UNIVERSITY OF TRENTO

ICT Innovation – Spring 2018

MSc in Computer Science and MEng Telecom. Engineering
EIT Masters ITA, S&P,SDE
Master in Innovation Management

Lecture 02 – Product Design and Development

Prof. Fabio Massacci

Tyco (now TE connectivity) Product Lifecycle

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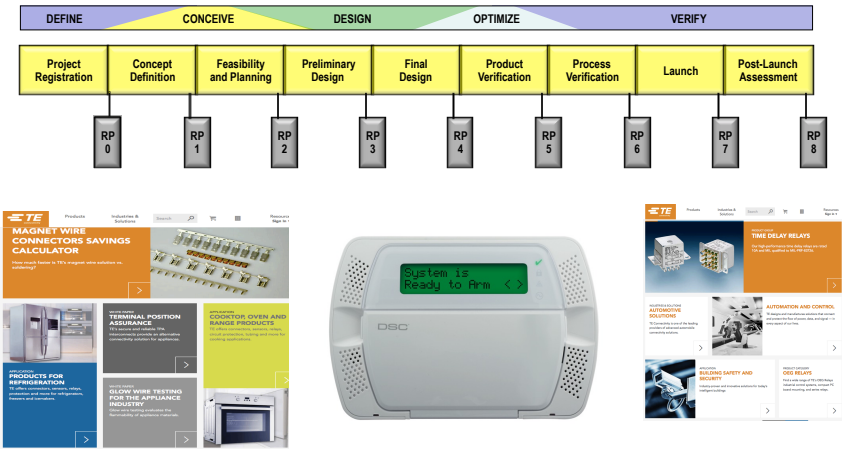

Product Lifecycle from TE

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#	PDD Step	Key Objectives
1	Project Registration	Define project and business unit needs
2	Concept Definition	Develop project concept and charter
3	Feasibility and Planning	Create product description
4	Preliminary Design	Create preliminary detailed design
5	Final Design	Detail and optimize design
6	Product Verification	Demonstrate product performance
7	Process Verification	Demonstrate process performance
8	Launch	Self-explanatory
9	Post-Launch Assessment	Identify lessons learned

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Product Design, Developement and Launch

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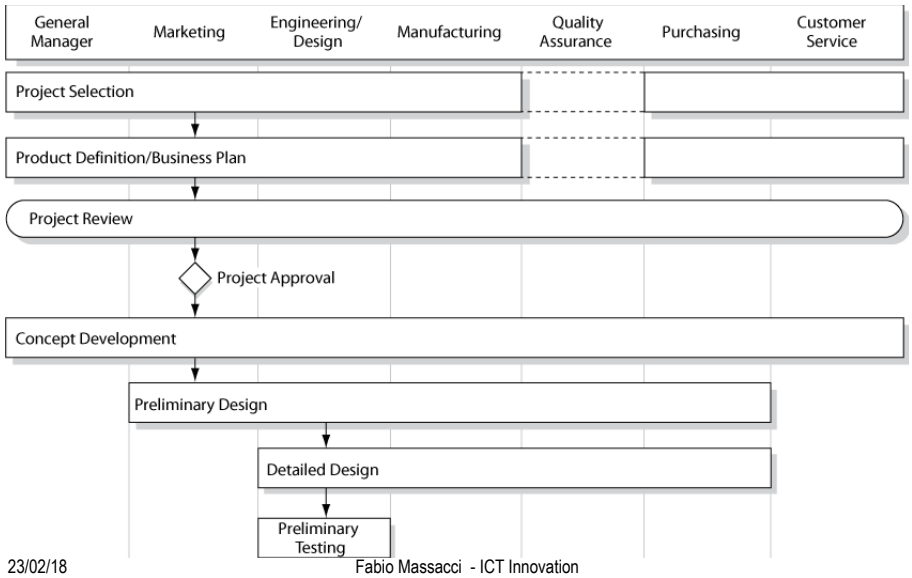

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Product Design, Developement and Launch

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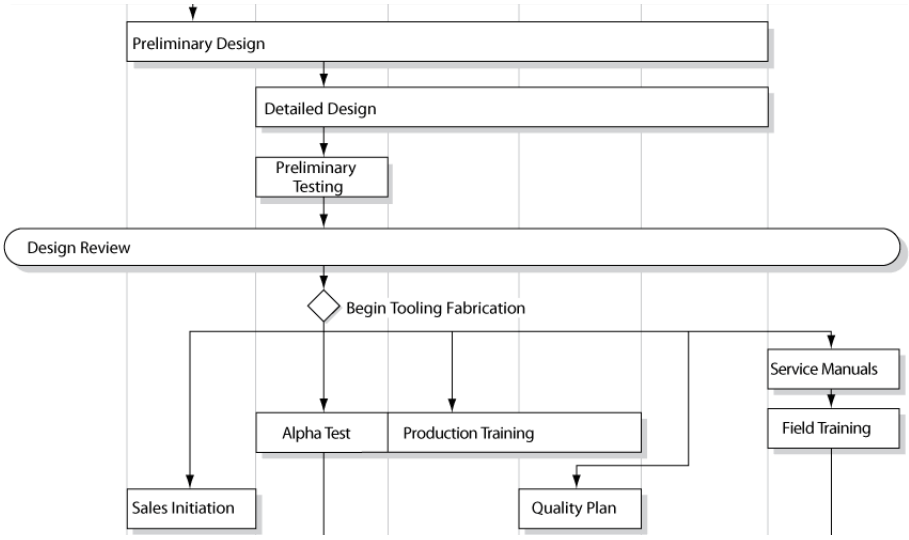

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Product Design, Developement and Launch

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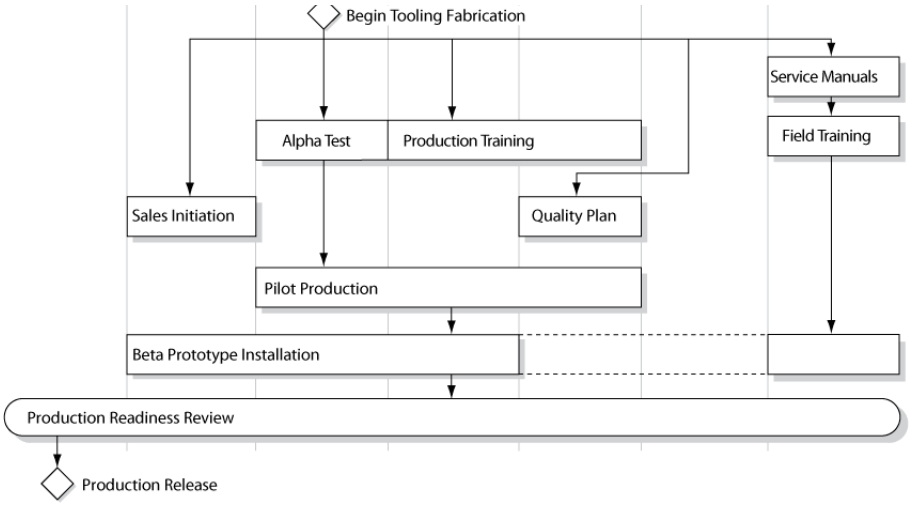

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

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Who will do what?

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- **Several roles required for the production of a product**
  - General Management
  - Marketing
  - Engineering
  - Manufacturing
  - Quality Assurance
  - Purchasing
  - Customer Services
- **They occurrs at most phases of the product development lifecycle**

Tyco's Process in one slide

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Rally Point Phase	0. Project Registration	1. Concept Definition	2. Feasibility and Planning	3. Preliminary Design	4. Final Design	5. Product Verification	6. Process Verification	7. Launch	8. Post-Launch Assessment
Primary Goal	Define project and business unit needs	Develop project concept and charter	Create product description	Create preliminary detailed design	Detail and optimize design	Demonstrate product performance	Demonstrate process performance	Launch product	Identify lessons learned
Marketing and Sales	Identify customers and market size	Capture voice of the customer	Develop marketing and sales plans	Review concepts with customer		Initialize field trials	Complete field trials	Finalize pricing and sales forecasts	Solicit customer feedback and satisfaction ratings
	Describe competitive features and benefits	Analyze customer needs	Create phase-in and phase-out plans				Finalize training plans	Complete sales and service training	Measure sales vs. forecast
	Identify target cost and price	Document customer needs							Complete phase-in and phase-out
Engineering	Identify project risks	Identify critical-to-quality specs	Create functional specification and performance metrics	Conduct a preliminary design review	Freeze hardware and software design	Finalize design documentation	Obtain regulatory approvals	Finalize product metrics	
		Develop and select concepts	Review concept selection	Build and test alpha prototypes	Complete engineering documentation	Complete beta prototype and field testing			
		Update project risks	Define product architecture	Assess product failure modes	Draft technical documentation	Apply for regulatory approvals			
			Assess technical failures modes		Secure beta prototypes				
Quality Assurance			Create preliminary test plan		Test beta prototypes for robustness	Complete quality assurance testing	Conduct process verification testing		
Manufacturing				Begin manufacturing process development	Finalize bill of materials (BOM)	Update manufacturing control plans	Run manufacturing pilots		Register obsolete and scrap products
				Conduct a preliminary manufacturing process review	Develop manufacturing control plans		Finalize manufacturing control plans		
Purchasing				Create a supplier participation matrix	Identify long lead-time items		Verify supply chain readiness		
				Assess suppliers for certification					
Legal		Search patents	Identify trade compliance issues	Identify potential patents	Prepare patent applications	Assure trade compliance			
Financial	Prepare preliminary business case	Refine business case	Complete financial package						Monitor return on investment
Project Management	Identify project timing, resources, and capital	Assess team capabilities/skills	Plan integrated product development schedule	Update RP1-2 deliverables	Update RP1-3 deliverables	Update RP1-4 deliverables	Update RP1-5 deliverables	Finalize all deliverables	Document best practices
	Prepare RP0 checklist & submit for approval	Identify development team members	Assign a project manager	Prepare RP3 checklist & submit for approval	Prepare RP4 checklist & submit for approval	Prepare RP5 checklist & submit for approval	Prepare RP6 checklist & submit for approval	Finalize launch plans and documentation	Prepare RP8 checklist & submit for approval
		Select a Rally Point process variant	Update RP1 deliverables					Update RP1-6 deliverables	
		Prepare RP1 checklist & submit for approval	Prepare RP2 checklist & submit for approval					Prepare RP7 checklist & submit for approval	

Tyco's Process a bird's eye view

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Rally Point Phase	0. Project Registration	1. Concept Definition	2. Feasibility and Planning	3. Preliminary Design	4. Final Design	5. Product Verification	6. Process Verification	7. Launch
Marketing and Sales	XXX	XXX	XX	X		X	XX	XX
Engineering	X	XXX	XXXX	XXX	XXXX	XXX	X	X
Quality Assurance			X		X	X	X	
Manufacturing			XX	XX	X	XX		
Purchasing			XX	X		X		
Legal		X	X	X	X	X		
Financial	X	X	X					

What Marketing People Do?

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#	PDD Step	Key Objectives
1	Project Registration	Identify customers and market size, Describe competitive features and benefits, Identify target cost and price
2	Concept Definition	Capture voice of the customer, Analyze customer needs, Document customer needs
3	Feasibility & Planning	Develop marketing and sales plans, Create phase-in and phase-out plans
4	Preliminary Design	Review concepts with customer
5	Final Design	....
6	Product Verification	Initialize field trials
7	Process Verification	Complete field trials, Finalize training plans
8	Launch	Finalize pricing & sales forecasts, Complete sales & service training
9	Post-Launch Assessment	Solicit customer feedback and satisfaction rates, Measure sales vs. forecast, Complete phase-in and phase-out

What Engineering People Do?

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#	PDD Step	Key Objectives
1	Project Registration	Identify project risks
2	Concept Definition	Identify critical-to-quality specs, Develop and select concepts, Update project risks
3	Feasibility & Planning	Create functional specification & performance metrics, Review concept selection, Define product architecture, Assess technical failures modes
4	Preliminary Design	Conduct a preliminary design review, Build and test alpha prototypes, Assess product failure modes
5	Final Design	Freeze hardware and software design, Complete engineering documentation, Draft technical documentation, Secure beta prototypes
6	Product Verification	Finalize design documentation, Complete beta prototype and field testing, Apply for regulatory approvals
7	Process Verification	Obtain regulatory approvals
8	Launch	Finalize product metrics
9	Post-Launch Assess.	

Marketing vs Engineering

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1. Identify customers and market size, Describe competitive features and benefits, Identify target cost and price
2. Capture voice of the customer, Analyze customer needs, Document customer needs
3. Develop marketing and sales plans, Create phase-in and phase-out plans
4. Review concepts with customer
5. …
6. Initialize field trials
7. Complete field trials, Finalize training plans
8. Finalize pricing and sales forecasts, Complete sales and service training
9. Solicit customer feedback and satisfaction rates, Measure sales vs. forecast, Complete phase-in/out

1. Identify project risks
2. Identify critical-to-quality specs, Develop and select concepts, Update project risks
3. Create functional specification and performance metrics, Review concept selection, Define product architecture, Assess technical failures modes
4. Conduct a preliminary design review, Build and test alpha prototypes, Assess product failure modes
5. Freeze hardware and software design, Complete engineering documentation, Draft technical documentation, Secure beta prototypes
6. Finalize design documentation, Complete beta prototype and field testing, Apply for regulatory approvals
7. Obtain regulatory approvals
8. Finalize product metrics

Is this always true?

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- **Does engineering activity stops with product launch?**
- **Should marketing wait during design?**
- **What happens after launch?**
  - Producs can break and needs to be serviced
  - Can argue it is a different function but not always true
- **Depends on Industry**
  - For consumer electronics easier to solve: if it is broken, we essentially replace parts (=re-manufacture a new one)
  - For other industries not so obvious: can't send a 50meters tall wind turbine controller to maintenance service in a box, can't cancel payroll of 1K employees
- **If product cannot be "replaced" but must be "serviced", then risk of fragility and cost of maintenance must be factored in the product**
  - Ex-ante (make sure it is serviceable or it has very high quality assurance) or ex-post (ask customer to pay hefty maintenance fee) or right licensing (no responsibility)

Yeah but maintenance doesn't apply to us

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- **For software we don't need "servicing": just update to the new version**
- **Myth driven by browsers or mobile apps**
  - software given to you in change of your personal data
  - without any service level agreement and
  - certainty that updates will break your extensions
- **"Normal" software is very, very, very different**
  - Data is often mission critical and must be migrated
  - Software might be literally on the field in thousands of copies and not reachable
    - Eg car software. Need to recall the car…

Largest Business Software Producer

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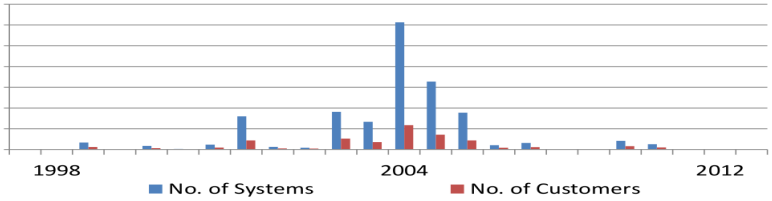
- **The company has updated products and yet**
  - Lots of customers are running software that are more than 10years old
- **Updates are costly!**
  - Even if you get a "free update" → data must be migrated
  - Even if all data works → process must be checked that nothing is broken
  - Even if process works → Final users must be re-trained to use new interfaces
  - Even if users can cope → fixing it might break something apparently unrelated
    - See Windows 10 free upgrade that £$%& all users of the Nvidia Quadro graphic card



- **What happens after the launch is also part of the PD of engineering**
- **We will get back on it later today**

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What if the product is a dud?

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- **When would you like to discover it?**
  1. Project Registration
  2. Concept Definition
  3. Feasibility and Planning
  4. Preliminary Design
  5. Final Design
  6. Product Verification
  7. Process Verification
  8. Launch
  9. Post-Launch Assessment
- **Movie Industry: Lone Ranger by Disney Co.**
  - Production (2-7): $225–250M
  - Launch (8): $150M
  - Post Launch Assessment (9): $160–190M Final Losses

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Ideal PD&D Process

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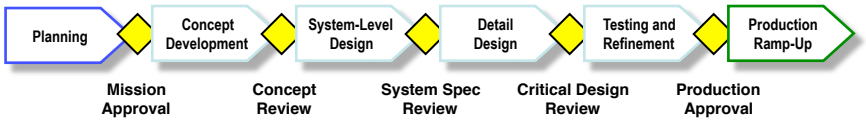
- **Key Idea → Streamline and improve process trying to make (only) successful products emerge at the end**
- **Eliminate**
  - Concepts that look unpromising (business-wise)
  - Concepts that are unwieldy to design
  - Systems that are complex or expensive to build (as intended)
  - Systems that are difficult to operate (as intended)
- **At all stages "value" based decision must be made based on**
  - Highest paid individual's opinion or
  - Experiments to check whether intuition is correct → easy for ICT product
    - with 3D printing reasonably easy for small manufactured products



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The Product Funnel per industries

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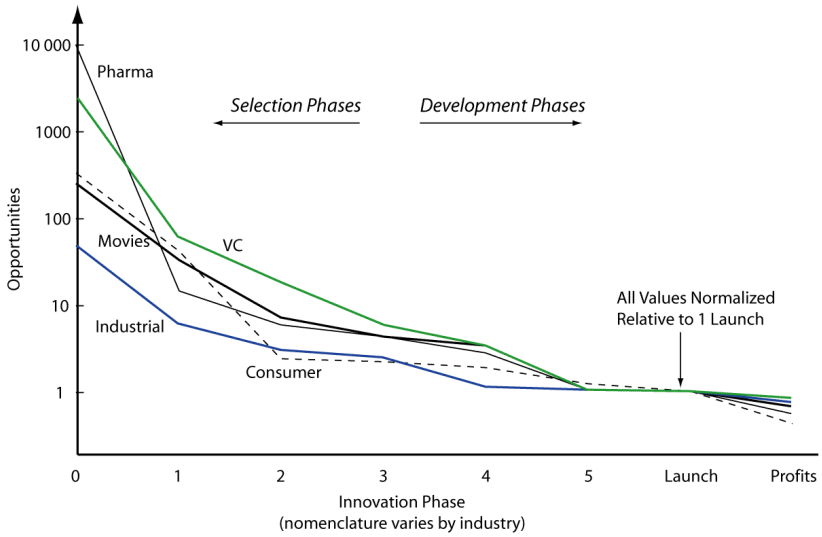

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Improved Variations

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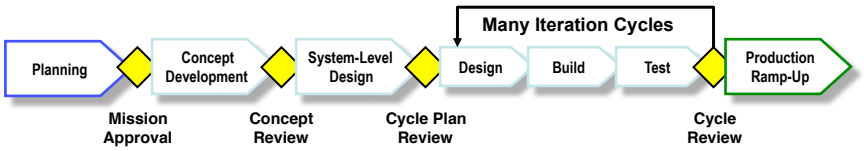
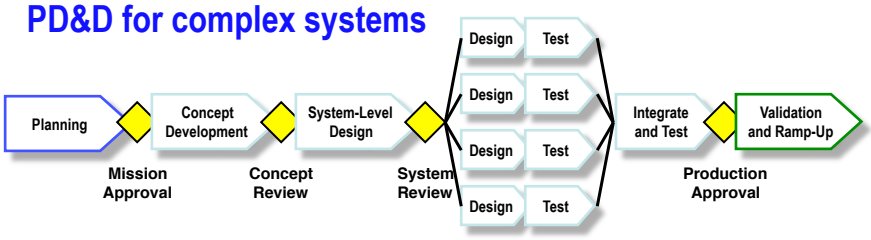
- **PD&D with fast prototyping cycle**



- **PD&D for complex systems**



Ideal PD&D Multi-disciplinary Team

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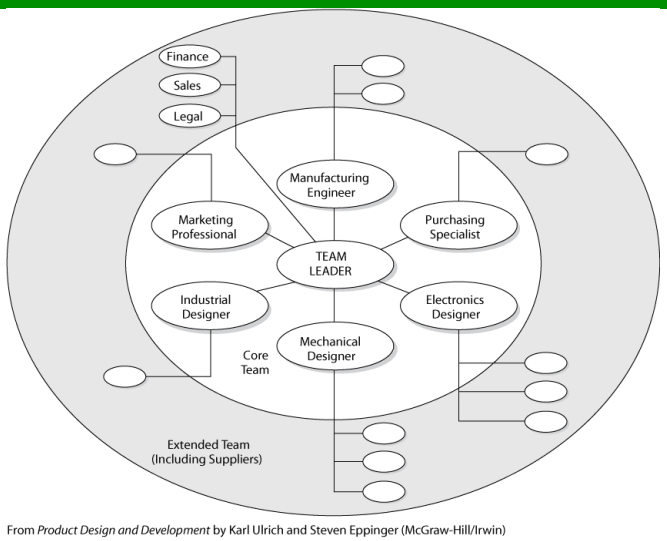

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Ideal PD&D Multi-disciplinary Team

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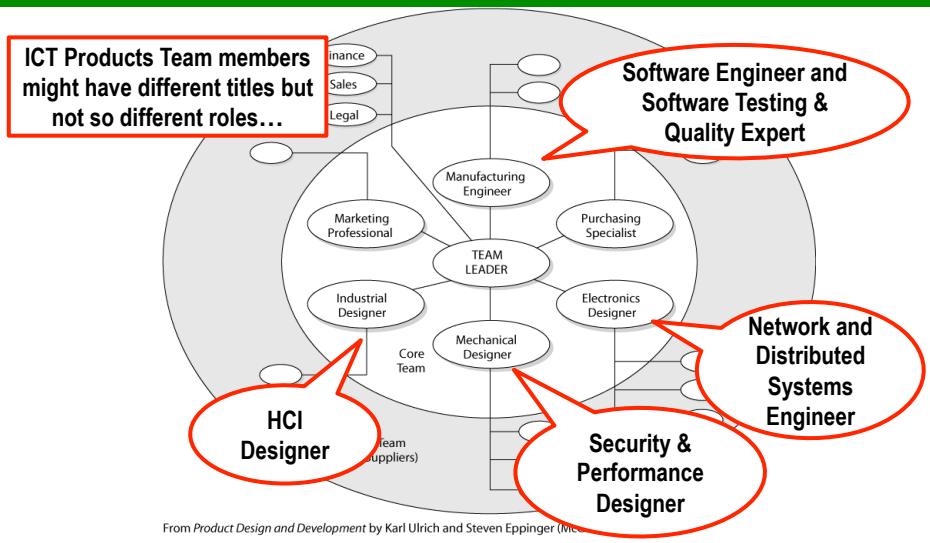

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Ideal PD&D Multi-disciplinary Team

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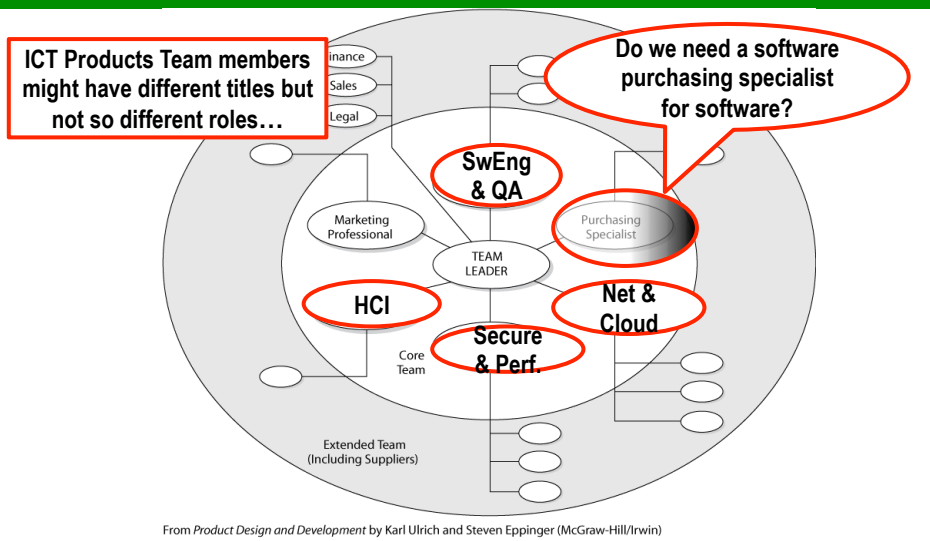

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Do we really need a purchasing expert?

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- **Hardware companies need a "Bill of Materials" of all components they use and must consider lots of aspects about purchasing (beside the obvious one, cost)**
  - Quality of Components
    - If you your motor cylinder has a leeway of 1mm → you can't buy a rubber band of 0.6mm +/- 0.5mm as some of them won't fit
  - Supply of Components
    - If your supplier of organic cocoa pods doesn't ship on February because of bad roads in the heights of Guatemala you need to stock it in January or otherwise your super duper chocolate factory will be idle
  - Obsolescence of Components
    - If the rubber band sticked to your motor cylinder breaks in two years → then your motor breaks in two years
  - IP or licensing agreement
- **If you develop software or services you seem to have an advantage and can get rid of that**

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What do you think?

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- **Supporting**
- **Opposing**

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ICT Innovation Myth

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- **Hardware companies need a "Bill of Materials" of all the components**
- **We build software so we don't need purchasing**
  - So you code everything yourself from scratch. Even your http parser you reprogramme it…
- **Oops but we still don't need worrying: we just use FOSS**
  - How do you select your API? What do you do when FOSS library changes its API?
  - Did you actually check you have the right license
- **FOSS products must be managed as the quality of your product depends on the quality…**
  - Blackduck → booming company which makes money just providing a software to manage one's software BoM
  - ERP Company mentioned before
    - They sell proprietary products but have more >500 FOSS libraries in different versions
    - They have a full process to manage licenses → check software quality → check security →check upgrade and maintenance
    - Software security by itself already requires a very careful BoM

Security as an example of Software BoM

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- **In 2008 you bundled Apache Tomcat as the underlying server of your integrated software offering to a large airline company to manage their passenger and cargo bookings and aircraft crew management system**
  - Or you bundled the latest ssh protocol to secure the key fob of a large car manufacturer
  - Lots of other examples
- **They are very happy and pay a hefty license every year to use the system as is, no major upgrade, just keep running**
- **In 2014 some £$%&/ publishes a serious vulnerability in Apache Tomcat (on the version that is new in 2014)**
  - What are you going to do?

What are you going to do?

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Just upgrade as your browser don't you?

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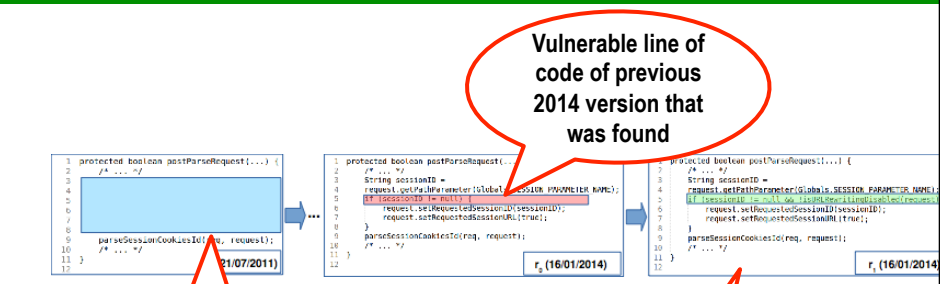

Just upgrade as your browser don't you?

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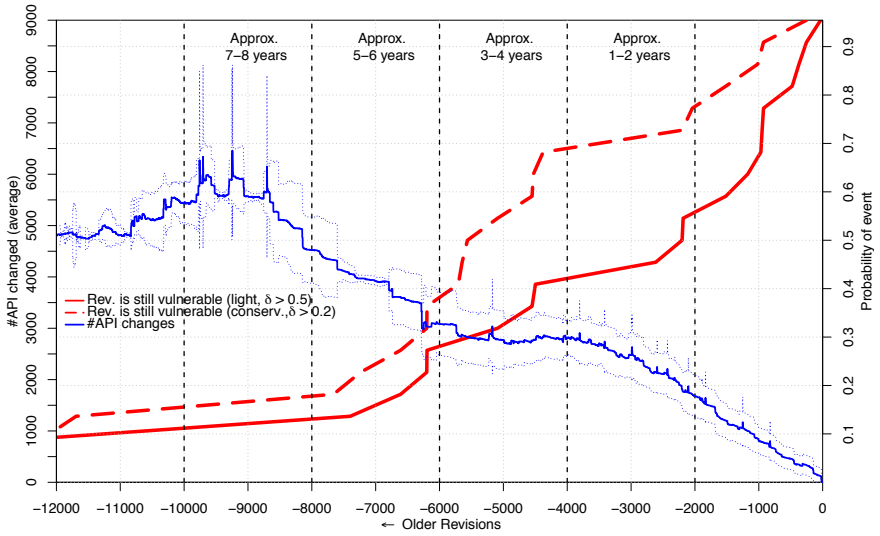

Concept Development Process

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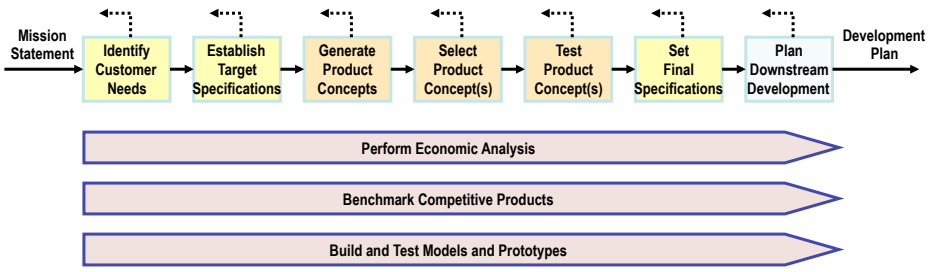
- **CD is similar to PD&D**
- **Divided in several steps**
  - As PD&D not necessarily sequential → parallel and iterative steps
- **Covered in Chapter 4-8 in the Textbook**
- **Economic Analysis → Business Development Lab Course**



Textbook

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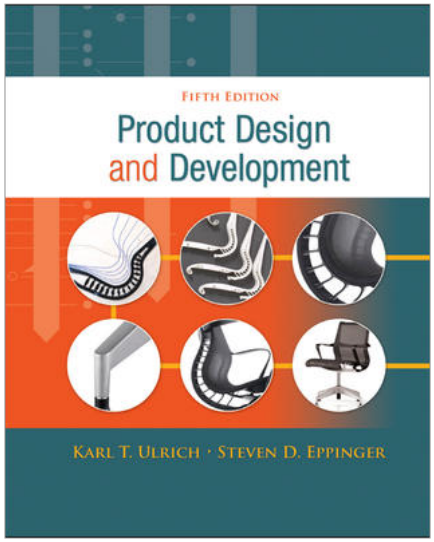
Product Design and Development
Karl T. Ulrich and Steven D. Eppinger
5th edition, Irwin McGraw-Hill, 2012

1. Introduction
2. Development Processes and Organizations
3. Opportunity Identification
4. Product Planning
5. Identifying Customer Needs
6. Product Specifications
7. Concept Generation
8. Concept Selection
9. Concept Testing
10. Product Architecture
11. Industrial Design
12. Design for Environment
13. Design for Manufacturing
14. Prototyping
15. Robust Design
16. Patents and Intellectual Property
17. Product Development Economics
18. Managing Projects



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