A structured approach to manage integration across functional areas in a complex organisation

PBMR's Journey

o Setting the scene

o The challenge

o How we solved it

o Governance

o Conclusion

About the company - PBMR

o **Pebble Bed Modular Reactor (Pty) Limited (PBMR)** was established to design, develop and market small-scale, high-temperature reactors both locally and internationally.

o The PBMR is a helium-cooled, High Temperature Reactor (HTR) and **is scheduled to be the first commercial scale HTR in the power generation field**.
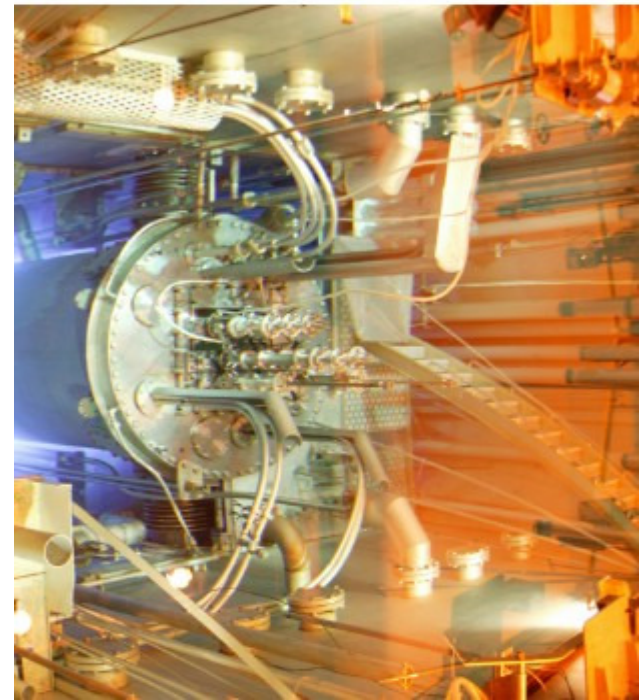
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21st century sustainability

o The PBMR's ability to economically generate electricity or high temperature steam as input to the production of hydrogen as the fuel of the future, desalinated water and industrial processes, not only **sets it apart from all previous nuclear reactors, but also from the next generation of energy sources**

o As a future **Generation IV** nuclear reactor, the PBMR complies to enhanced safety, minimal waste and improved proliferation resistance requirements

Unique Technology → **Unique Challenges**

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The Challenges…

o A **young company** starting without integrated processes and systems in a renaissance industry with the aim to deliver world class high technology products in a highly regulated environment

- Top level engineers and scientists drawn from many diverse industries, each with their own culture and beliefs, including diverse views on design approach, processes and systems

- A strong project delivery approach induced functional silo-based teams, with independent and non-integrated processes

- Greater focus on individual functions than the whole, limited integrated view

- A very strong culture of mechanical/component design vs. process plant design

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The Challenges…

o A young company starting without integrated processes and systems in a **renaissance industry** with the aim to deliver world class high technology products in a highly regulated environment

- The nuclear industry declined world-wide after major incidents such as Three-Mile island and Chernobyl in the 1980's

- Pressure to reduce the Green house gas (GHG) emissions associated with fossil fuel plants propelled nuclear back into a key position, but

- Skills and capabilities must be redeveloped to fit modern trends from a 1970's paper mindset

- Is the deign of a nuclear plant a system engineering or a process engineering problem? Or both?

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The Challenges…

o A young company starting without integrated processes and systems in a waking industry with the aim to deliver world class high technology products in a highly regulated environment

- Everything done in the nuclear industry is regulated by a national and international nuclear regulatory system mandated by law to ensure that the public is safe

- Nothing happens in the nuclear industry without approvals and licenses, and these are issued following sound proof that the required management systems and capabilities are in place.

- Absolute traceability of information from first requirements, through the design, manufacturing and commissioning, operation and eventual decommissioning of a nuclear installation is required – a strong Life Cycle approach.

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The Challenge in short:

Integrated Enterprise Capability
## is the
Entry Criteria for playing
in this market

An Business Architects Dream?
or Nightmare!!!!

The historic approach (pre 2008)

o The typical Quality and Safety management philosophy and structures were followed characterized by:

- The documentation of an Enterprise Management System based on the functional business structures and presented as a controlled structure of "Policies, Procedures and Processes"
- Appointing Management Systems Managers to identify process categories (groups/domains) and the required processes
- The Design, approval and publishing of the processes, with associated controls, templates and guidelines
- Buying best of breed software packages in isolation, to enable processes
- 450+ processes identified and documented to cover the engineering design phase of the life cycle. (A further 2500 estimated to cover the complete Life Cycle)

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Enterprise Management System Structural Elements
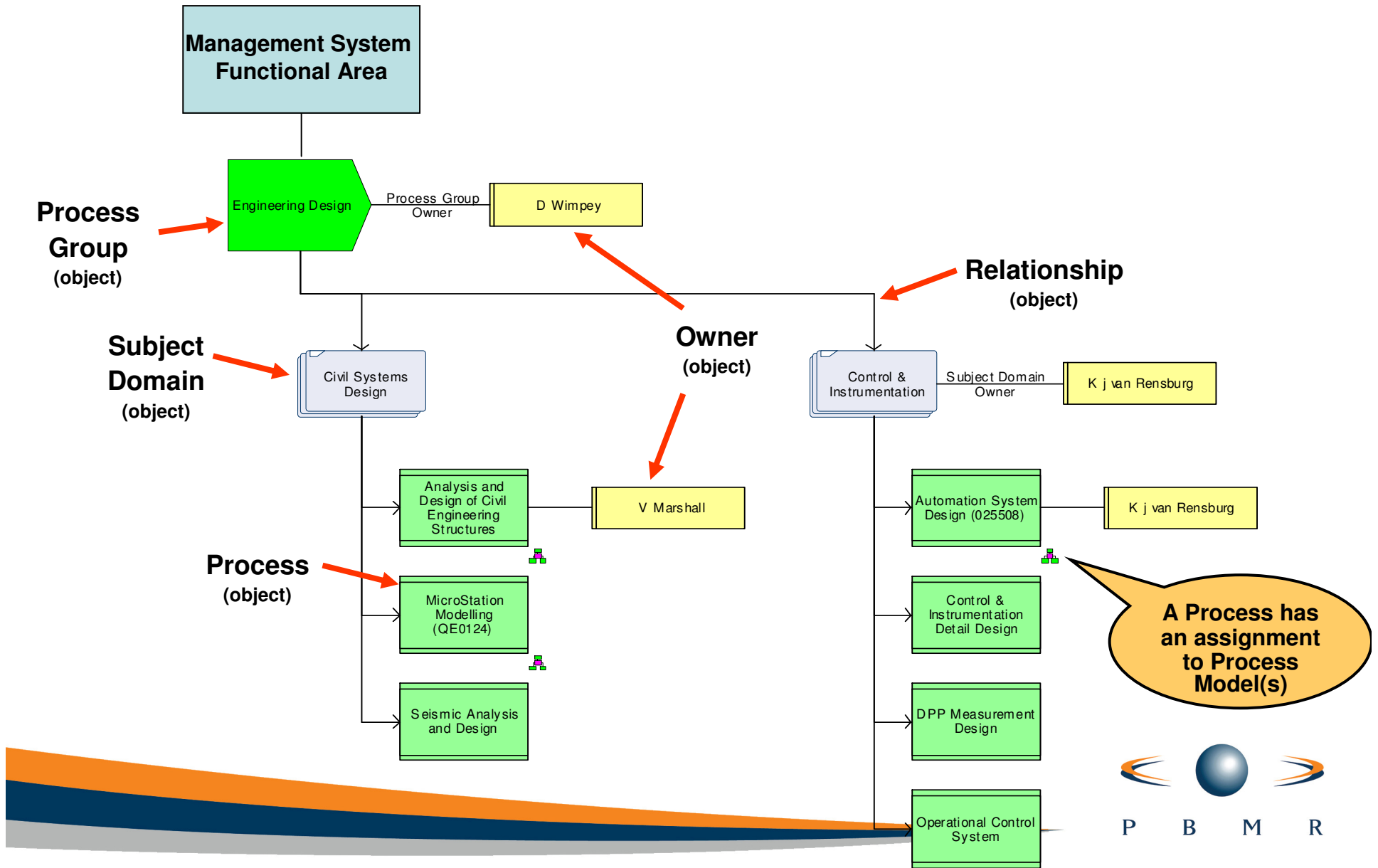
Individual Processes Assignment to the Management System Structure
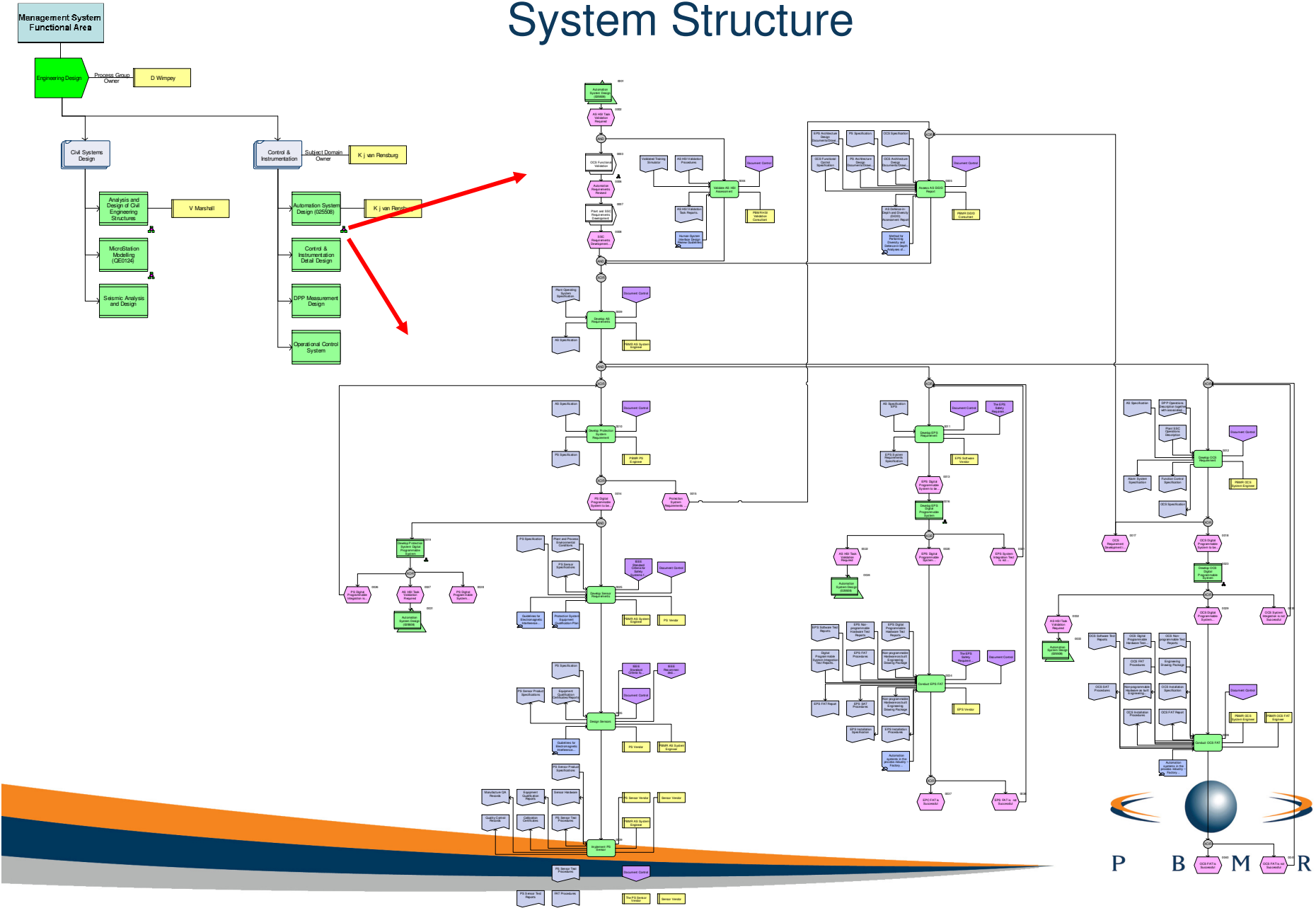
2008 status check

o Some well documented processes under configuration management

o Many software systems (20 major and >200 minor systems)

o Audit requirements met

BUT

o Was this capability sufficient to enable the seamless flow of activities related to the design and operation of a nuclear plant with its strict controls and traceability requirements?

No → Deficiencies still existed

Why not?

o The mechanism to ensure integration and completeness of the set of processes was **reliant on individual discipline** and knowledge and no dependable methodology existed to confirm cross-integration

o The design process is a **non-linear and iterative** process with multiple-branched feedback loops

o **Level of complexity** so high that process integration cannot be achieved by analysis of the interaction of value chain items

o **Σ(all processes) $\neq$ nuclear plant design capability**….typical design management type process breaks existed, resulting in technical process not interlinked

o The result was that *several* **"unmatched" process start and end events** existed – unable to match the flow and progress of the design.

o Integrated document repository streamlined the "silo approach" and did not support integration
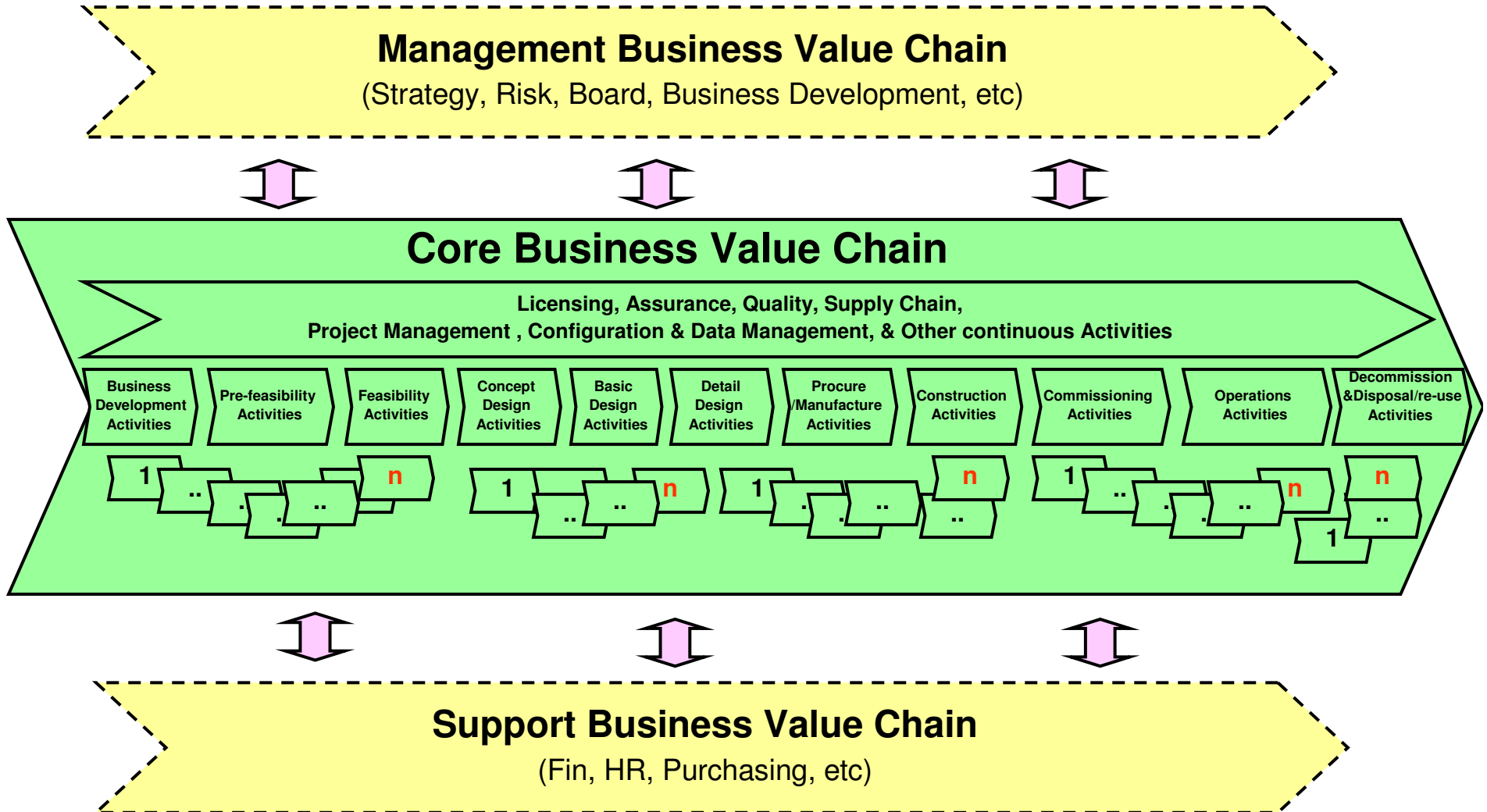
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The New Approach – 2008 onwards..

TWO Major Approach Changes:

o   The logical **Life Cycle Value Chain** approach in-addition-to the Functional Structured Enterprise Management System approach

o   Adoption of an **End-to-End Event Logic** model for consolidation and integration of the operational level processes

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The Value Chain Approach

Management Business Value Chain

(Strategy, Risk, Board, Business Development, etc)

Core Business Value Chain

Licensing, Assurance, Quality, Supply Chain,
Project Management , Configuration & Data Management, & Other continuous Activities

| Business Development Activities | Pre-feasibility Activities | Feasibility Activities | Concept Design Activities | Basic Design Activities | Detail Design Activities | Procure /Manufacture Activities | Construction Activities | Commissioning Activities | Operations Activities | Decommission &Disposal/re-use Activities |

1 .. .. .. n 1 .. .. n 1 .. .. n 1 .. .. n n 1 ..

Support Business Value Chain

(Fin, HR, Purchasing, etc)

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2-Dimensional Decomposition of the Value Chain

The **Systems Engineering** methodology, in combination with the Industry Practice of **Plant Delivery Management**, required the decomposition and grouping/clustering of the Plant/Product Life Cycle Management value chain according to:

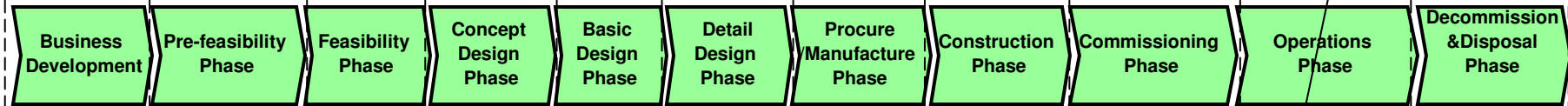o   Life Cycle phases/stages

o   Functional discipline "Swim Lanes"

….as following

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Plant/Product Life Cycle Decomposition

Value Chain Phase

Swim lane

Business Development	Pre-feasibility Phase	Feasibility Phase	Concept Design Phase	Basic Design Phase	Detail Design Phase	Procure /Manufacture Phase	Construction Phase	Commissioning Phase	Operations Phase	Decommission &Disposal Phase

Functional Work Area: Business performance (s)/Risk Management perspective

Functional Work Area : Requirements Management perspective

Functional Work Area : Licensing perspective

Functional Work Area : Safety perspective

Functional Work Area : Plant Systems Engineering perspective

Functional Work Area : Process Engineering perspective

Functional Work Area : Plant Design & Integration perspective

Functional Work Area : Equipment Design perspective

Functional Work Area : Operations and Support perspective
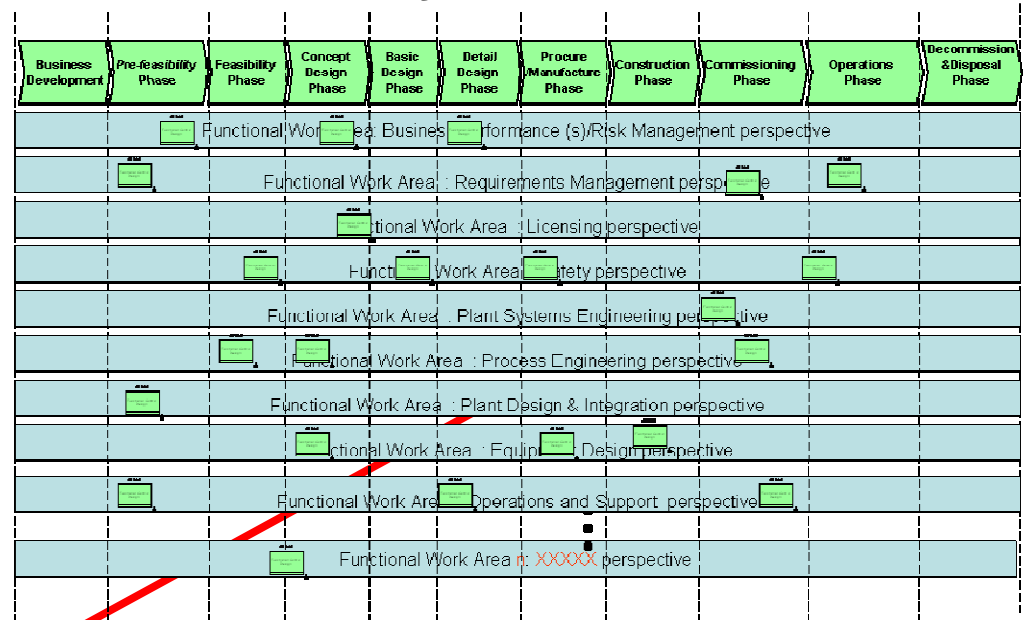
Functional Work Area n: XXXXX perspective

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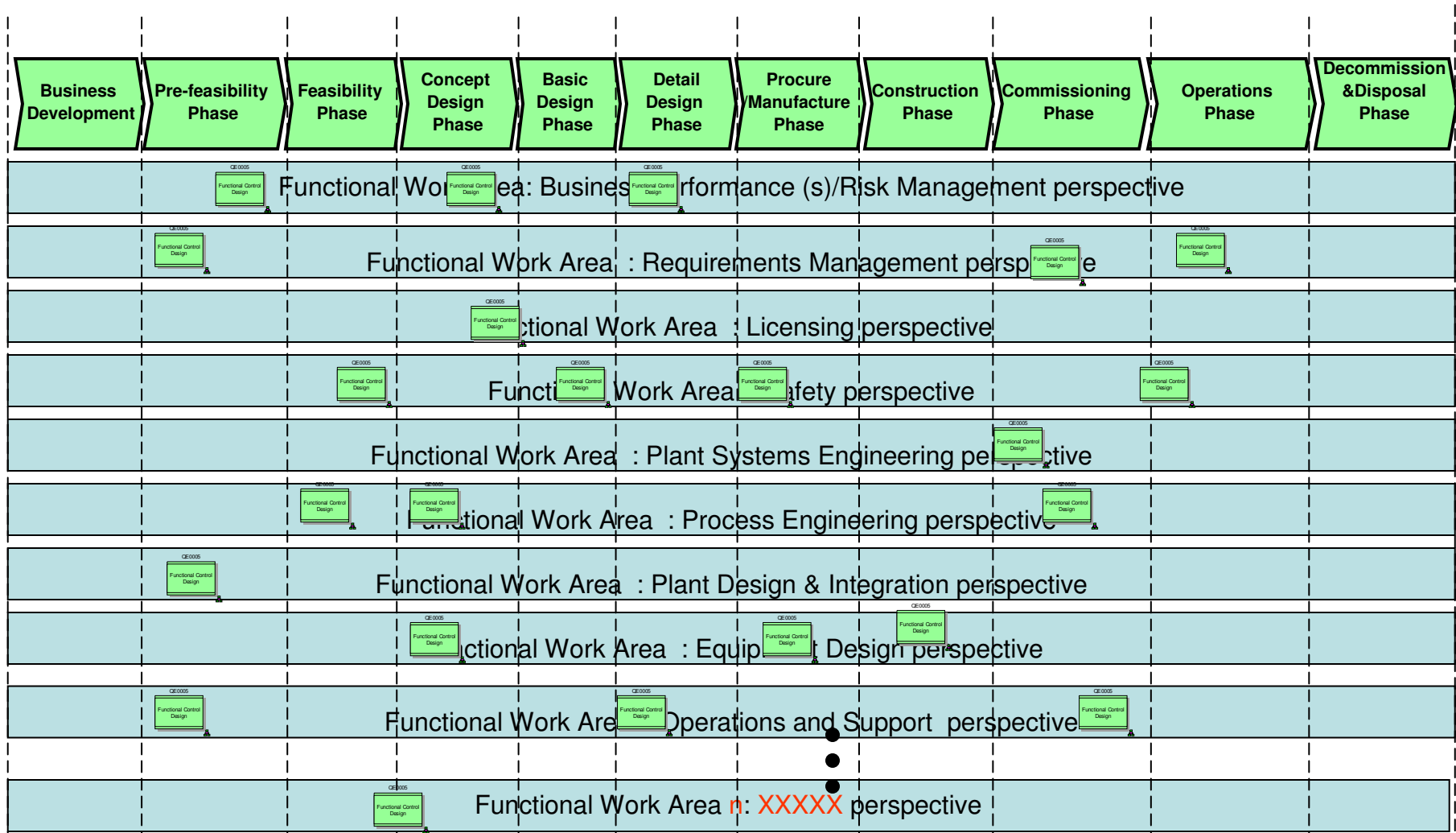
Thus - Providing Multiple "Process" Views

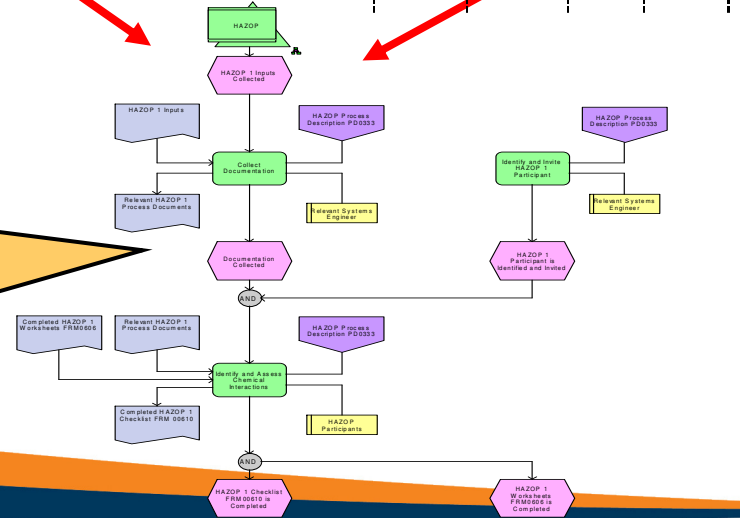## Enterprise Management System View
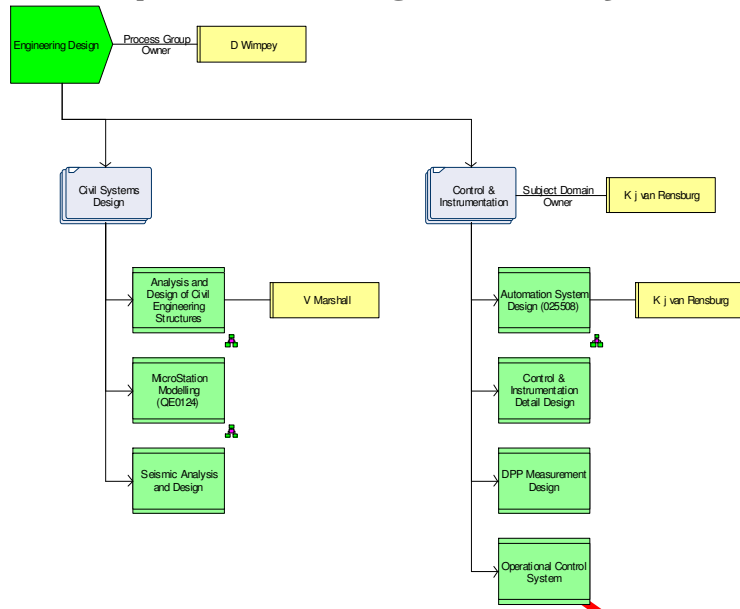
The detailed process remains the same irrespective of higher level view however, now with improved integration

Life Cycle Value Chain View


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Introducing Events

Based on IDS Sheer's Architecture for Information Systems (ARIS) Methodology, **EVENTS** were introduced to in the process modeling to force clear definition of the process "states" at the interface points.
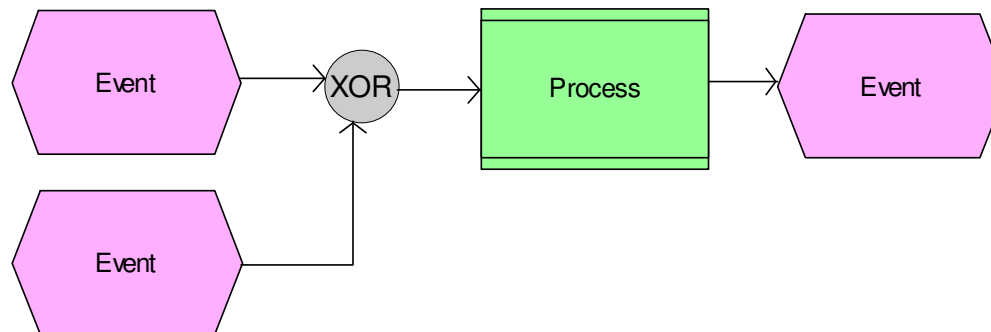

The design processes often have multiple start and end events to facilitate branching in the flow

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The High Level Events Logic model

o <u>The main objective</u>: to visually depict the end-to-end logical interaction of the Life Cycle processes on the "operational" level, one level below the Life Cycle Value Chain

o To have clarity on time/phases hand-over in the flow

o The model is overlaid on the 2-dimensional phases/swim lanes matrix
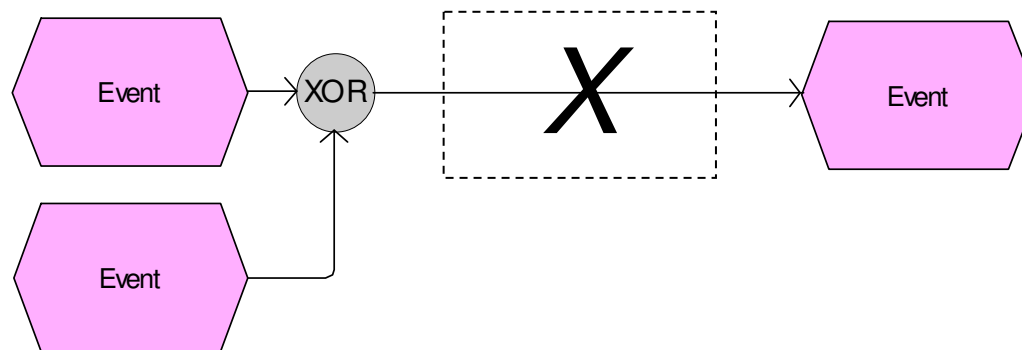
Plant/Product Life Cycle Decomposition
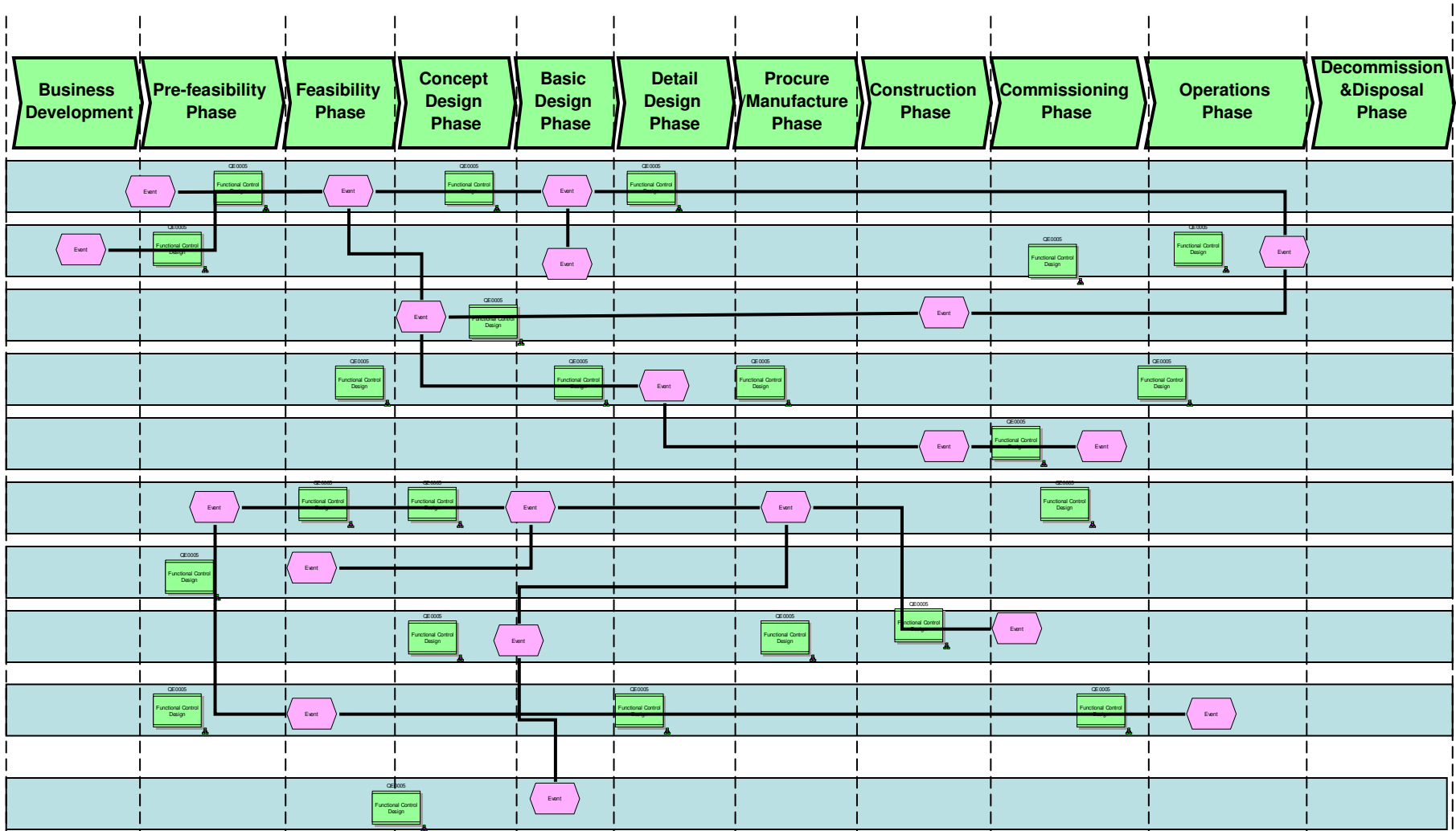
The High Level Events Logic Model Priorities

o The development and level of detail on the high level events model is determined by the following priorities:

- Priority 1: Support important milestones
- Priority 2: Align capability with licensing deliverables – these are predominately nuclear safety related technical outputs, typical IAEA defined processes (International Atomic Energy Agency)
- Priority 3: Align with industry System Engineering standards: ISO 15288 / IEEE 1220
- Priority 4: The highest possible level of detail that will still enable integration between functional areas

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Key steps to build the End-to-End Event Model

o Facilitate a common understanding and agreement on the deliverables, context, naming and design maturity level of each phase

o Define the functional areas – this could be a combination of functional / system hierarchy in generic groupings

o Populate the main stream of events on the diagram and link them

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…Key steps to build the End-to-End Event Model

o Develop the logic in small specialized work teams, based on the perception of each functional area of how they fit into the whole

o Have hard conversations with the aim to reach consensus

o Retain traceability of all inputs back to origin

o Identify and facilitate resolution of different viewpoints early

o Small teams – max 2-5

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The Life Cycle Integration Room
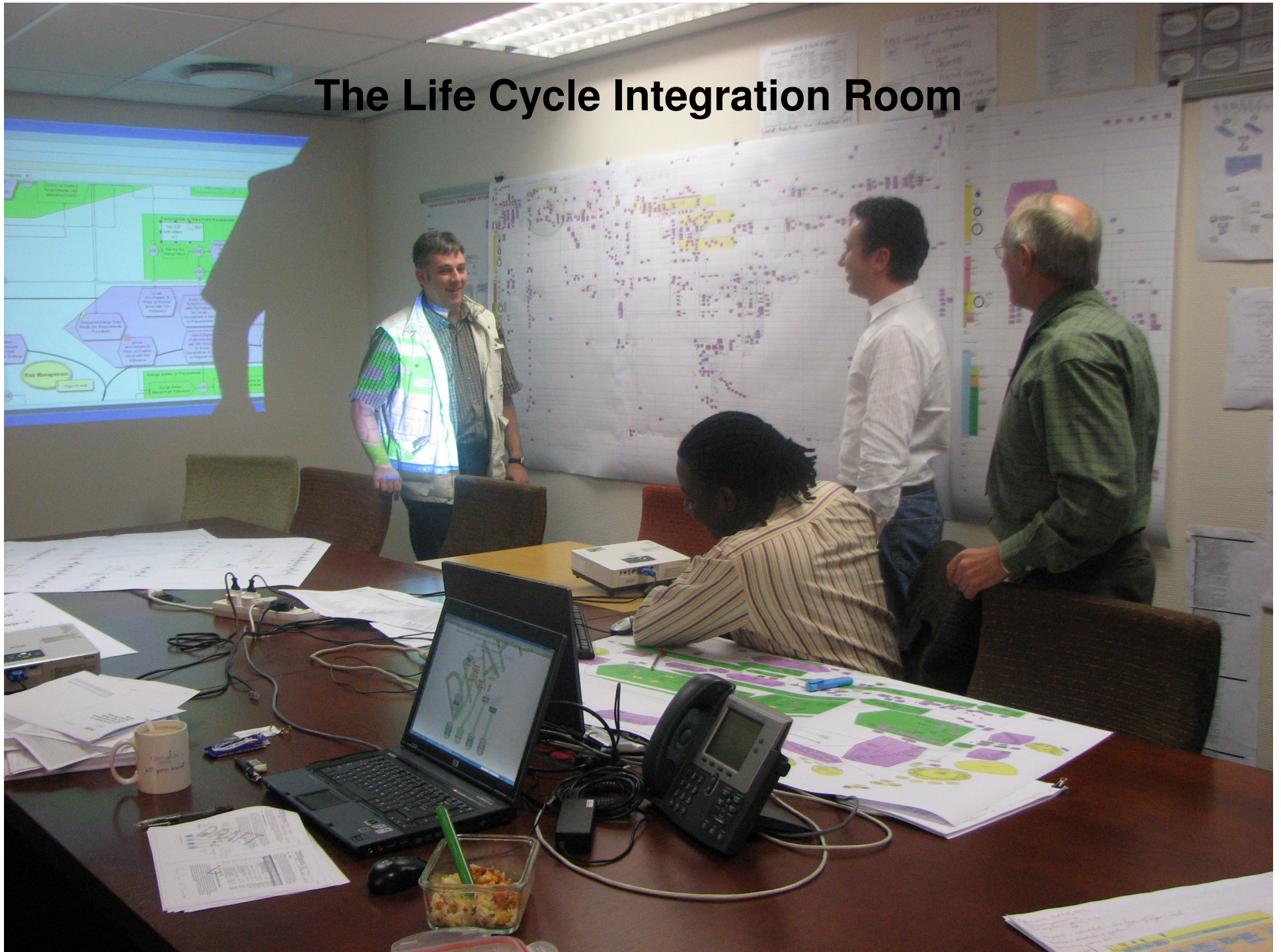
# Bedding the logic down in processes?

- o Processes process groupings are re-fitted between the aligned events
- o The Event Model remains as the foundation/master for process integration verification….
    - ▪ Individual process are interfaced based on the Event Model events
- o Each of the Swim lanes (functional disciplines) can be extracted. The Swim lane over the Life Cycle will be partitioned into processes. There are many processes in the stream, reflecting the intermittent evolvement of the functional discipline

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Completing the Process Integration
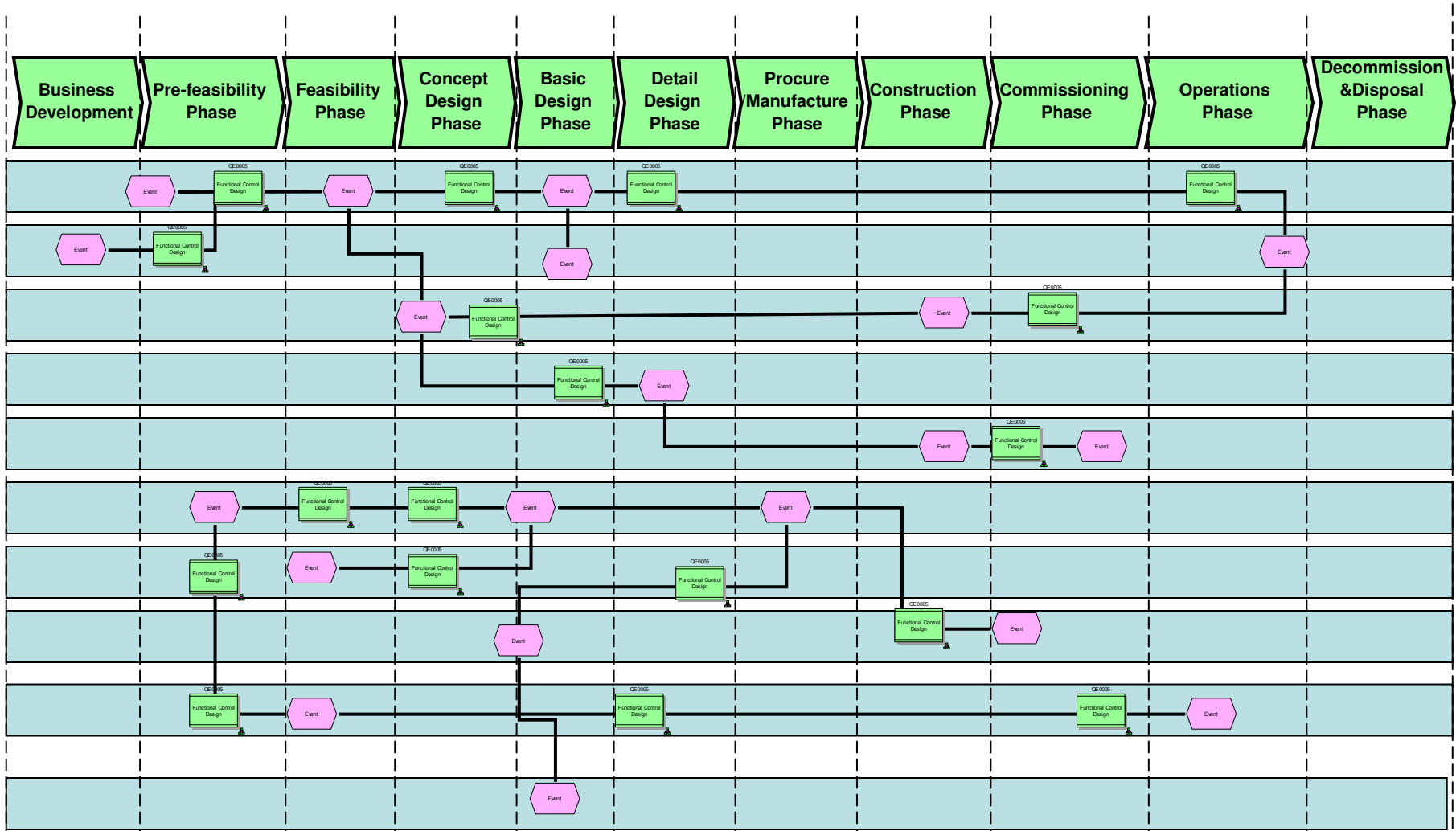
Publishing User Specific Process Integration
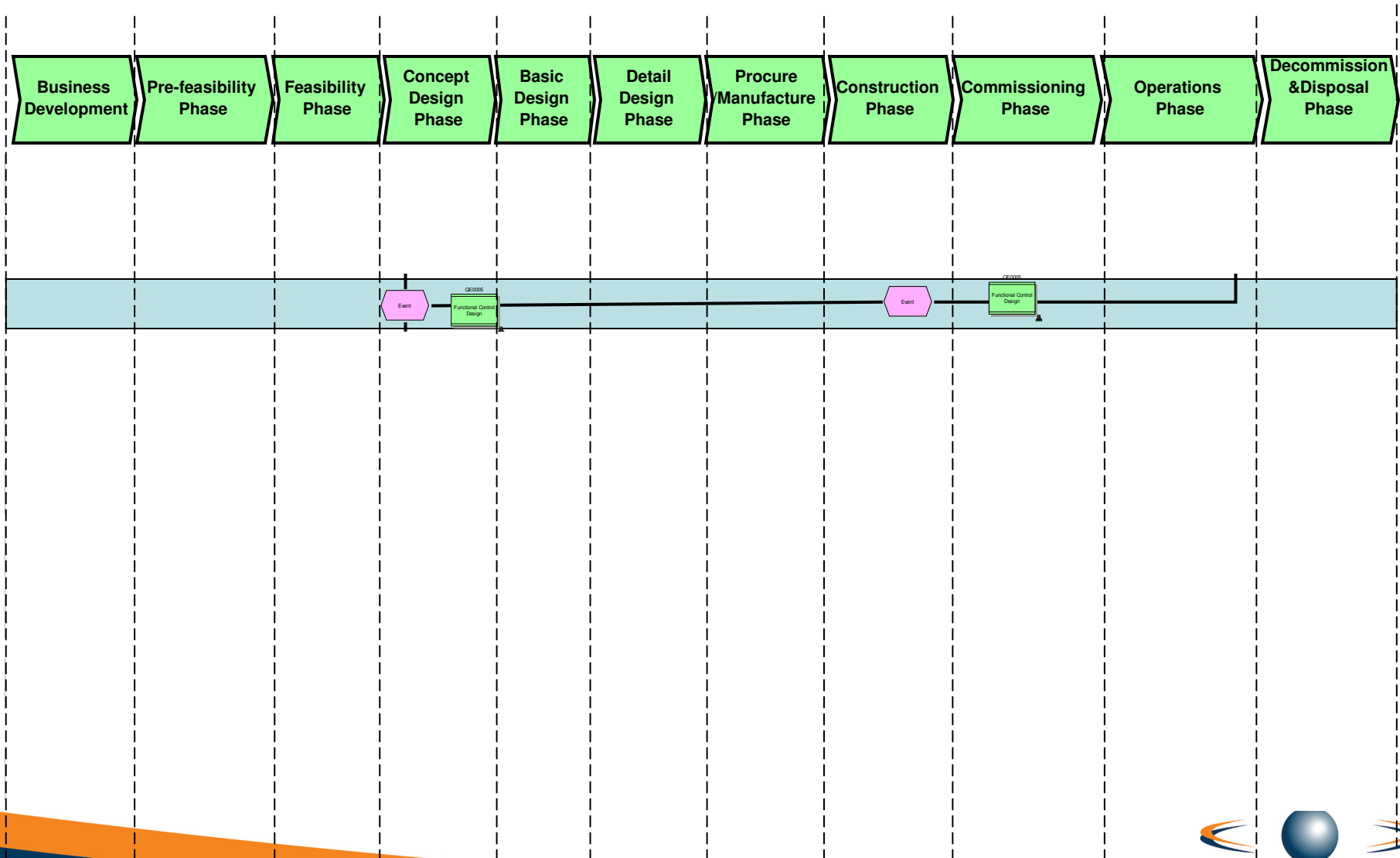
Governance of the high level event logic

o Two way

- Governance of the integrated model itself – difficult because of the complexity and high number of stakeholders. Appoint "owners" of Life Cycle phases as well as functional domains (Swim Lanes). Changes to the model need only be approved by affected owners and not all owners, but under the supervision of the chief business architect

- Governance of the business processes – At process or process group level the event logic mandates the start and end events of a process – no core business process can be defined unless it can be integrated with the event logic.

In this context we are not concerned with the detail or quality of lower level processes, integration is the sole focus.
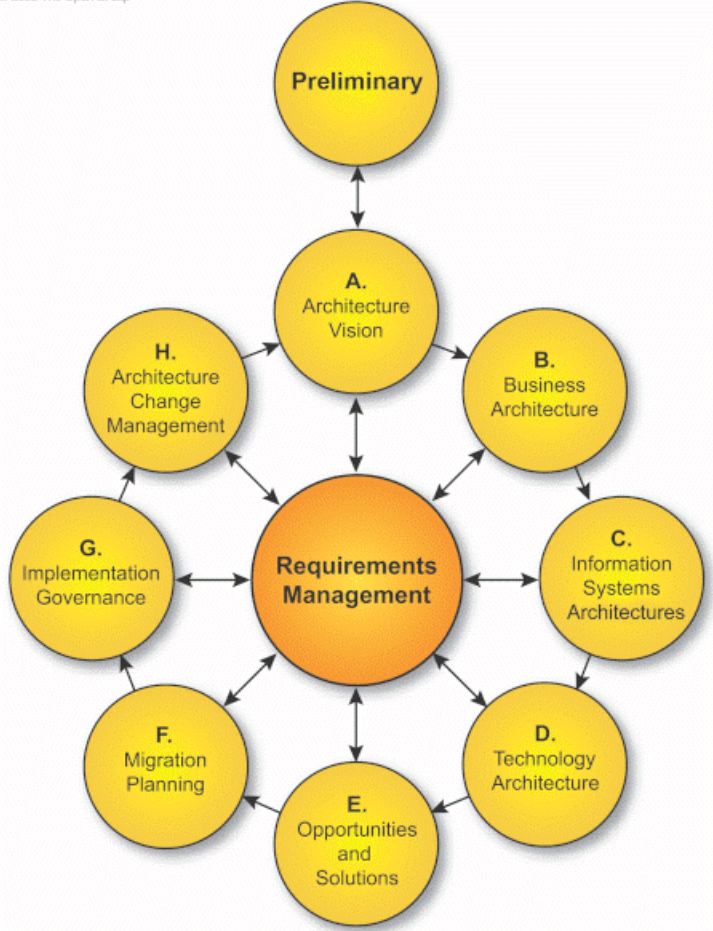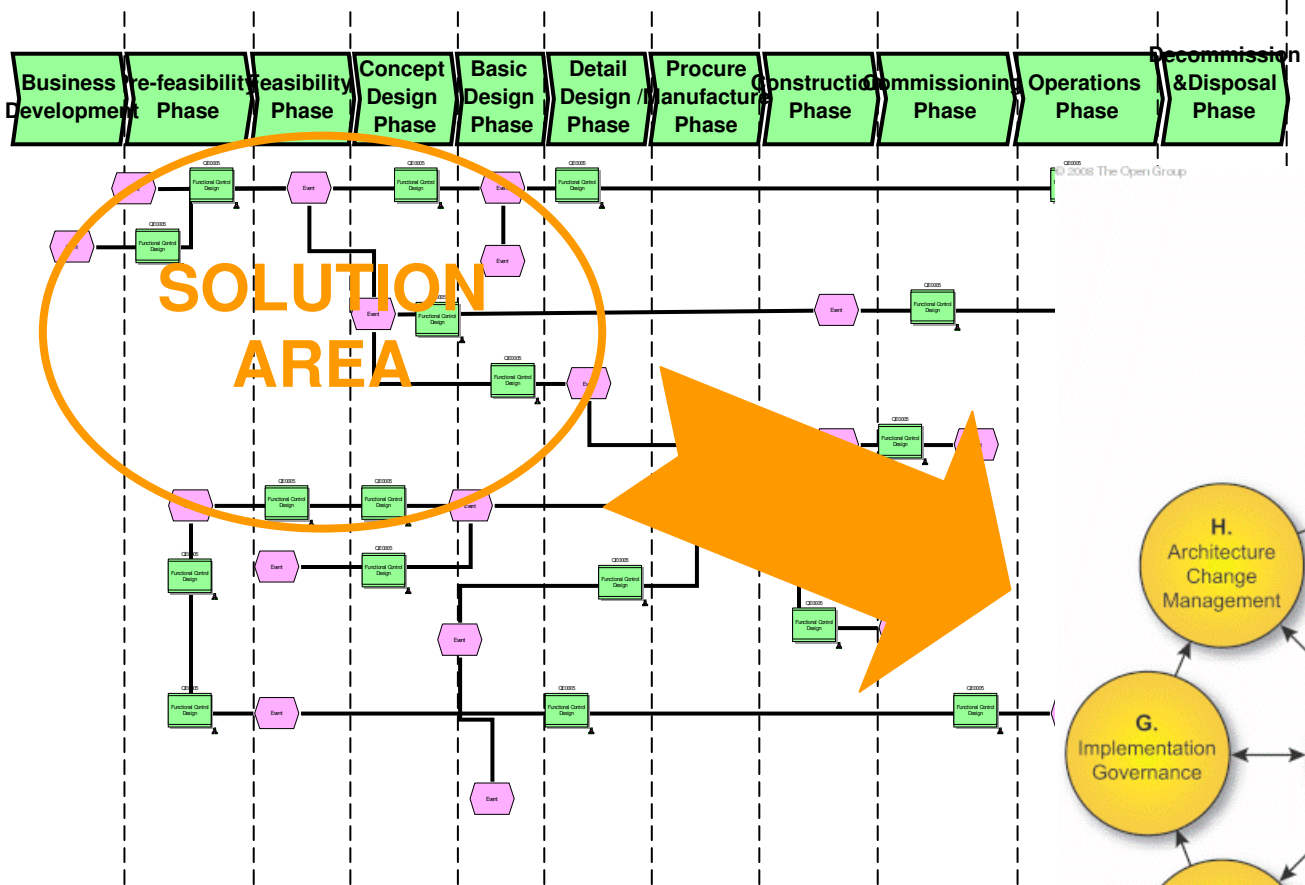
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Next step implementation - The solution approach

o   A solution is viewed as a grouping of functions in specific life cycle stage(s), often strongly aligned with industry solution offerings

o   The context of a solution from the end to end life cycle model, with boundaries and integration points fixed in the model.

o   The value of the end to end life cycle model is to ensure completeness between solutions

o   A solution is handled as a large project with its own stakeholders, following the entire TOGAF ADM to reach maturity

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# Solution Implementation Example

SOLUTION AREA

In conclusion

o PBMR uses the high level life cycle logic model as a tool to manage and govern end to end business integration

o Solutions are identified and positioned on the end-to-end life cycle logic model, and developed as projects following the TOGAF ADM

o The approach is young, but the success and buy-in achieved over the past 8 month is testimony to the success of the methodology

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Thank You

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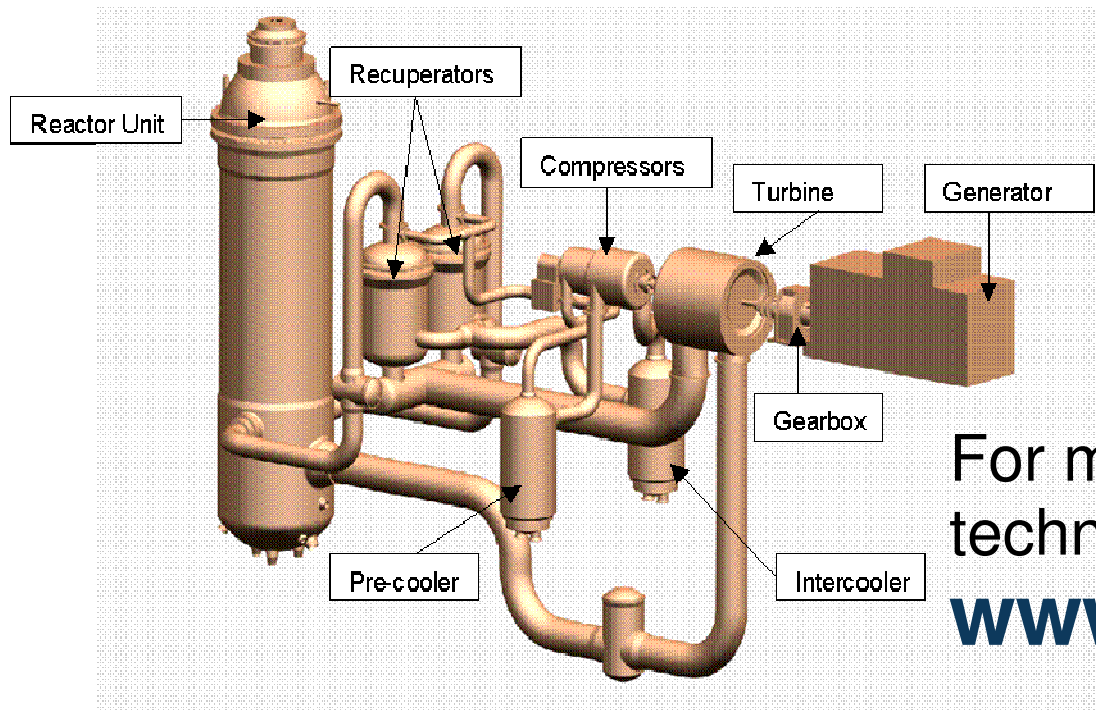
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