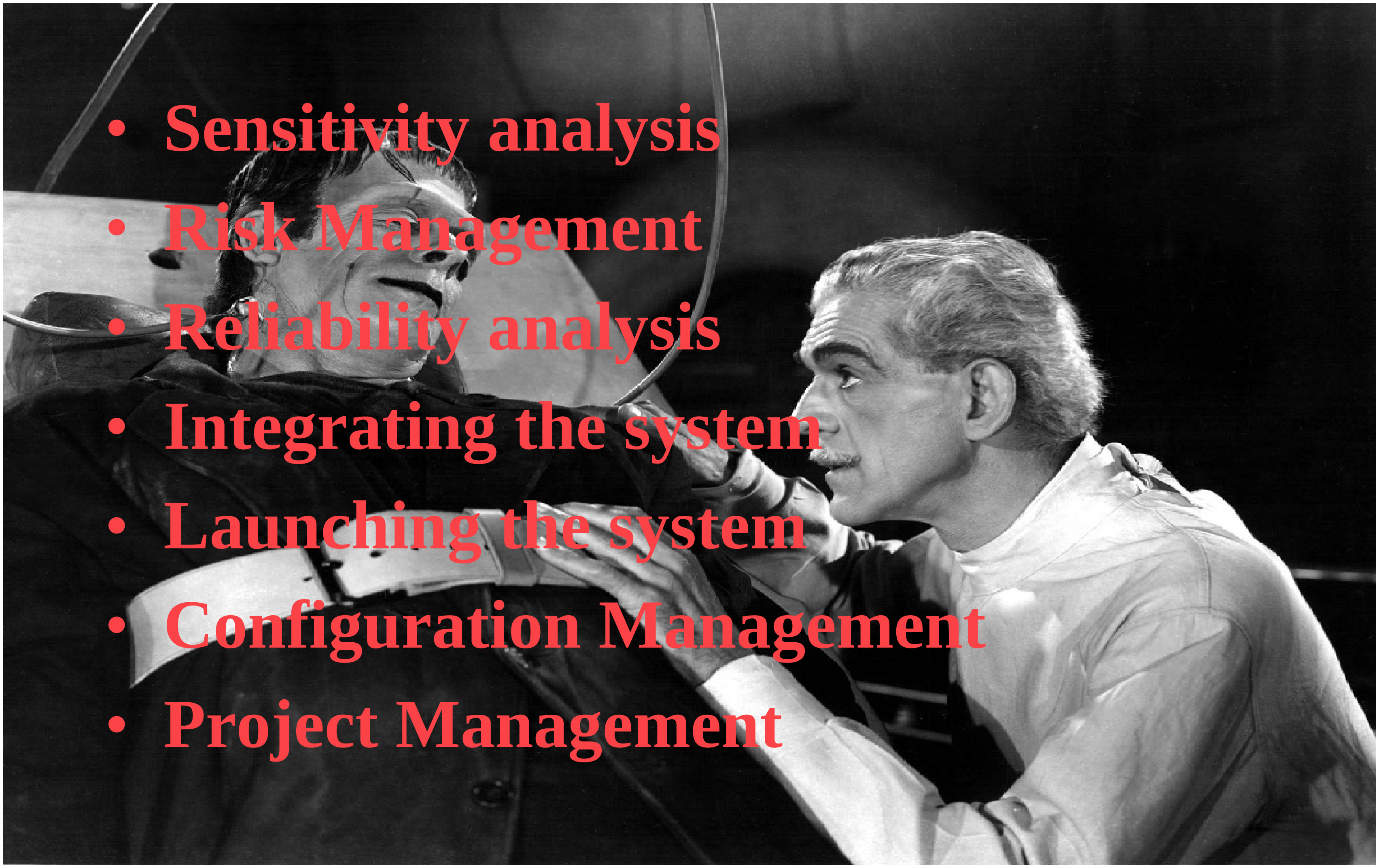
Systems Engineering: From Dream to Reality

Epilogue (3)

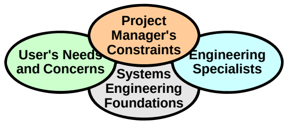
- Understanding customer needs
- Discovering systems requirements
- Validating requirements
- Investigating alternatives
- Defining quantitative measures
- Modeling the system
- Functional analysis
- Systems Design

Systems Engineering: From Dream to Reality

Epilogue (4)

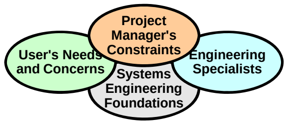


- Sensitivity analysis
- Risk Management
- Reliability analysis
- Integrating the system
- Launching the system
- Configuration Management
- Project Management


Project Manager's Constraints
User's Needs and Concerns
Engineering Specialists
Systems Engineering Foundations

Epilogue (4)

- Documentation
- Leading teams
- Assessing performance
- Re-evaluating and improving quality


Project Manager's Constraints
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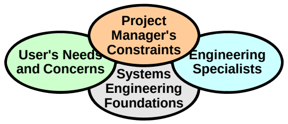
Epilogue (5)

- **System Engineering is responsible for making sure all of these tasks are performed in an engineering environment. However, the System Engineering process must be tailored for each project. Often this means omitting certain tasks, which reduce cost but increases risk. If you choose to omit one of these tasks, you should ask yourself,**

Why?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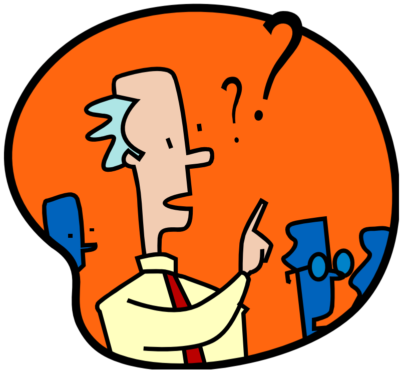
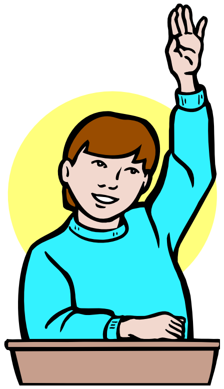
Wrap-Up

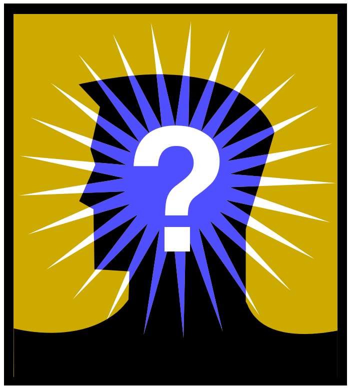
- Foundations of Systems Engineering
- System's User's Needs and Concerns
- Project Manager's Financial and Schedule Constraints
- Capabilities and Ambitions of the Engineering Specialist

Systems Engineering: From Dream to Reality

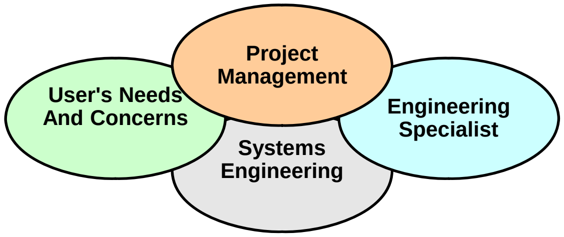


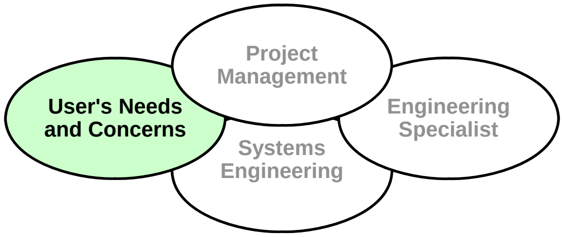


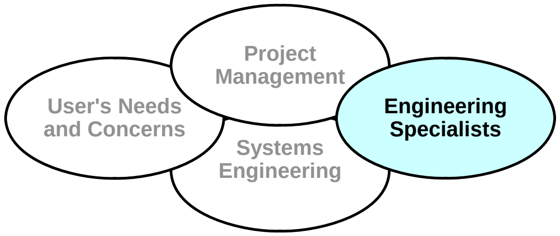
Questions

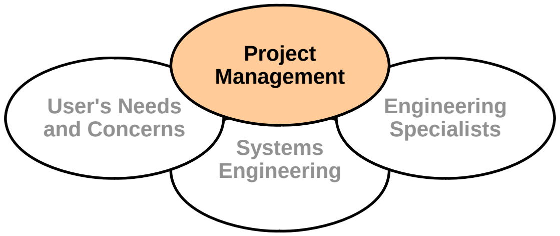


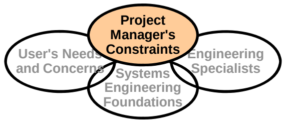
Acronyms and Bibliography







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Acronyms

ARC:	Assumption, Risk, Constraint
CCB:	Change Control Board
CI:	Configuration Item
CM:	Configuration Management
IQA:	Internal Quality Audit
PMP:	Project Management Plan
QA:	Quality Assurance
SEMP:	Systems Engineering Management Plan
SOW:	Statement of Work
V&V:	Verification and Validation

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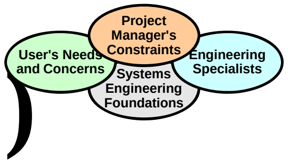
Systems Engineering: Evaluation (1)


Project Manager's Constraints
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(1) How relevant was the workshop content to your job?

not relevant	just right	very relevant

(1.1.) Which sections were particularly relevant?

(1.2.) Which sections were not as relevant?

(2) How was the pacing of this workshop?

too slow	just right	too fast

(2.1.) Which sections would you recommend be:

(2.1.1.) shortened?

(2.1.2.) lengthened?

(2.1.3.) added?

(2.1.4.) deleted?

(2.1.5.) kept (these were really valuable)?

(3) How well did the workshop materials work for you?

not at all	just right	extremely well

(3.1.) How can we improve them?

Systems Engineering: Evaluation (2)

not at all — just right — very much

(4.) How well did exercises and discussions help you understand the materials?

(5.) How good a use of your time was this workshop? Why? Why not?

(6.) Do you plan to use these ideas in your current project / team / organisation? Why not?

no, none — maybe, some — yes, many

(6.1.) How well prepared do you think you are to:

not at all — OK — very well

(6.1.1.) apply them within your organisation?

(6.1.2.) participate in systems engineering activities?

(6.1.3.) lead / coach systems engineering activities?

(6.2.) What type of assistance would you like to have as you tailor, use, practice, roll-out these systems engineering techniques?

(6.3.) What major concerns do you have about using these techniques? about introducing / adapting them within your organisation?

(7.) Any overall comments you'd like to share ...