# Six Sigma Green Belt - Study Guides

# A Brief History of Quality

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# 1. History of Quality

***"Quality is never an accident; it is always the result of high intention, sincere effort, intelligent direction and skillful execution; it represents the wise choice of many alternatives "***

**- William A Foster**

- Improving the quality of goods and services offered by a company has been the single most important factor in increasing profits. Additional benefits include:
  - Improving customer satisfaction
  - Building market share
  - Gaining competitive advantage and sustainability in the market.

- High quality has been the cornerstone of all successful companies – and successful companies explicitly mention high quality as their most important strategic goal.

- There has been a lot of theoretical study about how to improve quality. Some important quality paradigms that we will review in this course include those from quality gurus like Deming, Juran, Crosby, Ishikawa and Taguchi

# 1.a W Edwards Deming

- Dr. W. Edwards Deming (Oct 1900 – Dec 1993) was born in Sioux City, Iowa, USA. Deming did his BS in Electrical Engineering and followed that with a Masters Degree and PhD from Yale University. Deming was instrumental in the rise of Japan as a manufacturing power and in the invention of theories for “Total Quality Management.” Some important tenets of Deming’s philosophy:
  - Use of statistical process control to identify special and common cause variations – special cause variations are erratic and unpredictable but common cause variations are inherent in the system. Ultimately, our objective should be to eliminate special cause variations and decrease common cause variations to improve quality of goods produced.
  - Quality depends on the policies of management and if management creates appropriate conditions and motivations for workers to improve quality, it will result in every worker contributing to a better quality product. His “Theory of Profound Knowledge” talks about how management should create conditions where every worker contributes towards quality improvement.
  - (Proposed) Use of the “Plan → Do → Check → Act” Model to improve quality
- Deming wrote a book called “Out of the Crisis” which set out 14 Management Guidelines which could be used by US companies to improve quality and compete with Japanese manufacturing.
- To facilitate Dr. Deming for his contribution to quality, Japanese Union of Scientists and Engineers (JUSE) has incorporated the “Deming Prize” for significant contributions made to product quality and statistical quality control.

# 1.b Joseph M. Juran

- Joseph M. Juran (Dec 1904) was born in Romania but emigrated to the US when he was 8 years old. Juran got his BS in Electrical Engineering and subsequently worked in Western Electric as a Manager.

- Some important tenets of Juran's philosophy:

  - Use of Pareto principle (80 – 20 rule) i.e. 80% of quality improvement is possible by fixing 20% of the problems. This rule helps in separating the vital few from the trivial many.
  - Quality from a customer perspective has two aspects : a) more features and b) freedom from trouble. So, improvement of quality should deliver these two aspects to customers.
  - Juran wrote a book called "Quality Control Handbook" which provides information to companies for improving performance through better quality.
  - Use of "Quality Trilogy Model" – this model uses Quality Planning, Quality Improvement and Quality Control for improving quality.
  - Hands-on involvement by management is necessary in the quality effort.

- In 1979, Juran founded the "Juran Institute" which has since become a leading institute for quality education worldwide and provides quality consultancy to several leading corporate houses.

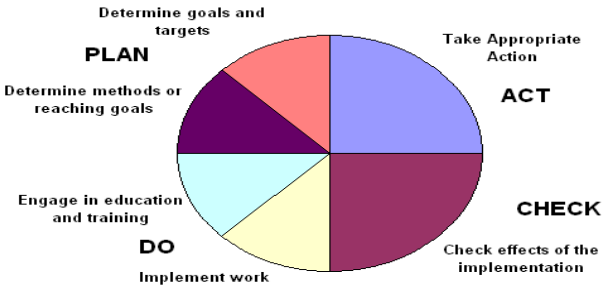
# 1.c Philip Crosby

- Philip Crosby (June 1926 – Aug 2001) was born in Wheeling, West Virginia, US. He worked in the Navy and graduated from the Ohio College of Podiatric Medicine in Cleveland. However, medicine did not excite him. He became very interested in quality issues in 1952, after he joined the American Society for Quality Control. Some important tenets of Philip Crosby's philosophy:
    - Quality should be defined as "conformance to requirements" and not a vague concept about "exceeding customer expectations".
    - Plan for "Zero Defects" – anything less is not acceptable.
    - Measurement of quality is the cost of non-conformance.
- In 1979, Philip Crosby founded the "Philip Crosby Associates" which taught management the importance of "Zero Defects" quality and the necessity of creating processes which do things right the first time.

# 1.d Kaoru Ishikawa

- Kaoru Ishikawa (1915 – April 1989) was born in Japan. He graduated in 1939 from Tokyo University with a major in chemistry. He was one of the pioneers of Quality Circle in Japan in the 1960's. He was also the recipient of the Deming Prize and the Nihon Kezai Press Prize. Some important tenets of Ishikawa's philosophy:
  - Use of cause and effect diagrams (also referred to as Ishikawa or Fishbone diagrams) to systematically list all the causes that can be attributed to an effect (or problem).
  - Expansion of Deming's Plan-Do-Check-Act Model.
  - Quality improvement is always a continuous process and can be taken a step further.
  - Importance of using quality tools like control chart, run chart, histogram, scatter diagram, Pareto diagram and flow chart.
  - Important  for all the employees of the organization to contribute towards better quality.(Importance of the contribution of all the employees of the organization towards better quality.)

**Ishikawa's quality model**



# 1.e Genichi Taguchi

- Genichi Taguchi was born in January of 1924 in Takamachi, Japan and studied technical engineering at Kiryu College. After the Second World War, Japanese companies had limited resources and were perceived as providing low quality goods. In the era where good quality was considered expensive, Taguchi revolutionized the concept of improving the quality of goods produced while simultaneously reducing costs. He is considered by many as instrumental in the emergence of Japan as a manufacturing power. Some important tenets of Taguchi's doctrine:
    - Manufacturing processes are impacted by external disturbance i.e. noise which impacts the quality of goods produced. Noise should be minimized wherever possible but some noise (e.g. bad weather) cannot be avoided. Systems should have "robustness" i.e. ability to function satisfactorily in spite of the noise and external disturbance.
    - Concept of "Quality Loss Function" is used to quantify decrease in the perceived value of the goods by the customer once the quality decreases.
    - Use of "Design of Experiments" – a concept which we will study later in the Six Sigma course.
- Taguchi was a recipient of the Deming Prize. He also received the "Indigo Ribbon" from the Japanese Emperor for his contribution to Japanese quality and industry.

# 2. Evolution of Six Sigma – difference from other traditional Quality Methods

- The origins of Six Sigma can be traced back to Johann Carl Frederick Guass,(1777 -1855) a legendary German mathematician and physicist. In 1818, he started working on the normal distribution which forms the basis of Six Sigma philosophy.
- The person who first coined the term “Six Sigma” was Bill Cohen, an engineer with Motorola. Later, in 1986, Bill Smith, a senior scientist at Motorola, standardized the way in which defects are measured using Six Sigma. Instead of measuring defects in thousands of opportunities, Six Sigma provided the ability to measure defects in millions of opportunities – thereby providing significant improvement in quality.
- Since that time, several companies including Motorola, Citibank, General Electric, Allied Signal etc. have achieved dramatic success by using Six Sigma methodology for improving quality and reducing costs (for example, Motorola has documented $ 16 billion in savings because of its Six Sigma efforts).
- There are several factors that make Six Sigma a more effective quality tool when compared with other traditional quality techniques namely:
    - Comprehensive
    - Project based approach
    - Cohesive process based approach
    - Quantitative approach
    - Commitment from all levels of organization

# 2.a Comprehensive

- Six Sigma is a very comprehensive methodology, which includes the best practices from other traditional quality techniques. The Six Sigma DMAIC Methodology looks at the whole project life-cycle including Define, Measure, Analyze, Improve and Control with well-defined tools and methodology at each stage (we will be learning more about the Six Sigma Methodology at a later stage in the course).

- It links directly to business goals and customer expectations.

- Since the Six Sigma Methodology is so comprehensive and very well defined, it can be used by

    - Companies across different business areas including Manufacturing, Finance, Technology, Construction, Engineering etc.
    - Companies of different sizes – big, medium or even small companies with less than 30 employees

# 2.b Project Based Approach

- Unlike traditional quality techniques, Six Sigma explicitly uses concepts of project management, and so enjoys several benefits of a project i.e. every Six Sigma project has a defined start date and end date, and a pre-defined project charter with goals, objectives and deliverables.

- Project planning tools like project plan, Gantt charts, PERT, planning trees etc are used for managing the project and require proper knowledge of different project management knowledge areas:
  - Project integration management
  - Project scope management
  - Project time management
  - Project cost management
  - Project quality management
  - Project human resource management
  - Project communication management
  - Project risk management
  - Project procurement management

# 2.c Cohesive Process Based Approach

- Detailed process maps created during the initial stages of a Six Sigma project provide an overview of complex processes in an organization, identify relationships and interdependencies between the processes and facilitate identification of problems.

- A Finance department is involved in estimation and validation of project financials and cost benefits from the project.

- Six Sigma methodology can evaluate different aspects within an organization including people, equipment, environment, materials etc. and identify the projects which can provide maximum benefits to the organization.

- Cohesive process based approach helps in getting a holistic view of the organization and identifying potential problem areas – Six Sigma projects can then be used to fix the problems identified.

# 2.d Quantitative Approach

- Since several traditional quality improvement approaches did not use rigorous quantitative methods, it was very difficult to measure the cost and benefits of those quality initiatives. By using rigorous quantitative and statistical techniques, Six Sigma provides mathematical analysis to determine which project offers the maximum benefit at the least cost i.e. all Six Sigma projects have measurable and quantifiable goals and associated costs.

- Following the quantitative Six Sigma concepts also helps to ensure that

    - The project goals align with the organizational goals
    - There are long-term benefits from the Six Sigma project.

# 2.e Commitment from all Levels of the Organization

- Six Sigma formalizes an organizational structure for Six Sigma projects and ensures commitment from all levels of the organization to achieve the quality goals. All the stakeholders – customers, senior management, project team members and other employees have a vested interest in the successful implementation of Six Sigma projects.
    - Executive Management (also referred to as Deployment Champions) is responsible for sponsorship of the project and allows for commitment of organizational resources to the Six Sigma project.
    - Master Black Belts and Black Belts act as consultants and experts in Six Sigma. They are also responsible for providing guidance and coaching to others in the organization about Six Sigma philosophy.
    - Six Sigma Green Belts serve as a liaison between the Black Belts and the project team. They perform the operations required for the Six Sigma project and work with the project team to ensure that appropriate deliverables are met.
    - The project team works in executing the actual work of the project through guidance provided from by Six Sigma Green Belts and Six Sigma Black Belts.
    - Subject Matter Experts in different fields (e.g. Finance, Human Resources etc.) may be involved in providing expertise wherever required.

# 2.e Commitment from all Levels of the Organization (continued)

- Proper training and motivation is provided to all the people involved in the Six Sigma project to ensure successful project implementation.

- Having a well-defined organization structure helps in creating a feeling of “shared ownership and responsibility” which can be critical in successful project implementation. More importantly, with well defined project hierarchy and pre-defined roles and responsibilities, all Six Sigma stakeholders know their tasks and work towards successful project implementation.

# 3. Defining Six Sigma – Philosophy and Objectives

- Literally, Six Sigma refers to decreasing the number of defects to 3.4 defects per million opportunities (i.e. success rate of 99.9997%). It attacks variation in processes, minimizing defects and waste, and thereby improving bottom-line.

- Six Sigma philosophy strives towards perfection. The scope of Six Sigma includes tools and techniques for careful definition, analysis and measurement of business processes to improve process capability. It relies greatly on statistical techniques to measure and quantify success. A lot of emphasis is also put on controlling existing processes to ensure that the processes do not deteriorate over time.

- Six Sigma is a comprehensive quality methodology that can be used to clearly understand an organization's business processes and customer needs, and either redesign the business processes or provide/ make incremental process improvements as desired.

# 3.a Defining Six Sigma – Philosophy and Objectives

Some highlights of Six-Sigma:

- Six Sigma is a business philosophy and top management driven.
- Six-Sigma is a problem solving methodology
- Six-Sigma is a metric to measure quality and process reliability.
- Six-Sigma focuses on both customer and bottom line.
- Six-Sigma is a highly quantitative approach to fixing quality problems.

# 3.b Defining Six Sigma – Philosophy and Objectives

| Six Sigma Score | Defects per million Opportunities | Okay Percentage |
|---|---|---|
| 2 | 308537 | 69.15% |
| 3 | 66807 | 93.32% |
| 4 | 6210 | 99.38% |
| 5 | 233 | 99.98% |
| 6 | 3.4 | 99.99966% |

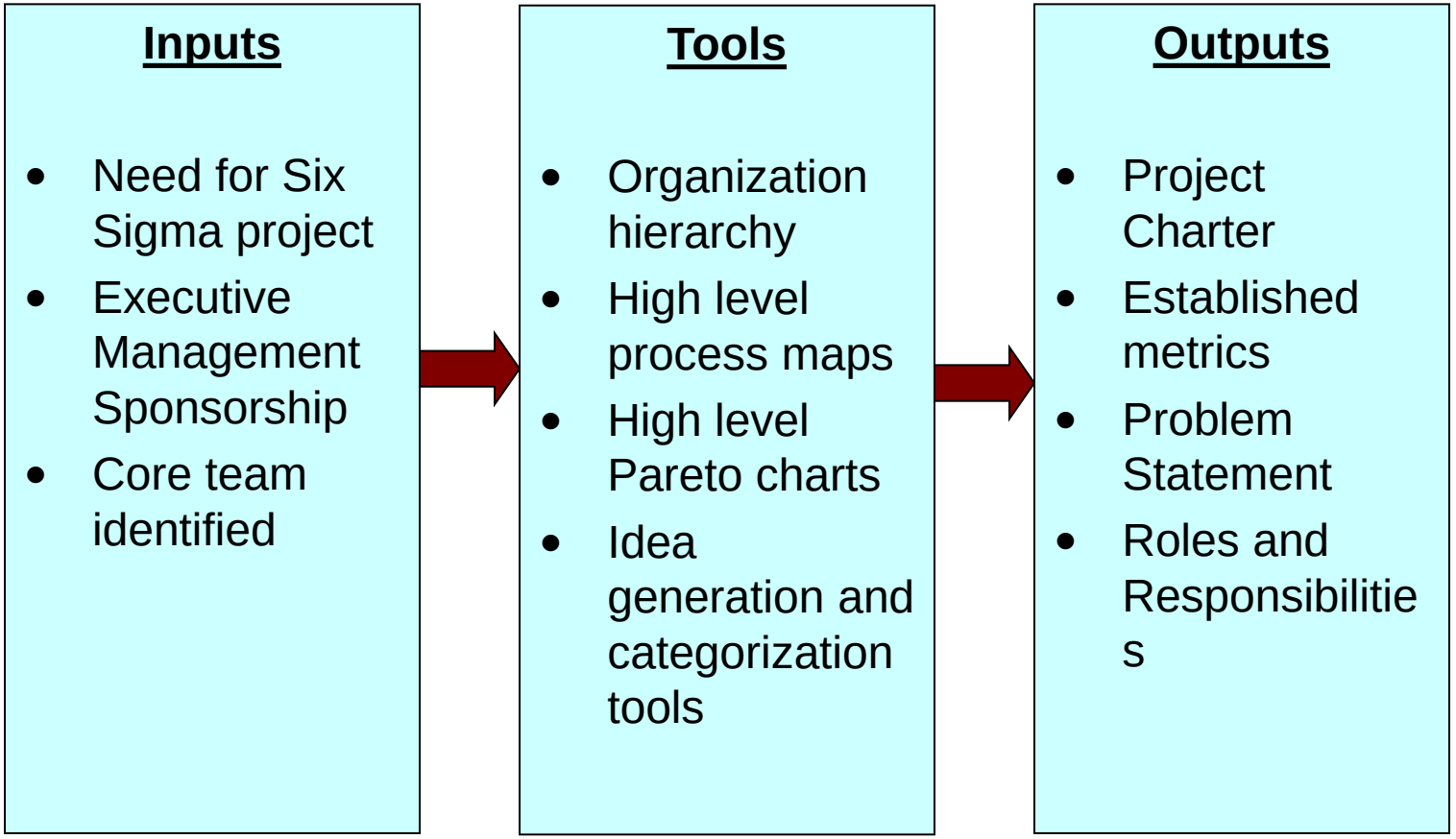
As the Six-Sigma score improves, the variation in the processes reduce drastically, thereby increasing the reliability of the system, which reduces the need for rework.

The reduction in amount of rework reduces cycle time and improves customer satisfaction.

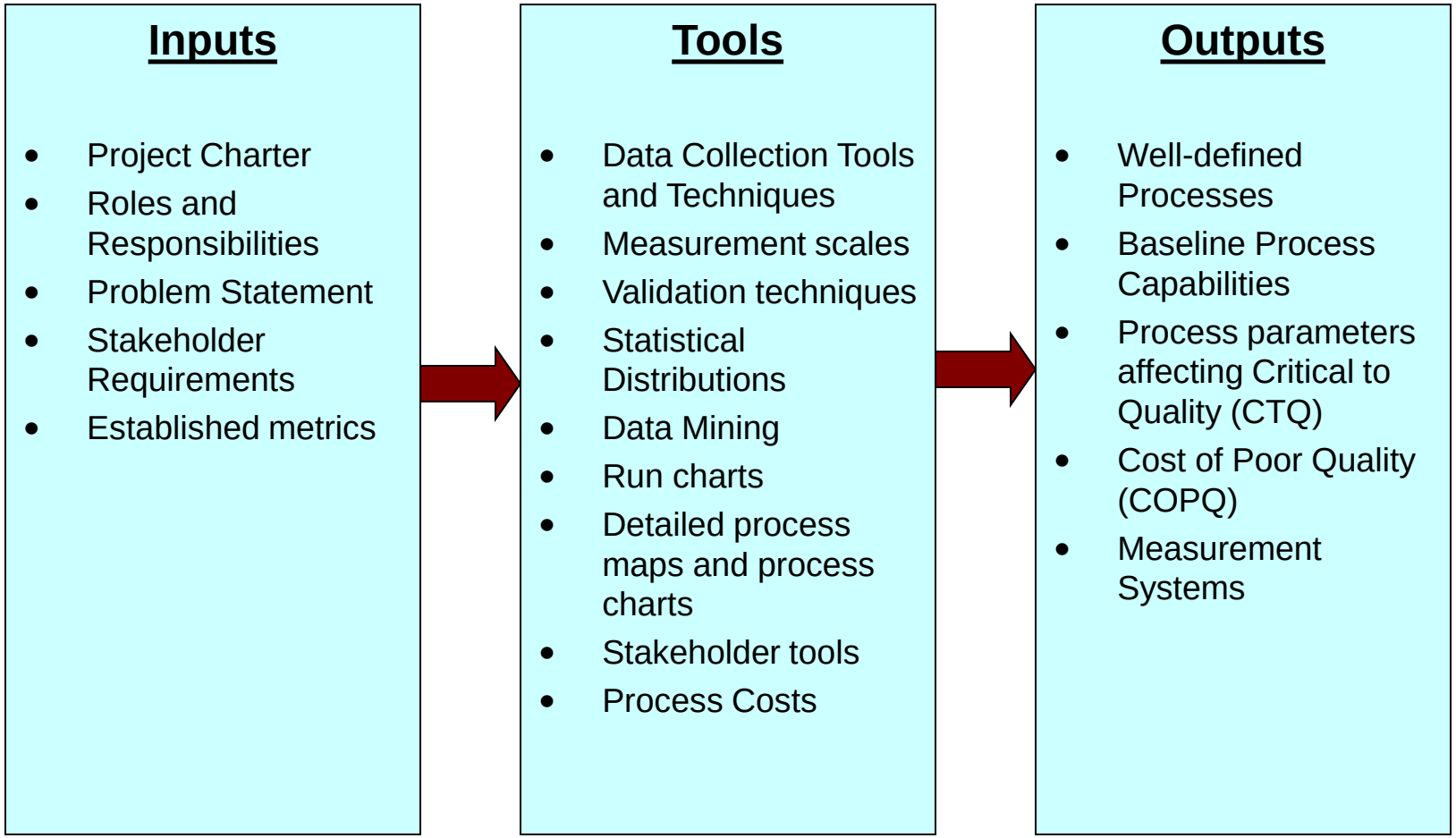
# 4. Overview of Six Sigma DMAIC Process

- Six Sigma is a very comprehensive methodology, which includes the best practices from other traditional quality techniques.
- The Six Sigma DMAIC Methodology looks at the whole Six Sigma project life-cycle with well-defined tools and methodology at each stage.
- DMAIC methodology lays down tactical steps to achieve Six Sigma quality.
- The different phases of the DMAIC Methodology are as follows:
    - Define
    - Measure
    - Analyze
    - Improve
    - Control

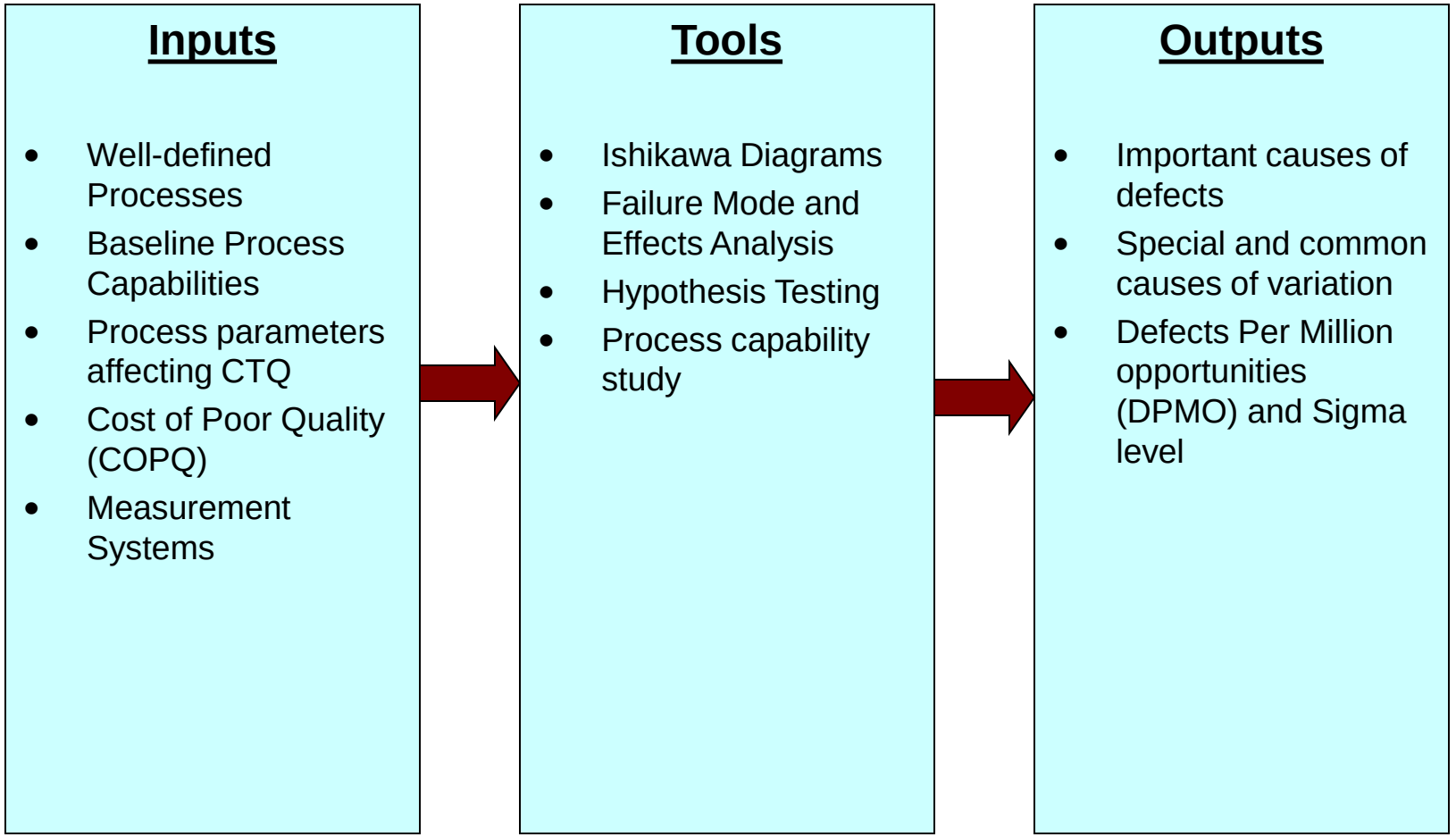
# 4.a Define



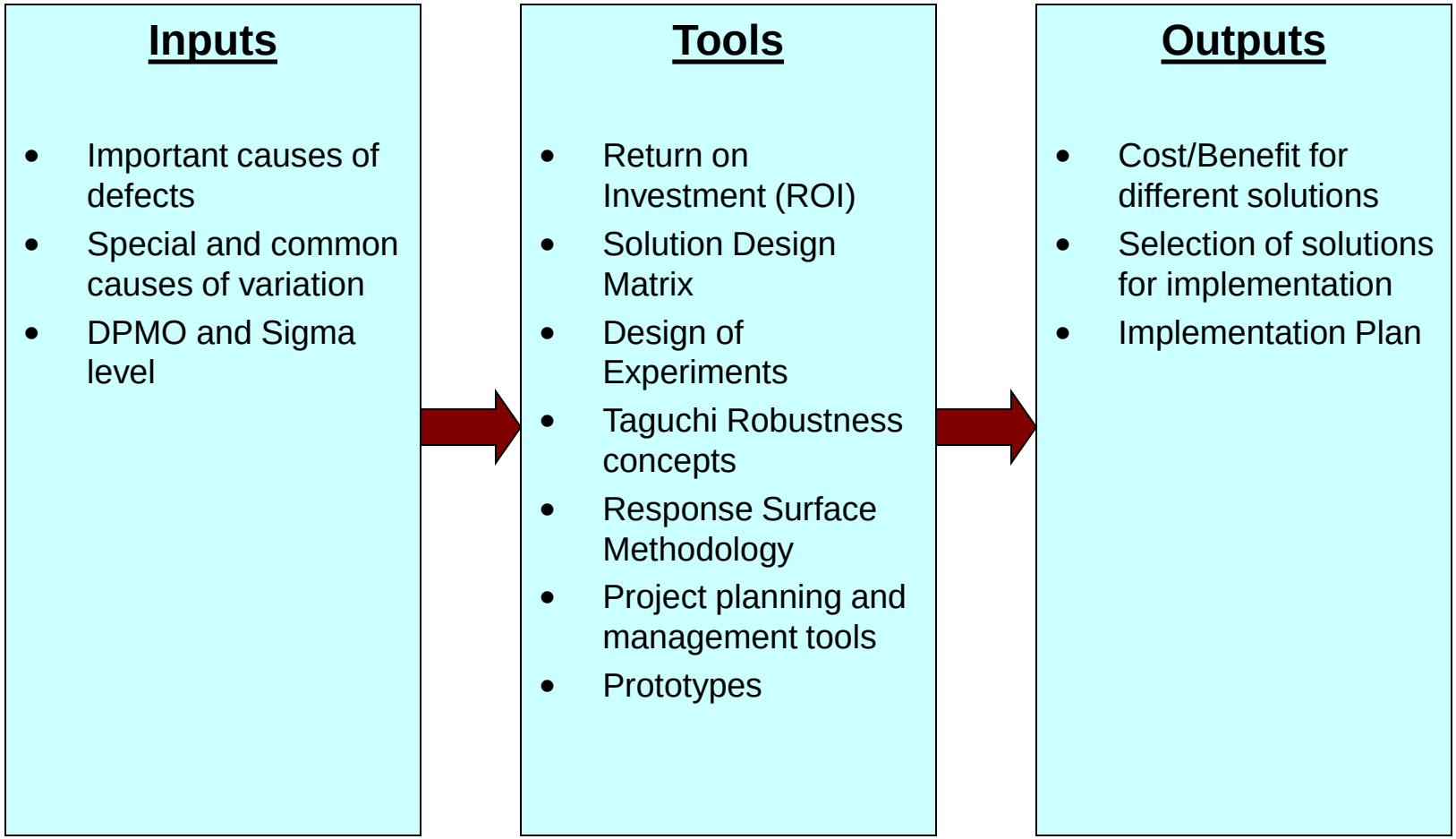
# 4.b Measure



# 4.c Analyze



# 4.d Improve



# 4.e Control