ENHANCING THE SYSTEM ENGINEERING PROCESSES






2015 Systems-of-Systems Engineering Workshop

GET CONNECTED to LEARN, SHARE, AND ADVANCE.

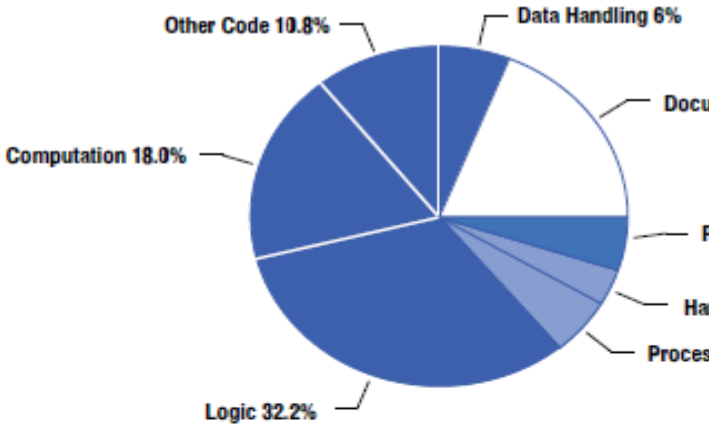
INTRODUCTION

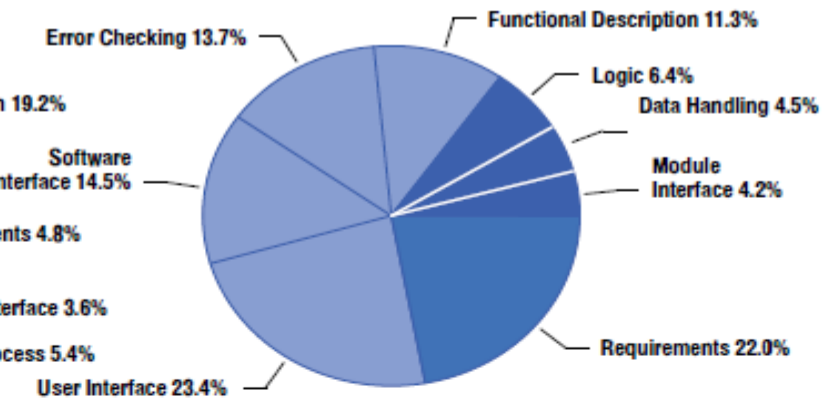
- **There is an increasing trend in systems complexity in the last century. Systems are no longer built by single individuals or by groups from a single discipline.**

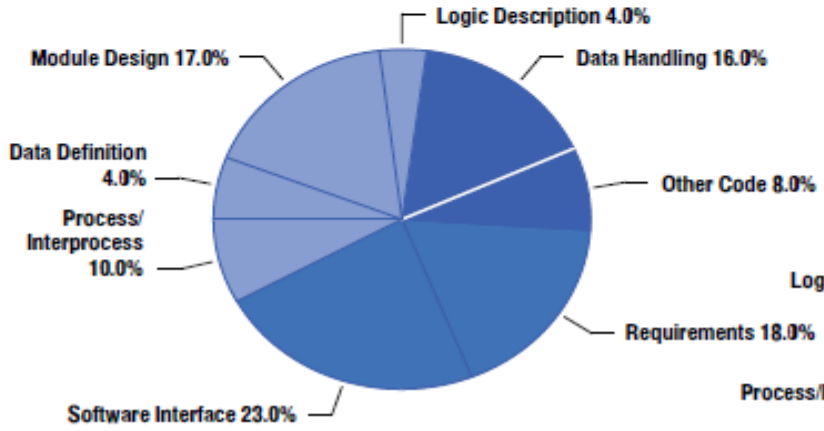
- **All types of scientific, engineering, technology and management disciples must work synergistically to build complex solutions and products.**

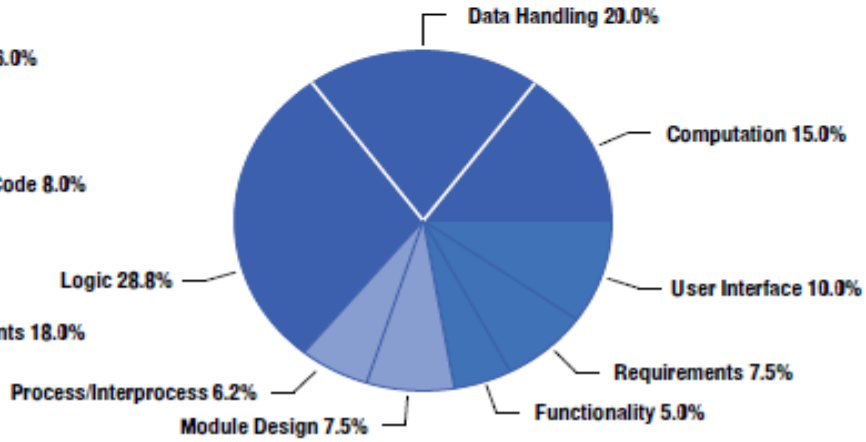
- **18% of system failures are caused by deficiencies in requirements, and so requirements become the focus of improvement.**

SOURCES OF ERROR









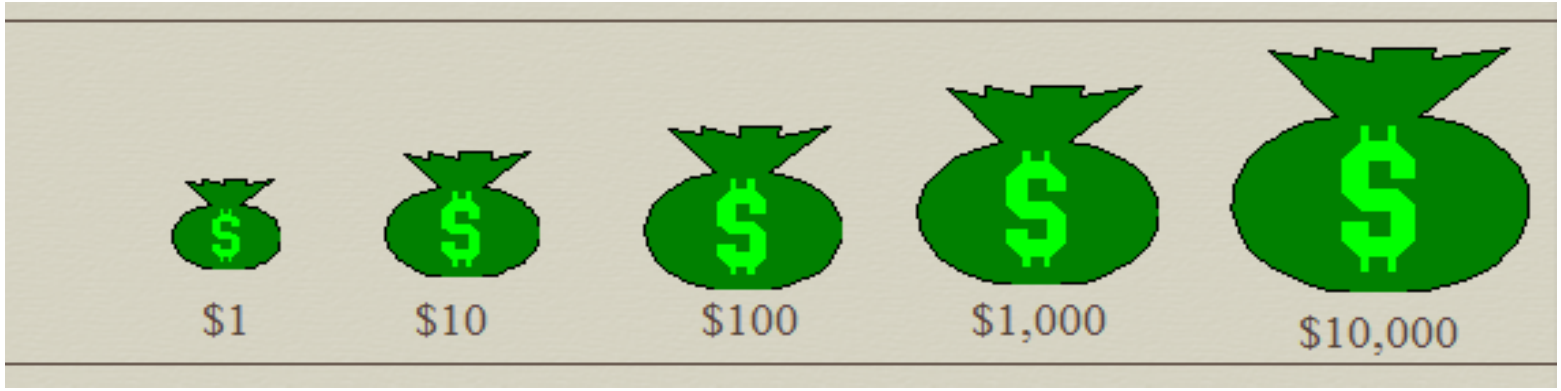
INTRODUCTION (CONTD)

- **An engineer relies on peer reviews, a defect removal technique used to identify and remove major defects from inspected products throughout the lifecycle.**

- **Peer review wastes time finding minor preventable defects, rather than identifying and resolving high impact defects.**

INTRODUCTION (CONTD)

- **Low quality components are delivered, delaying the discovery of defects to late phases of the development cycle, where their removal cost is much greater.**



INTRODUCTION (CONTD)

- **Statistics shows that only 9% of the projects in companies were successful. 31.1% of projects were cancelled before they ever get completed.**
- **Projects completed by the largest American companies have only approximately 42% of the originally-proposed features and functions.**
- **The cost of these failures and overruns are just the tip of the proverbial iceberg.**

INTRODUCTION (CONTD)

RULE OF TEN				
	Defects	Defects Found	Cost to Fix/Detect	Cost
UNIT TESTING & INSPECTION	15,000	13,500	$100	$1,350,000
SYSTEM TESTING	1,500	1,350	$1,000	$1,350,000
UAT	150	135	$10,000	$1,350,000
PRODUCTION	15	14	$100,000	$1,400,000
Total Cost of 500,000 lines of code				**$5,450,000**

REQUIREMENTS CATEGORIZATION

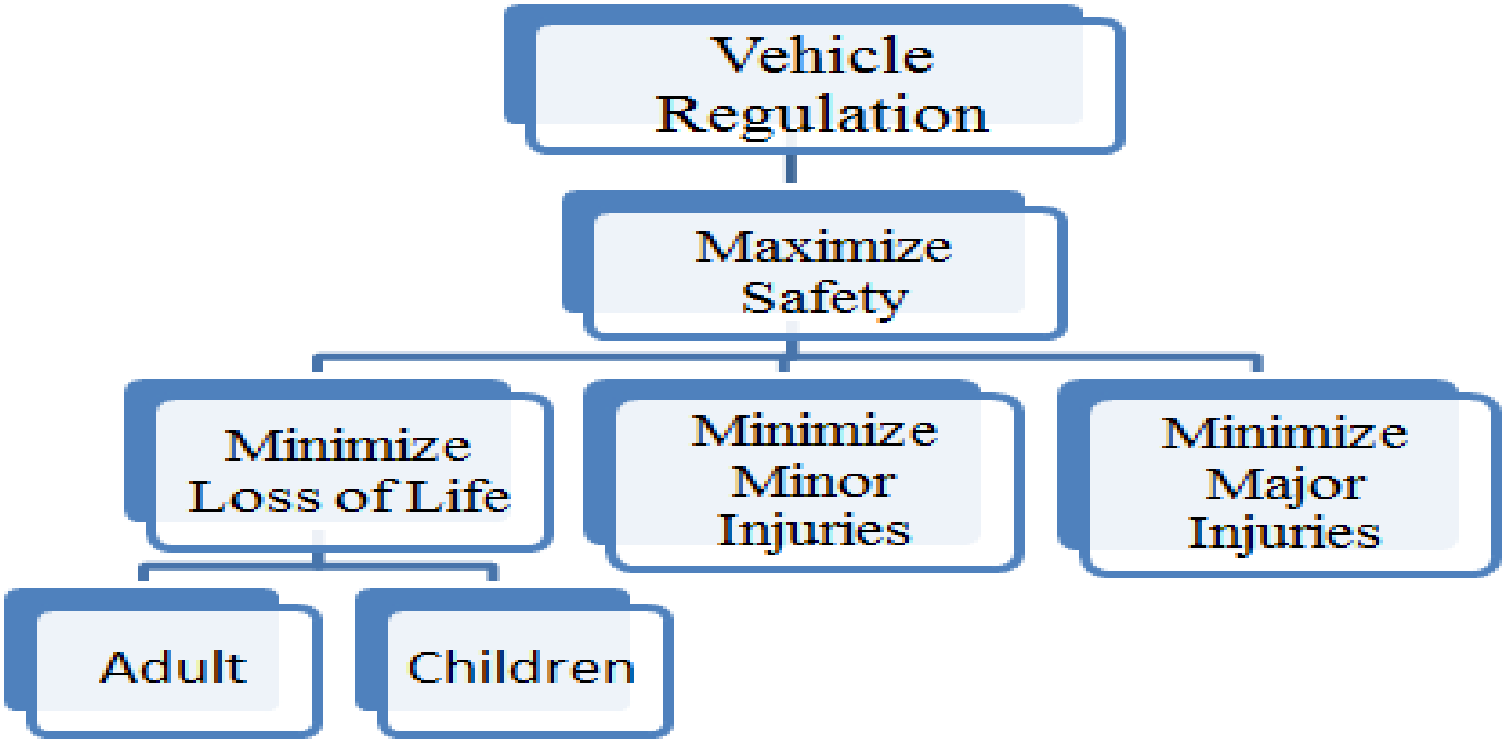
- **According to Laplante, “Part of the challenge in getting the requirements has to do with understanding what the requirement is”**

- **According to Clemen Robert, Fundamental and Means objectives can be explained with an example of a human being in a work environment where humans want to work for minimized time and maximize time with family. Maximize time with family is the fundamental objective and minimize time is the means objective.**

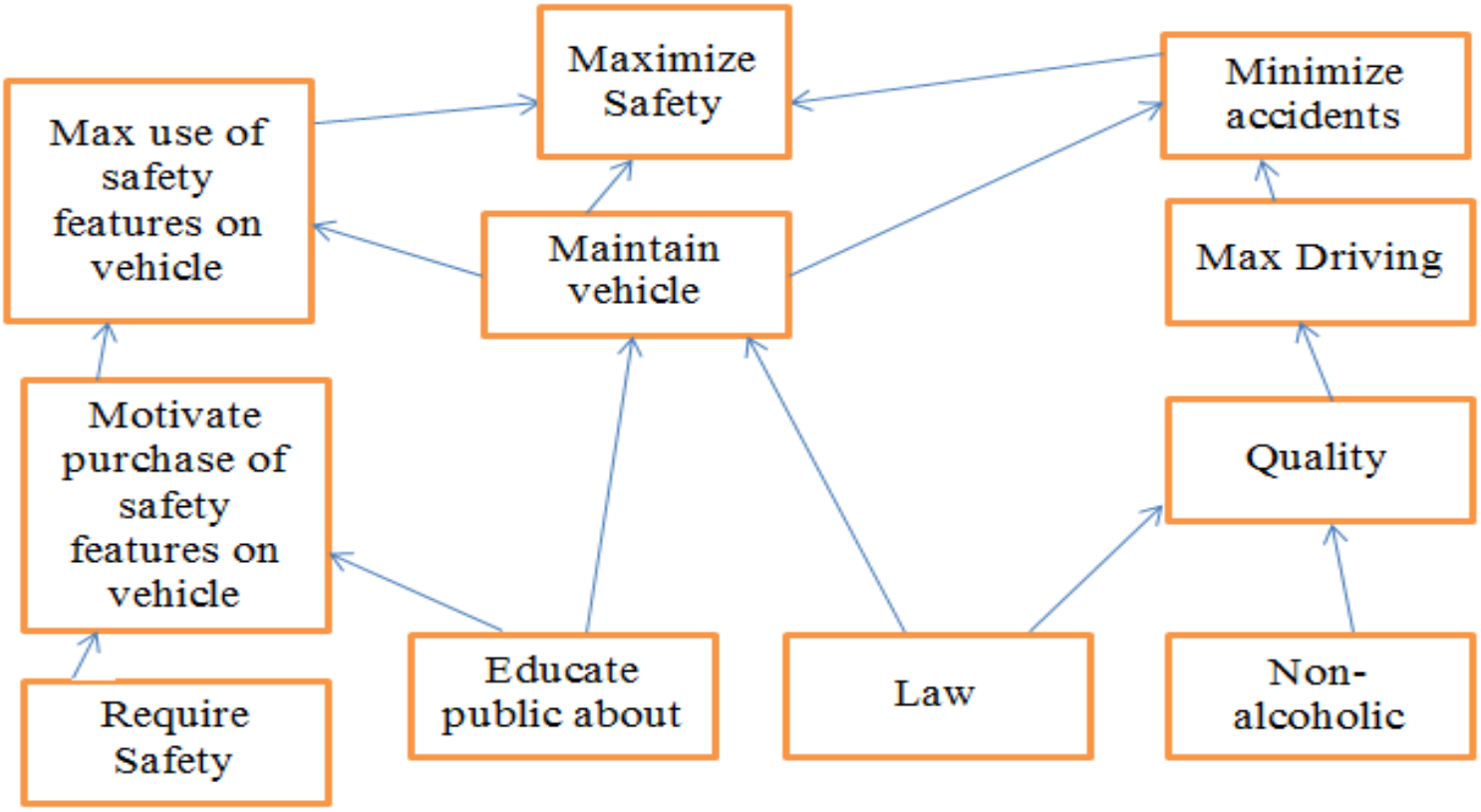
FUNDAMENTAL AND MEANS OBJECTIVES

- **Fundamental objectives are arranged in hierarchies. The upper level is used to represent the abstract and the lower levels can be used to describe the requirements in detail. Means Objectives are arranged in networks .**

FUNDAMENTAL OBJECTIVES



MEANS OBJECTIVES



TECHNIQUE FOR FUNDAMENTAL AND MEANS OBJECTIVES

	Fundamental objectives	Means objective
To move	Downward in Hierarchy	Away from fundamental objective
Ask	What do you mean by that?	How could you achieve this?

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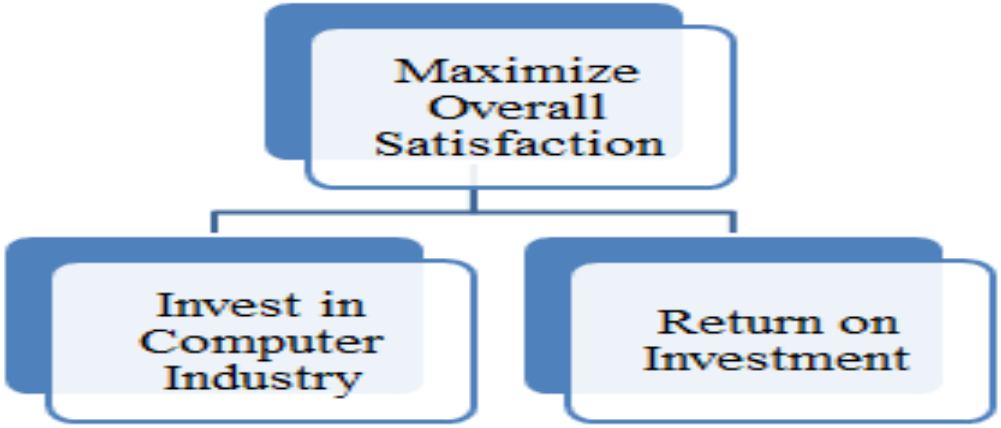
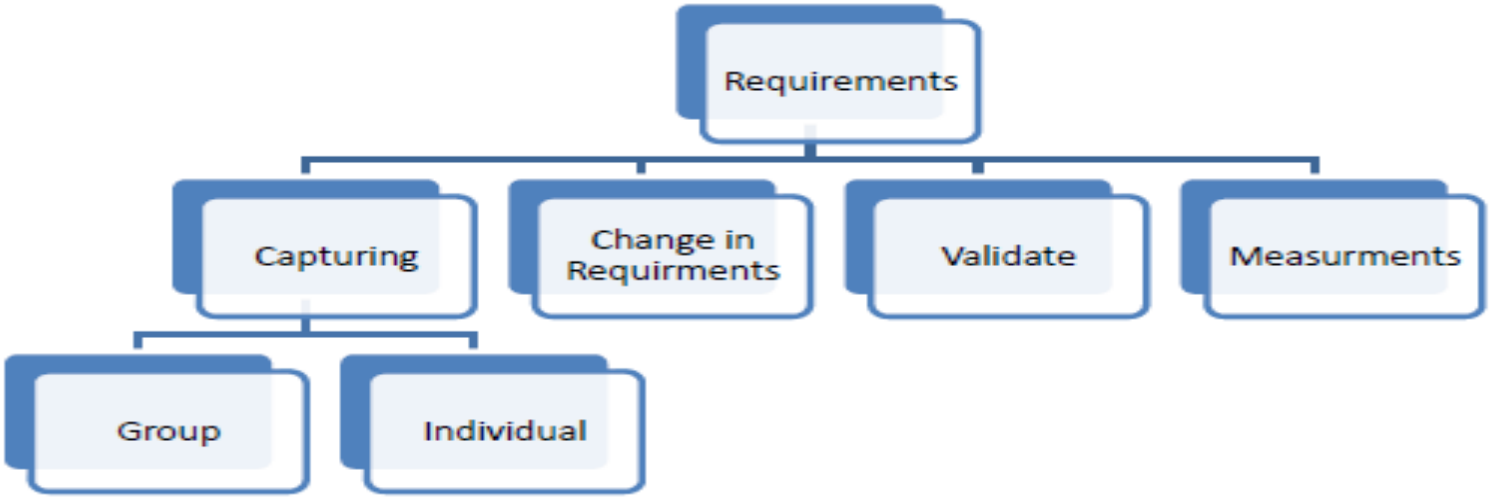
INFLUENCE DIAGRAMS

- **For every decision being made there is a consequence.**



GENERALIZATION OF REQUIREMENTS



LEAN IN SYSTEM ENGINEERING

- **Lean can be applied to the system engineering product lifecycle. Lean is a methodology which is used to eliminate waste, with the goal of creating value and high quality products with short development and production times.**

- **Lean tools that can be used are Kanban and Poka-Yoke.**

KANBAN

- **Kanban is a signal to control inventories between processes and can be used before the beginning of production phase.**
- **Kanban is a signal given to start the production so that the customer gets exactly what they want and when they want it.**
- **One of the eight wastes in lean is excess inventory. By limiting the resources allocated in preliminary design phase engineers can make sure that the resources are not wasted and by continuous improvement product can be developed without defects.**

RULES OF KANBAN

- **The subsequent process should withdraw products from the preceding process in the quantity specified by the Kanban signal.**
- **The preceding process should produce its products in the quantities withdrawn by the subsequent process.**
- **Nothing is produced without Kanban signal.**
- **The number of Kanban should be reduced.**
- **Defective products should never be transported to the subsequent process.**

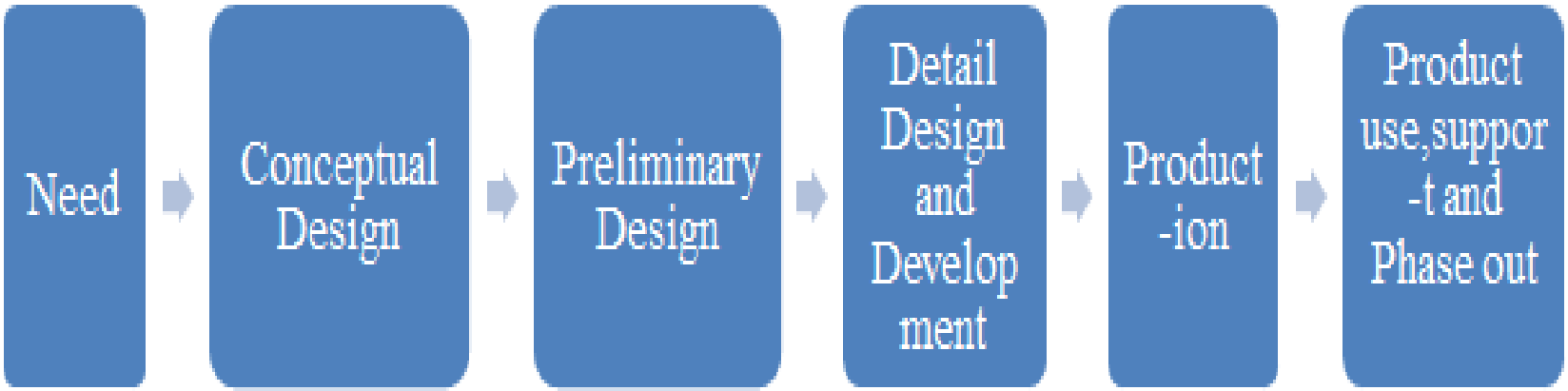
POKA-YOKE

- **Poka-Yoke focuses on the process and looks to detect errors. Poka-Yoke can be applied at the end of each phase so making a transition from one phase to another phase is error free.**

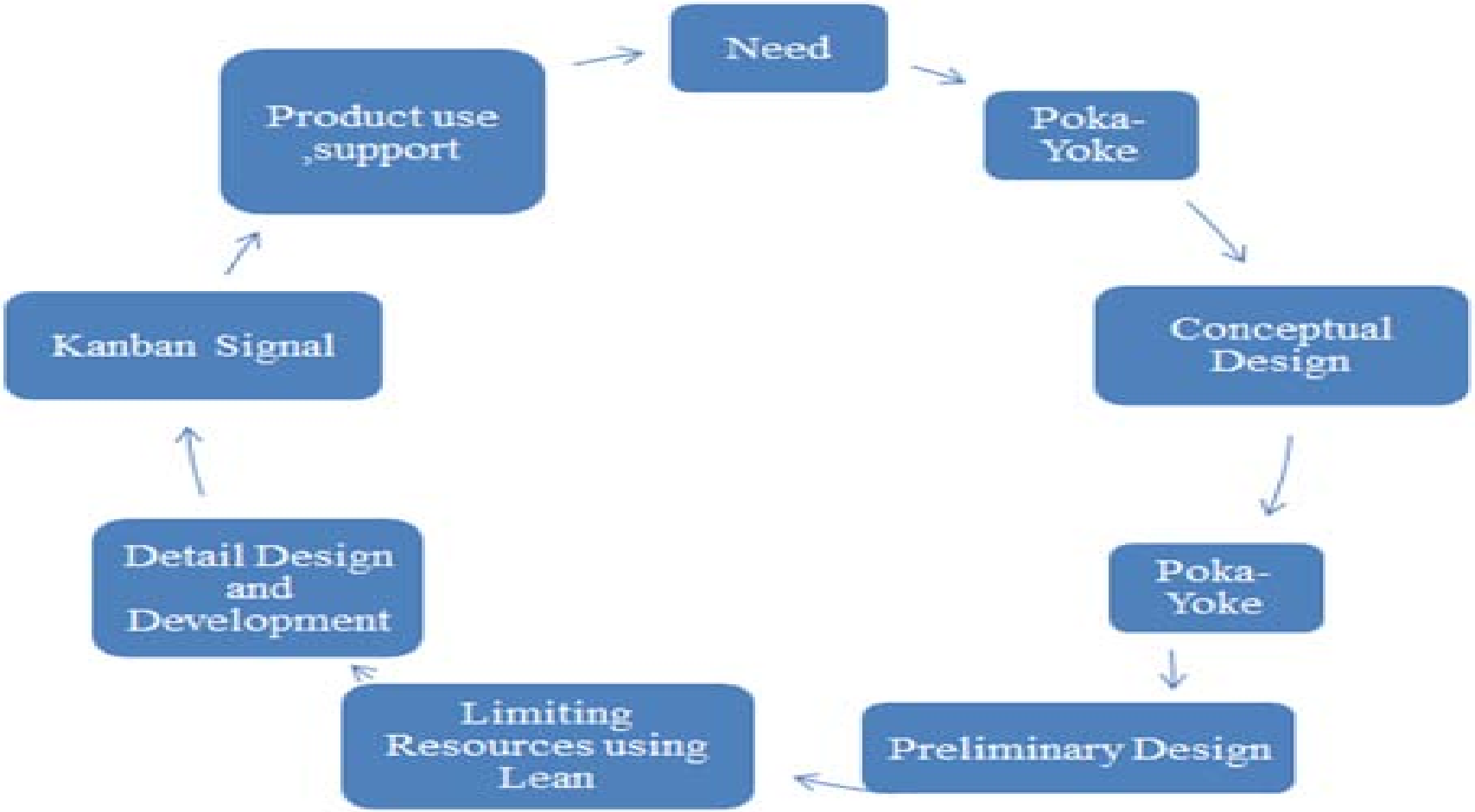
- **Poka-Yoke helps engineers and processes work right the first time.**

- **Poka-yoke refers to techniques that make it impossible to make mistakes.**

SYSTEM ENGINEERING PRODUCT LIFECYCLE



PROPOSED CHANGES TO THE SYSTEM ENGINEERING LIFECYCLE



CONCLUSION

- **The proposed concepts of Fundamental, Means Objective, Influence diagrams and leans tools such as Poka-Yoke, Kanban are introduced to the system engineering processes is a trade -off between spending more time in the front end to produce a product without defect versus spending more time towards the end of the product life cycle to correct the defects and producing a product that is not meeting the customer requirements.**

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