Academic Forum

Systems Engineering for General Industries

by

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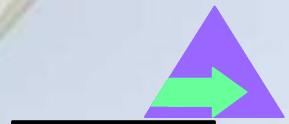

Discussion Points

1. Discussion on General Industries
2. SE Maturity Model on Sustainability
3. Maturity Assessment: General Industries
4. Minimum SE Activities for General Industries
5. Proposed Changes to the Academic Approach

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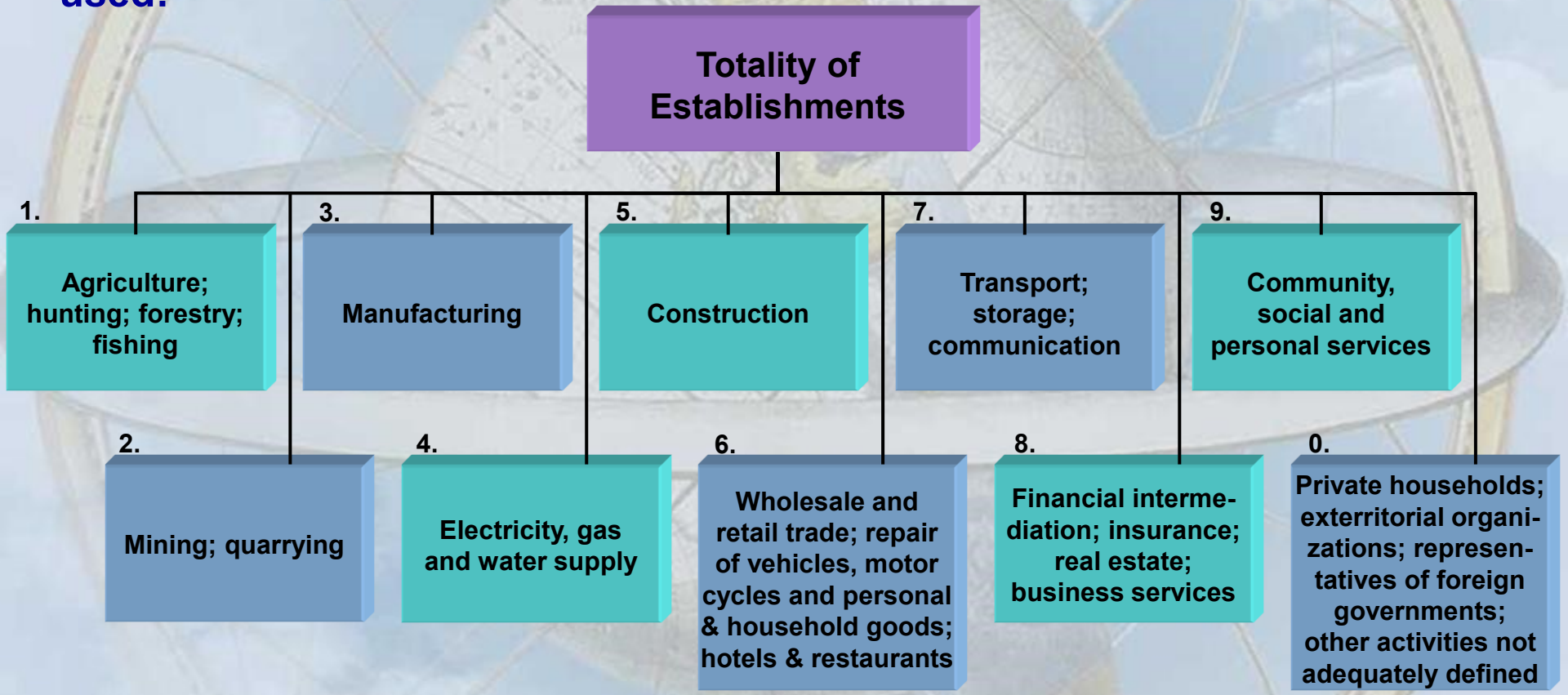
General Industries (1)

A vast number of technical projects, that do not apply SE formally, are in progress at any time in the world. Globally there are probably more project contractors in the EPC, EPCM, Engineering, Manufacturing and Construction sectors than all the contractors in the traditional industries (defence, aerospace, software, etc.) applying SE taken together. The former category (loosely referred to as "general industries") deliver systems that do not get the benefit of the holistic approach offered by SE; hence, many of these systems may not be as efficient, effective, safe and environmentally friendly as what they could have been. The long term impact of these systems on the planet and humanity may be significantly more detrimental than all the systems delivered by the industries practising SE traditionally.

General Industries (2)

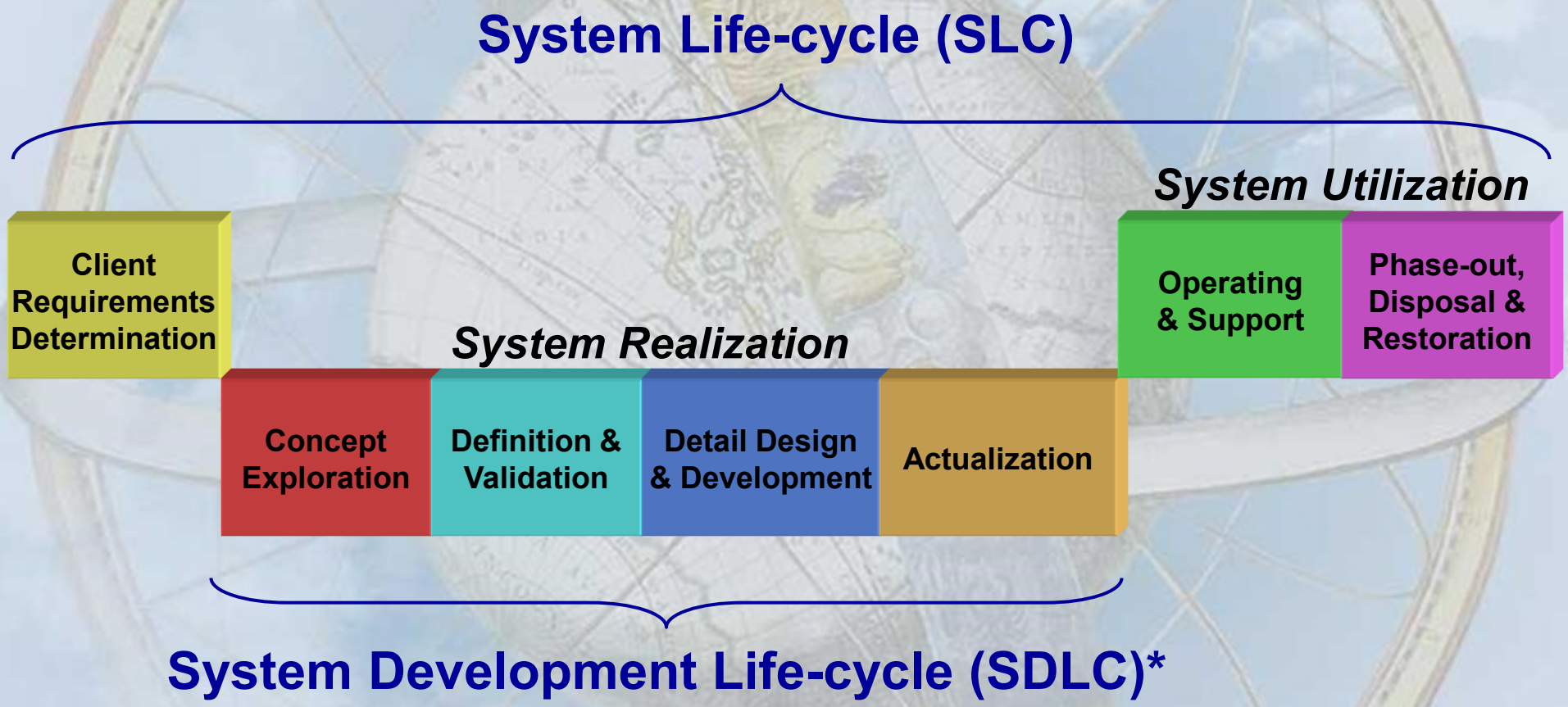
In order to highlight the global extent of these systems, the International Standard Industrial Classification (ISIC) of all economic activities may be used:



Examples of systems:

1. Fish processing plants; 2. Mines; quarries; mineral processing plants; 3. Pulp & paper plants; metals processing plants; oil refineries; food processing factories; foundries; manufacturing plants for plastics, glass, paints, fabrics, chemicals; tanneries; abattoirs; 4. Coal-fired and oil-fired power stations; nuclear power plants; nuclear waste disposal facilities; 7. Airports; 9. Other waste disposal facilities.

Project & System Life-cycles



* The SDLC is sometimes understood as equal to the Project Life-cycle (PLC)

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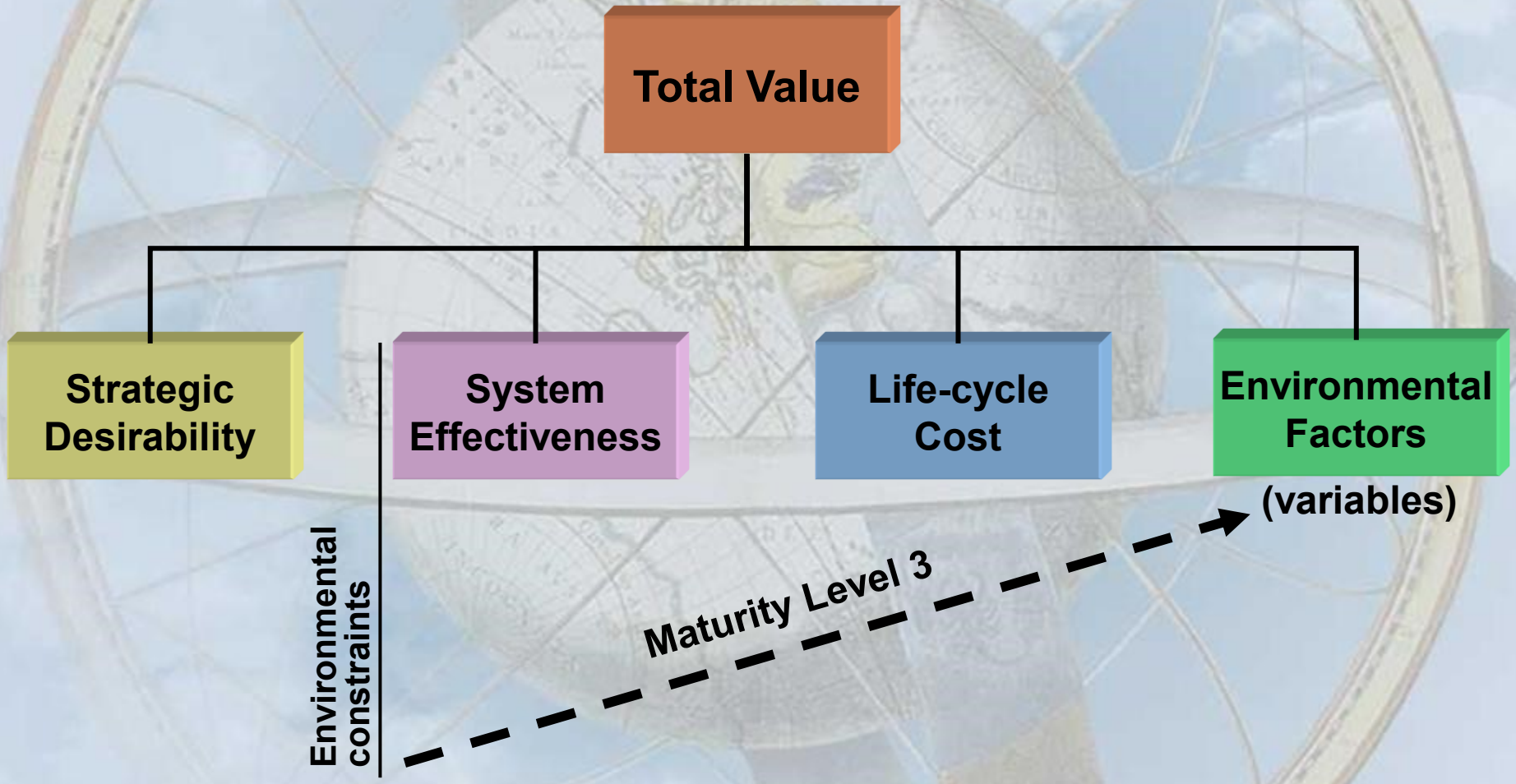
SE Maturity Model on Sustainability

Level No	Maturity Level	Characterized by …
0	Ignorant	Environmental aspects receive little or no attention during the system development life-cycle and the resulting systems are unlikely to meet regulatory requirements.
1	Ad Hoc	Environmental aspects are dealt with in an ad hoc manner and by performing only the minimum of required activities (typically out-sourced to specialist companies) in order to comply with national regulatory requirements. Through-life environmental performance is measured only to satisfy those regulatory requirements that are actually enforced.
2	Integrated	Environmental aspects are fully integrated into project processes and reflected in process maps for the complete system development life-cycle with the objective of meeting regulatory requirements. Through-life environmental performance is monitored to ensure compliance with all regulatory requirements specified.
3	Advanced	Environmental aspects become a top-level area of decision and trade-off (together with effectiveness, cost and strategic desirability) during system selection with the objective to surpass the minimum performance levels of some or all of the regulatory requirements. Through-life environmental performance is monitored comprehen-sively to ensure compliance with all requirements specified.

…. continued

Level No	Maturity Level	Characterized by …
4	Excellent	In addition to Level 3 aspects, environmental performance receives through-life attention to improve performance beyond specified levels, in the same manner that cost and effectiveness are continual-ly improved through-life.
5	Strategic	In addition to Level 4 aspects, consumption minimization of non-renewable and/or environmentally harmful energy resources is one of the stated objectives of the system development life-cycle and receives concerted effort throughout, including energy recovery and recycling approaches.
6	Sustainable	In addition to Level 5 aspects, consumption minimization of all other non-renewable and/or environmentally harmful planet resources is one of the stated objectives of the system development life-cycle and receives concerted effort throughout, including resource recovery and recycling approaches.

Environmental Factors: Advancing from Constraints to Variables



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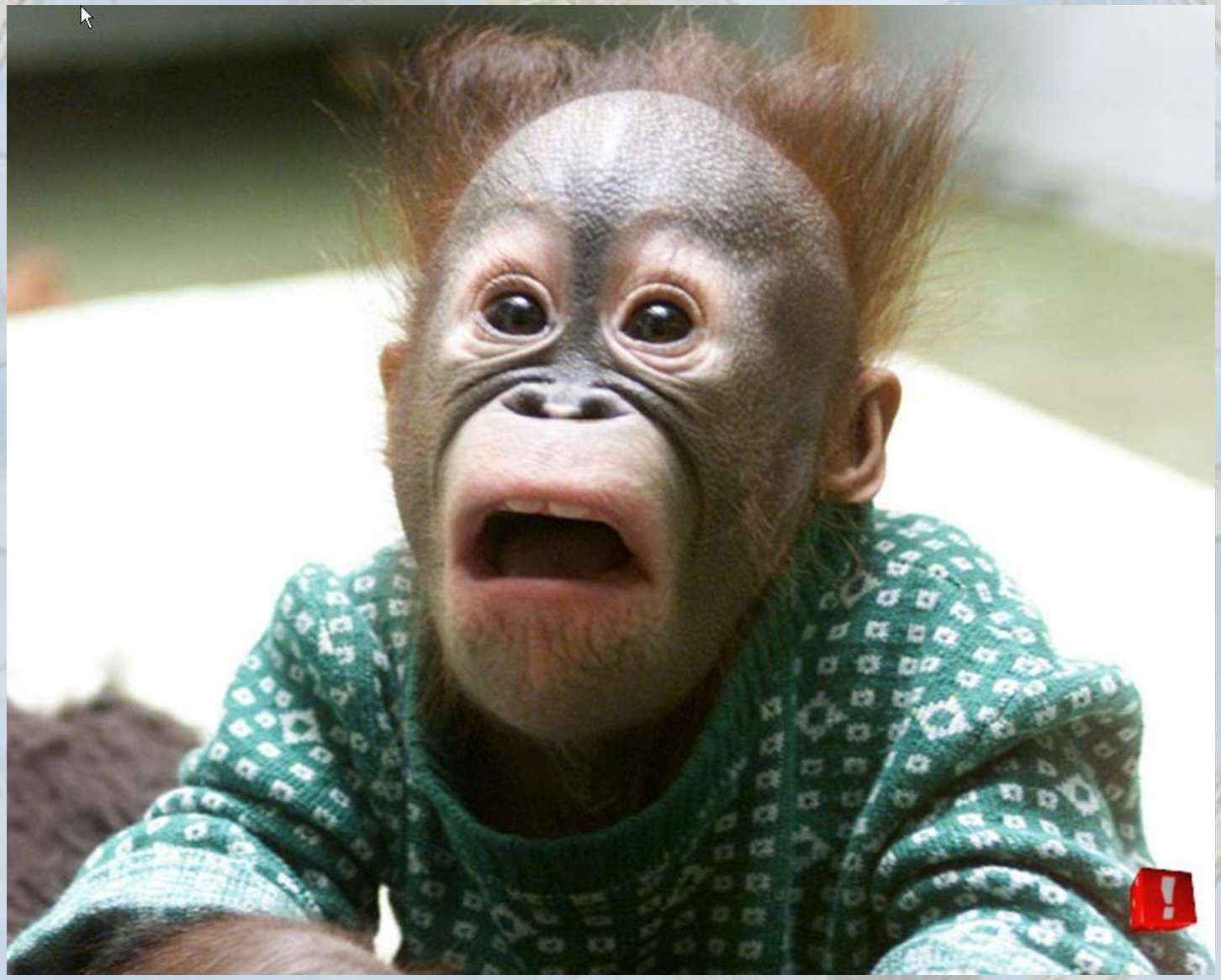
Systems Engineering ???#$%&*???



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Maturity Assessment: General Industries

Where do client, main contractor and specialist contractor businesses in the General Industries currently rate on the maturity model?

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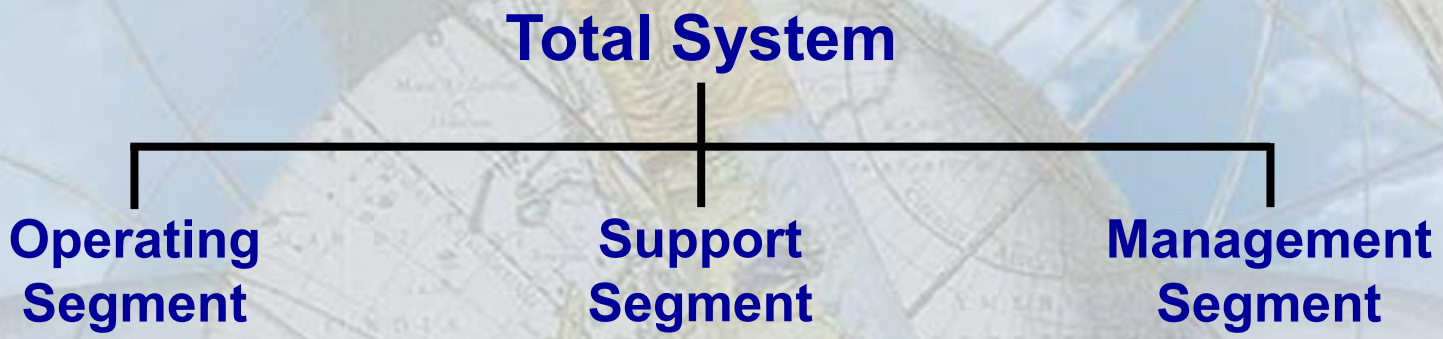
The Concept of a Total System



Total Systems are built from 7 Generic System Elements:

- **Hardware (h/w):** equipment used in operating, support and management of the system
- **Infraware (i/w):** infrastructure, installations, facilities, amenities, etc.
- **Software (s/w):** operating programmes, application programmes, firmware, middleware
- **Bioware (b/w):** people (e.g. operators, maintainers, managers)
- **Dataware (d/w):** documents (e.g. manuals, charts, specifications, drawings, data files, plans, reports)
- **Consumaware (c/w):** consumables (e.g. fuels, lubricants, coolants, cleansers, paper, steam, clothing)
- **Services (ss):** maintenance, cleaning, transport, dataware updating services, etc.

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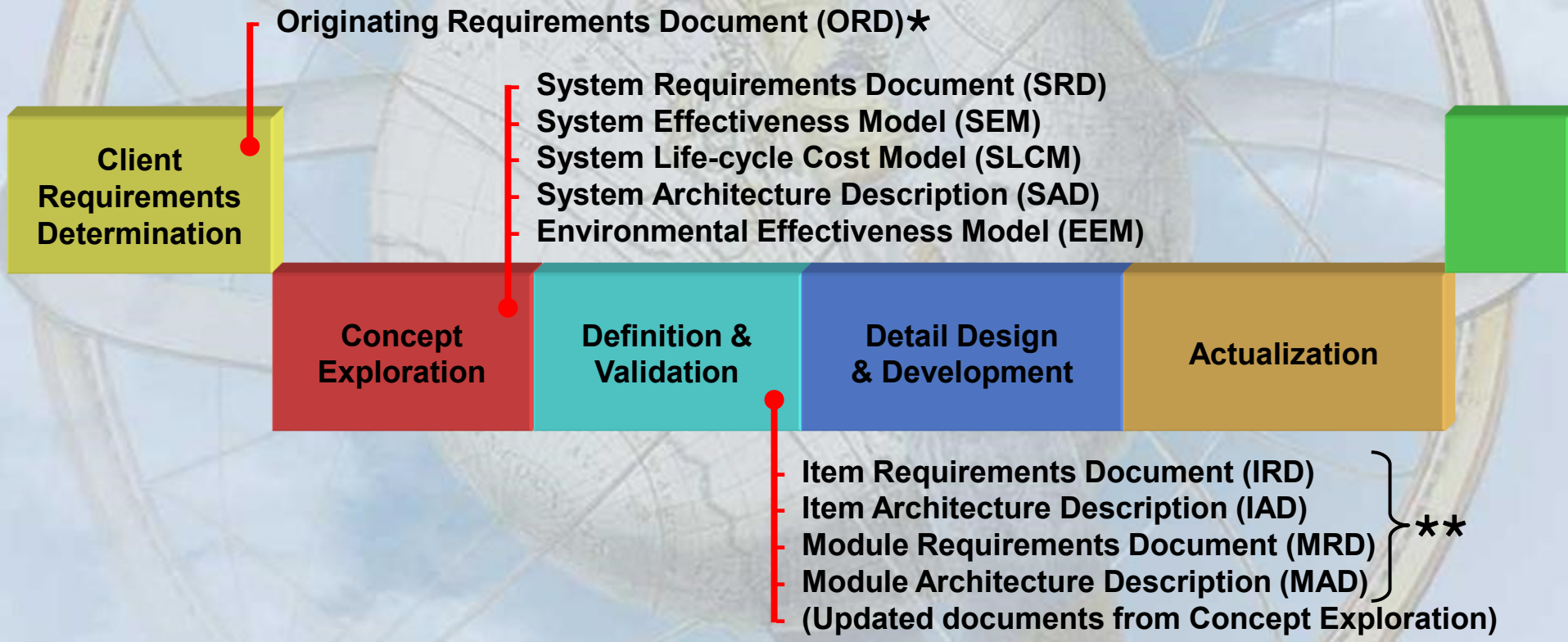
Standard Systems Hierarchy

System	
Level	**Level Name**
9	Global System
8	Societal System
7	Enterprise System
6	User (Business) System
5	System Segment
4	Item
3	Module
2	Component
1	Constituent

Minimum SE Activities for the General Industries

Focus on:
- the three upfront phases of the SLC
- the critical, high priority documents
- all system elements of Total Systems



* [also called: Client Requirements Statement (CRS)]

** [for Items and Modules requiring definition and development]

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Proposed Changes to the Academic Approach

The following changes are proposed in order to reach students on their way to the General Industries, as well as for continuing education of practitioners :

- Start off by teaching about systems first, rather than the SE process. In my experience this works better.
- Emphasize the concept of Total Systems, including an environmental management component. This helps to portray the big picture.
- Focus on the early phases of the SLC, because this is where SE can make a significant difference in systems of the General Industries.
- Adopt a sound process metamodel with embedded high-fidelity dynamics. [Generic end-to-end process descriptions can be confusing.]
- Stress the truth that formality in SE activities add value! [If we claim to know the facts, why not simply "put it on paper".]
- Include at least one semester course on SE at undergraduate level. Students cannot start professional careers without some understanding of this meta-discipline. [Some never go on to M-studies!]

Thank you!

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