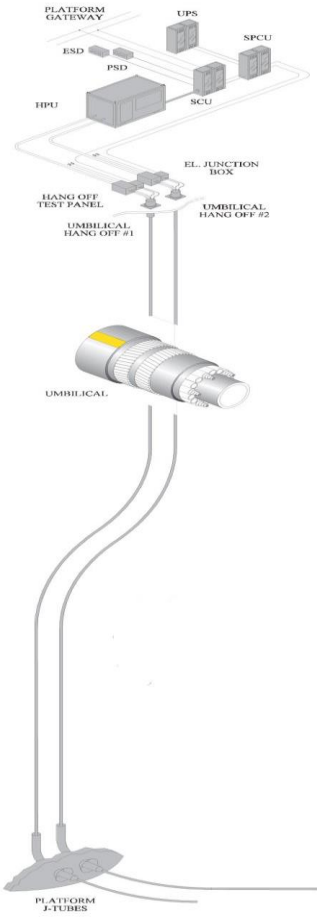
Subsea Control System Quality & Reliability Assurance

27.10.2016 GEC Subsea

Session 1

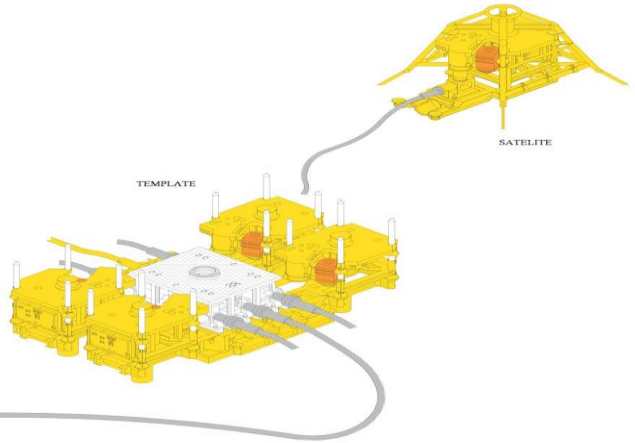
- Product reliability and requirements
  - Key standards & documents
  - Key reliability parameters and how Statoil makes use of these
  - Redundancy*
  - Electronics and IPC
  - Qualification & Robustness testing
- Statoil's experiences with subsea equipment and failure rate, and lessons learned*
- Q & A session

Main functions



Secure PSD (Process Shut Down) & ESD (Emergency Shut Down) to bring equipment / facility in safe state

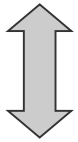
Steering, control and monitoring of sensors, actuated valves and downhole equipment



Main Components

- HPU
- Subsea Control Unit (SCU or MCS)
- Subsea Power & Communication Unit
- Operator stations
- Test Panels

Topside



Subsea

- Umbilical
- Communication Distribution & Subsea Control Moduls
- Sensors

Subsea Control System
- Product / Component Reliability

Reliability = The probability that an item will perform a required function without failure under stated conditions for a stated period of time

- Vital to ensure subsea control system operation within specified parameters
- Vital securing PSD & ESD to bring facility in safe state
- Vital to ensure system availability

Vital for safe oil & gas production!!!

Product / Component Reliability

Key requirements (Technical, Subsea Control System related)

International Standards	
API 17F	Standard for Subsea Production Control Systems
ISO /TR 10949	*Hydraulic fluid – Component cleanliness – Guidelines for achieving and controlling cleanliness of components from manufacture to installation.*
ISO 4021	*Hydraulic fluid power –Particulate contamination analysis*
ISO 4405	*Hydraulic fluid power- Fluid Contamination –Determination of particulate contamination by the gravimetric method*
ISO 12103-1	*Road Vehicles – Test Dust for Filter Evaluation*
ISO 18413	*Hydraulic fluid power –Cleanliness of parts and components*
ISO 23309	*Hydraulic fluid power systems –Assembled systems –Methods of cleaning lines by flushing*
ISO 90003	Guidelines for the application of ISO 9001:2000 to computer software
Statoil Technical Requrements	
TR 1233	Subsea Production Control Systems
TR 3037	Automation systems integration of subsea production control

Product / Component Reliability

Key requirements (Technical, Subsea Control System related)

Joint Requirements	
SAE AS 4059	Cleanliness Classification for Hydraulic Fluids
IPC-A-610	Acceptability of Electronic Assemblies
IPC-7711/7721	Rework, Modification and Repair of Electronic Assemblies
J-STD-001	Joint Industry Standard –Requirements for Soldered Electrical and Electronic Assemblies
SIIS STD-01	Subsea Instrumentation Interface Standardisation
SIIS RP	Subsea Instrumentation Interface Standardisation Recommended Practice
IWIS RP	Intelligent Well Interface Standardisation Recommended Practice
SEAFOM TSD-02	Functional Design and Test Specification for Subsea Electrical and Optical Connectors and Jumpers
3428A rev1.5	Joint Operator Specification Obsolescence Management for Subsea Production Control Systems

Product / Component Reliability
Parameters

Measurable

- System availability
- Failure rates
- Retrival frequency

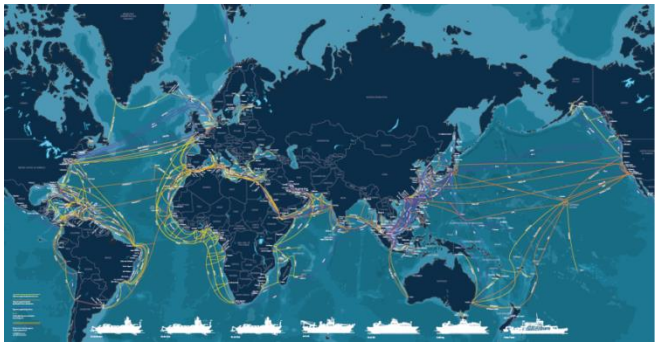
«Soft»

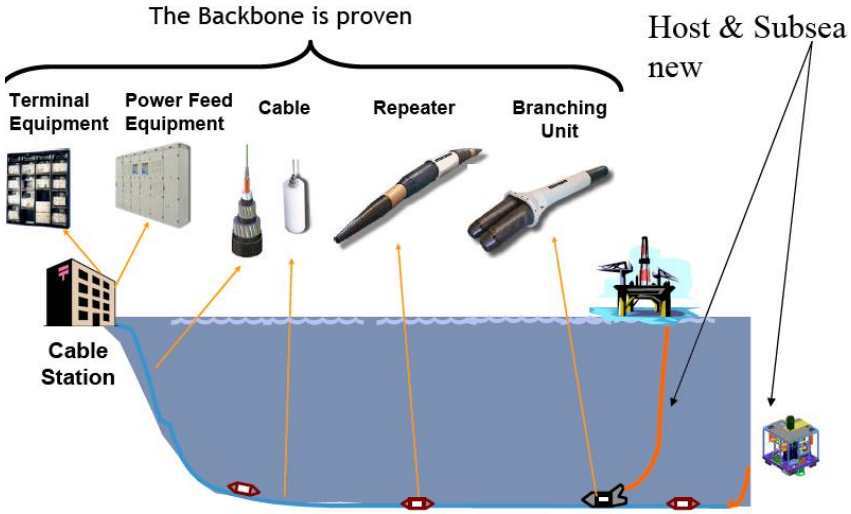
- Evolution of governing and operational requirements
- Technology evolution
- General Operational experience
- Dialogue with suppliers

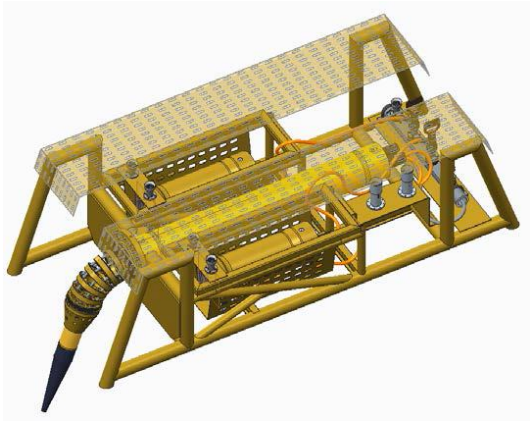
Product / Component Reliability
Example “Technology Evolution” – DC/FO

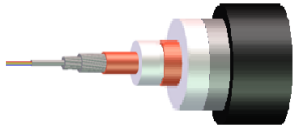
Background:

- Current systems have limitations -> power and distance
- DCFO: new cabled system based on telecom standards
- Alcatel Lucent Submarine Networks (ASN) industrial partner







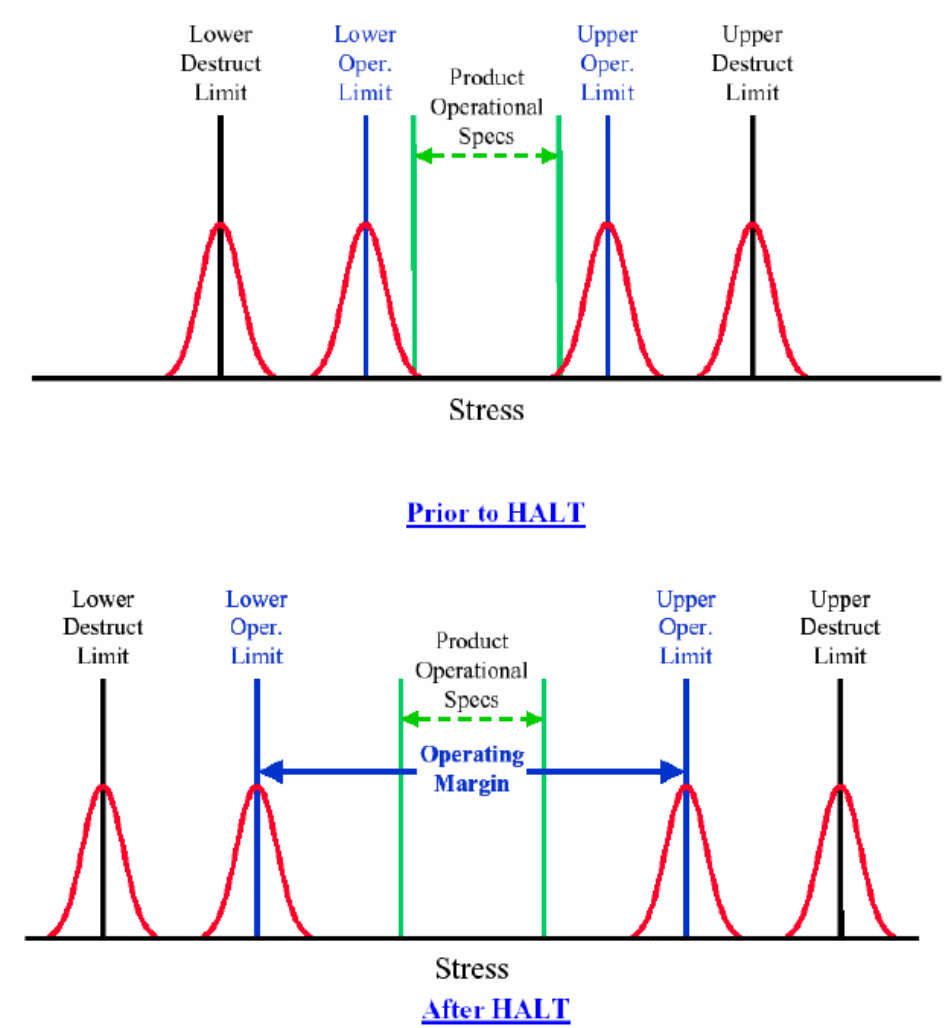


Product / Component Reliability
Qualification & testing – HALT

Highly Accelerated Life Testing (HALT)

- Stress testing methodology for products and solutions aiming to provoke failures commonly seen after long-term use within a relatively short period of time
- Results can be used to modify the solution so that the product's lifetime is increased.
- HALT is first and foremost a method that helps in the development of reliable products with a long lifetime.
- It is not a method for predicting how long lifetime a product will have.

Product / Component Reliability
Qualification & testing – HALT



Product / Component Reliability
Qualification – HALT

- There is no **one** right way to run HALT.
- One way is to start using single environments, then running with combined environments for comparison using various samples.
- Typical tests are:
  - cold step test
  - hot step test
  - rapid temperature cycling test
  - stepped vibration (random) test
  - combined environment stress

Product / Component Reliability
Qualification – HALT

HALT	TRADITIONAL LIFETIME TEST
Finds weaknesses	Verifies in accordance with a standard
Tests beyond limits and assesses	The purpose is to approve the product
Very short testing time	Long testing times
Few units	Often many units
Stimulates failures to arise regardless of the stimuli	Simulates real-life effects
Tests beyond the specification limits	Tests within the specification limits
Development tool	Verification tool
Success criteria: FAILURE	Success criteria: NO FAILURE

TR 1233: Highly Accelerated Lifetime Testing (HALT) should be used to ensure quality of PCBs.

Product / Component Reliability
Electronics Assembly

IPC-A-610 - Acceptability of Electronic Assemblies

- Widely used acceptability standard for electronic assemblies
- Collection of visual quality acceptability requirements
- Also covers Electrostatic discharge (ESD).

IPC J-STD-001D - Requirements for Soldered Electrical and Electronic Assemblies

- Contains comprehensive, critical details about
  - Processes
  - Materials
  - Testing methods for soldered assemblies.

Product / Component Reliability
Electronics Assembly

IPC-A-610 and J-STD-001 have three product classes

- **CLASS 1 - General Electronic Products**
- **CLASS 2 – Dedicated Service Electronic Products:**
  - Includes products where
    - Continued performance and extended life is required, and for which uninterrupted service is desired but not critical.
    - Typically the end-use environment would not cause failures.
- **CLASS 3 – High Performance Electronics Products:**
  - Includes products where
    - Continued high performance or performance-on-demand is critical
    - Equipment downtime cannot be tolerated
    - End-use environment may be uncommonly harsh, and the equipment must function when required.

- **Statoil require CLASS 3**

Session 2

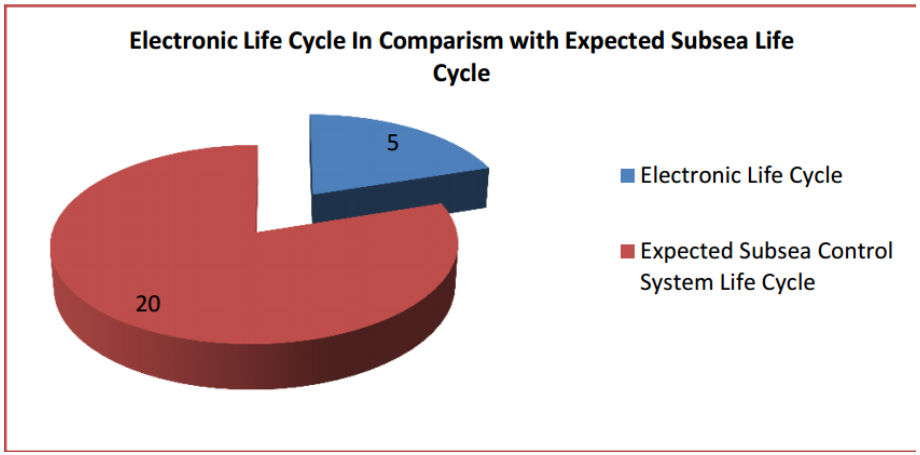
- Sub-supplier quality assurance
- Component obsolescence
- Q & A session

Sub-supplier quality assurance

- “Mundighetskrav”, Industy standards, Statoil requirements & expectations
- Statoil process landscape (e.g. from technology development (FR12) to project execution (FR05))
- Project contracting strategy & associated risk picture
- Complexity of supply chain (e.g. sub-supplier level)
- Experience & trust

Component obsolescence

- Obsolescence is a particular issue in subsea production systems due to
  - Long lifecycle of these (25 years or more)
  - Difficulty and cost associated with accessing them to undertake repairs or upgrades.
- Obsolescence cannot be avoided, however, it can and should be managed to mitigate for and control its negative impact.



Component obsolescence

Typical criticality overview in Subsea Production Control System

Equipment	Core Component	Technology Evolution	Replacement Alternatives	Obsolescence (Risk)
HPU	Electrical	Moderate	Less difficult	Low
EPU	Electrical	Moderate	Less difficult	Low
Umbilical & UTA	Mechanical	Low	Less difficult	Low
Electrical/ hydraulic flying lead	Mechanical	Low	Less difficult	Low
Subsea Booster pump	Mechanical	Moderate	Difficult	Moderate
Subsea separator	Mechanical	Moderate	Difficult	Moderate
Software	Programme	High	Less difficult	Moderate
SCM	Electronics	High	Very difficult	Very high

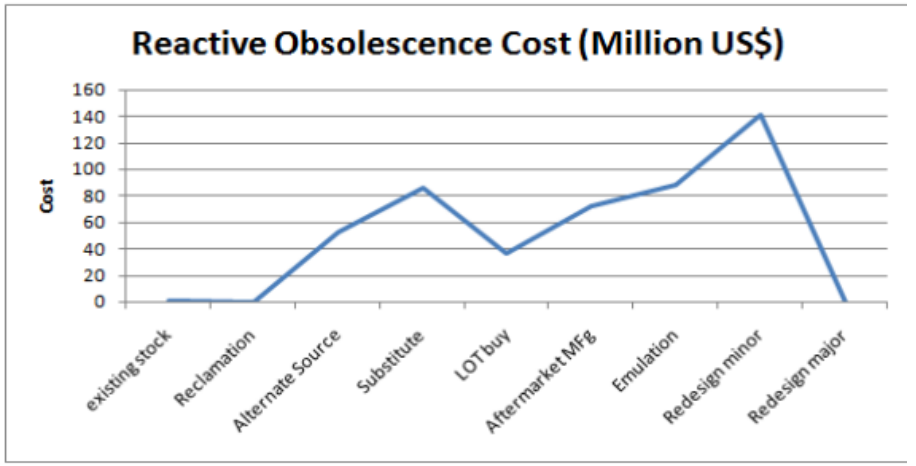
Component obsolescence
Typical cost resolution (Tordis)

- Reactive Obsolescence cost

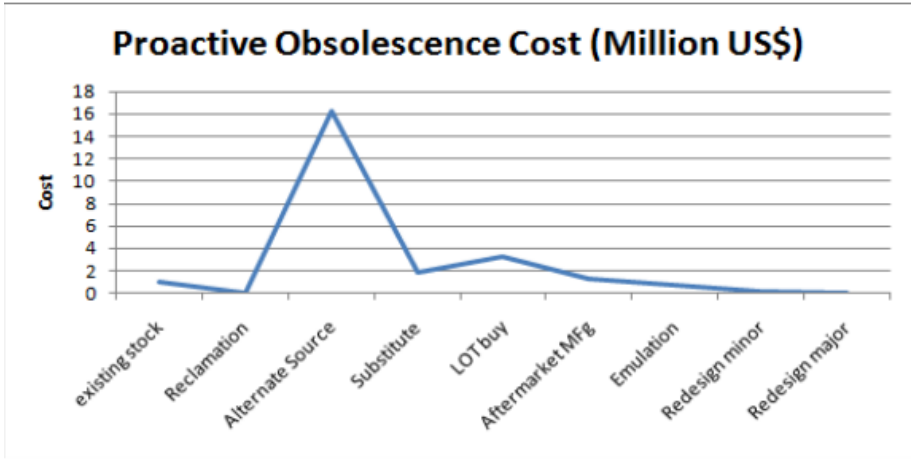
= US$478 M

- Proactive Obsolescence cost

= US$26.2 M



- Loss production following a reactive resolution strategy can imply high OPEX.



Source: Cranfield University

Component obsolescence

http://www.subseaobs.com/

- Joint operator approach resulting in «Subsea Obsolescence Management - Joint Operator Specification 3428A v1.5»
- Supplement to IEC 62402 «Obsolescence management»

Obsolescence management = Co-ordinated activities to direct and control an organization with respect to obsolescence.

- Purpose of joint Operator effort is to define a pro-active Obsolescence Management Process (Preventing, Predicting, Resolving)

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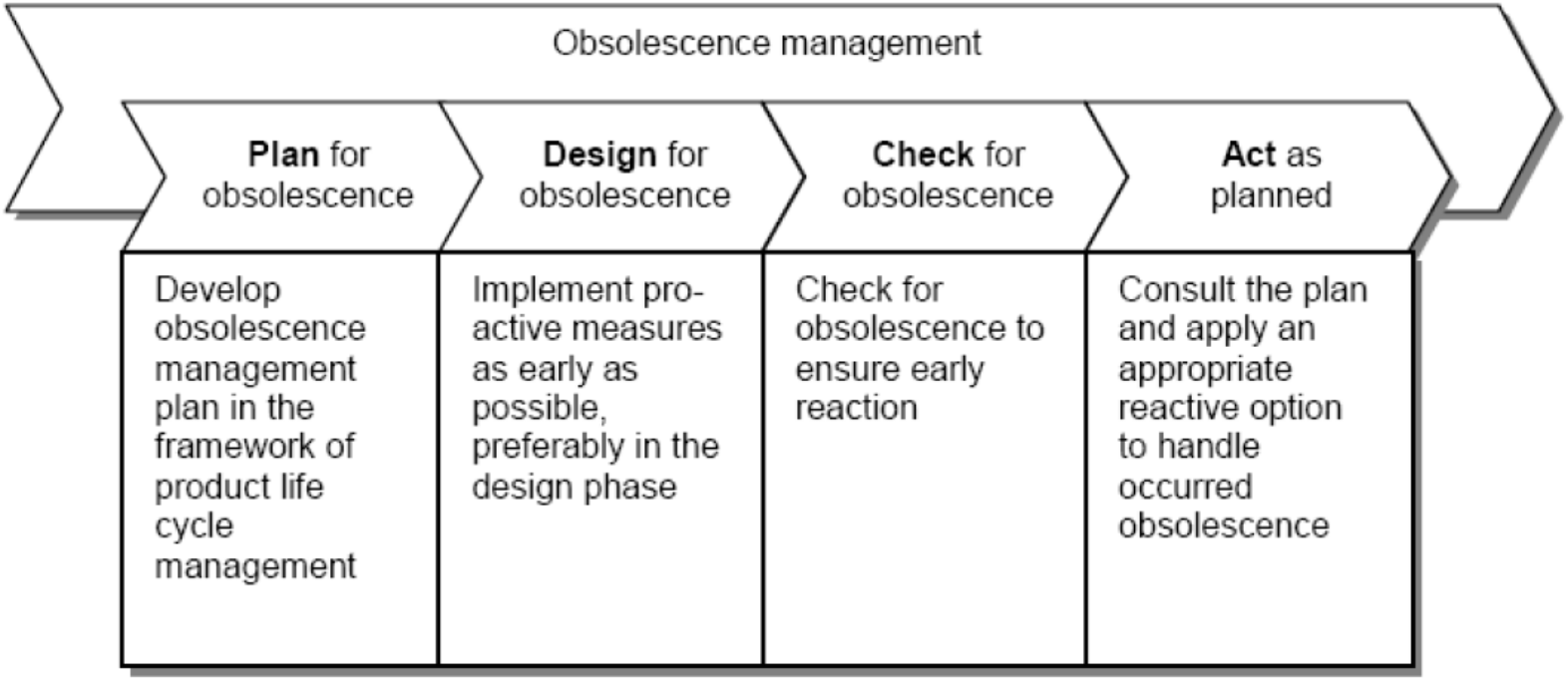
Component obsolescence

http://www.subseaobs.com/

- Pro-active Obsolescence Management Process



Component obsolescence

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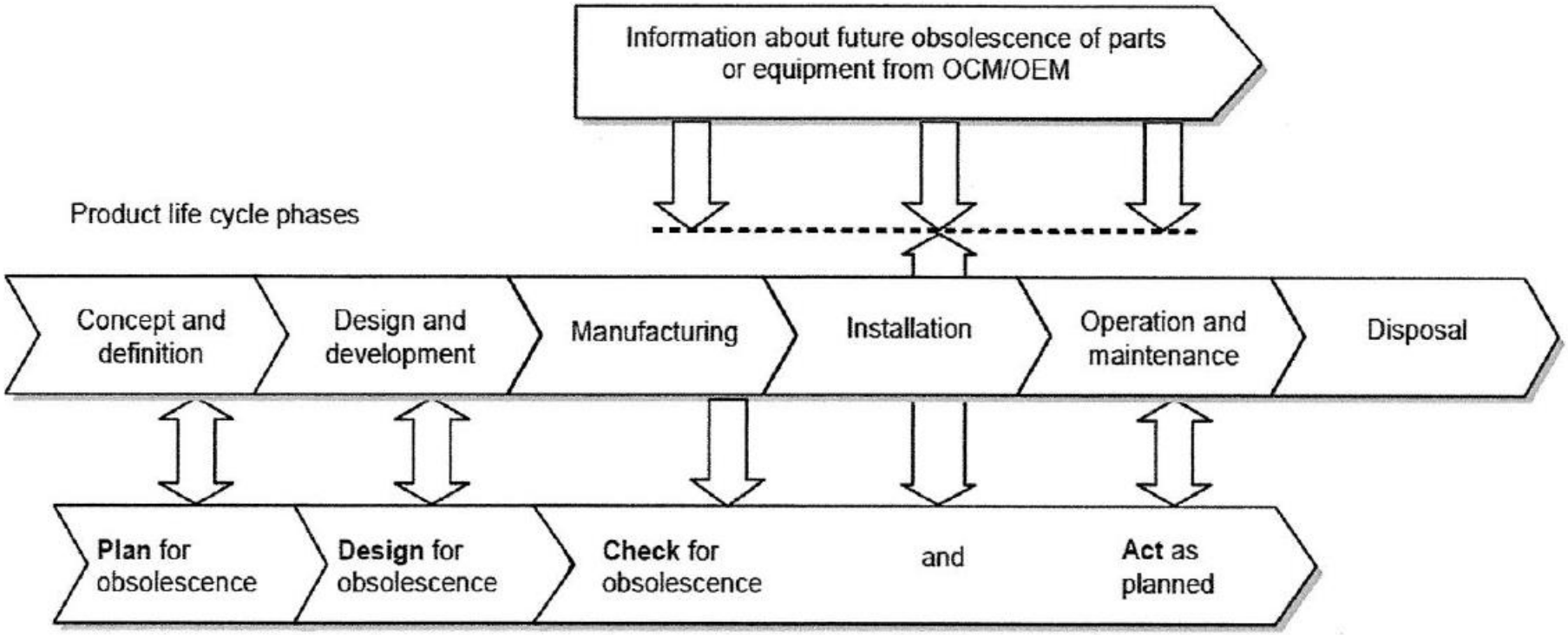
- Pro-active Obsolescence Management Process in life cycle context



Component obsolescence

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- **Minimum requirements:**
  - Obsolescence Management Plan
  - Communication Plan
  - Product Life Cycle Diagram
  - Obsolescence strategies - Availability of Obsolescence Information
  - Obsolescence mapping and monitoring - Management of Obsolescence Prediction
  - Obsolescence strategies - Management of Obsolescence Resolution
    - Sourcing (e.g. last time buy)
    - Re-design

There's never been a better time for good ideas

Subsea Control System Quality & Reliability Assurance

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