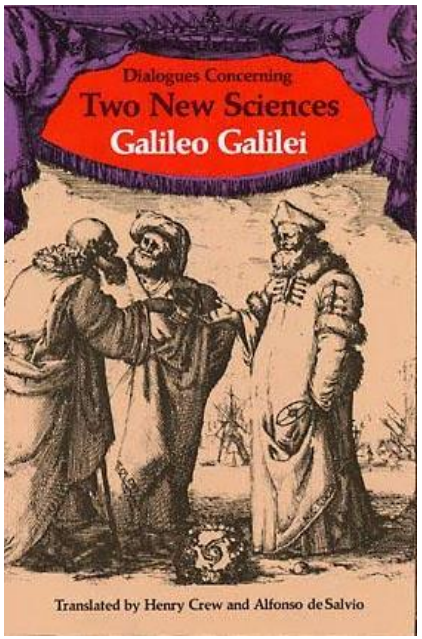
Engineering Design

History is full with examples of people who achieved great goals by means of their intelligence or determined will, but seldom without passion. History is also full with people who never accomplished much of anything because they could never bring themselves away from mind inactivity. Designers belong to the first category that is passionate about conceiving, planning, creating, and executing ideas.

History

- The forefathers of engineers such as practical artists and craftsmen advanced their work primarily by trial and error.
- Filippo Brunelleschi (born April 15, 1446) was an Italian **designer** and a key figure in architecture, recognized to be the first modern engineer, planner and sole construction supervisor.

Scientific Revolution



- Galileo's 1638 "**Two New Sciences**," a canonical text of early modern science which seeks methodical explanations and adopts a scientific approach to practical problems, is a landmark regarded by many engineers.
- "Two New Sciences" is the basic of engineering sciences that today's engineering students study as strength of materials and dynamics.

Apprenticeship to Scientific University Education

- Apprenticeship is a system of learning by doing. It is a formal, on-the-job training program through which a novice learns craft, trade, or vocation under the guidance of a master practitioner.
- Historically, most early engineers began as apprentices on canal and railway projects. In the US, around the 1850s some schools started following the French model, the "polytechnics." Learning institutions started reducing shop learning hours and adding more basic science in the classroom.
- After WWII, the Europeans brought their concepts on engineering education to the US.

By the 1980s and Later

- By the 1980s, hands-on skills declined enormously. The result was that design was treated poorly and therefore almost neglected.
- Disappointment with this lack of skills further fueled shift back to laboratory and design skills. Engineering schools were criticized for offering too few practical and hands-on courses.
- Students were not sufficiently schooled in teamwork and team approaches to problem-solving.

After 1990s

- The 1990s brought significant changes in engineering education. Freshman and capstone design and lab experiences started becoming standard. Universities attended more to industry concerns, causing even greater shift away from science to the “hands-on” and applied work.
- Universities are increasingly introducing design-intensive curricula including introducing students to real-world problems; teaching teaming and communication skills, creativity, innovation, and habit of lifelong learning; and integrating knowledge from science and business considerations.

Design Explained

Design is not just what it looks like and feels like. Design is how it works. **Steve Jobs**

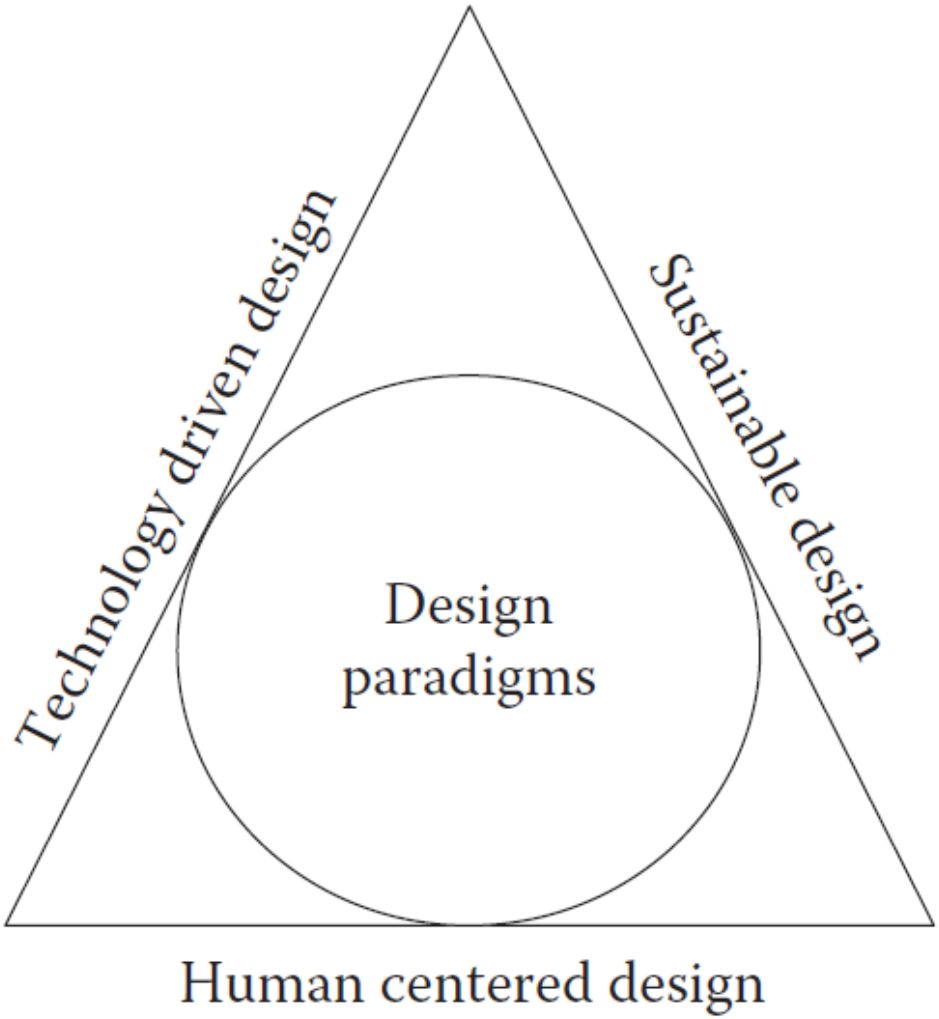
Design is the "Central Creative Process" of Engineering

To conceive of fashion in the mind
To formulate a plan for
To plan out in a systematic, usually graphic form
To create or contrive for a particular purpose or effect
To create or execute in an artistic or highly skilled manner

Design Requirements

- Design is a formal professional endeavor requiring specific knowledge, skills, and abilities.
- Design is rational involving logical reasoning, mathematical analysis, computer simulation, experiments and field trials.
- Design requires inquiry into the stakeholder's requirements and expectations, available design techniques, previous design solutions, past design failures and successes, etc.
- Design is iterative. Artifacts are analyzed with respect to functional and non-functional requirements, constraints, and cost. Revisions are based on experience and feedback mechanisms.
- Design requires value judgments. Courses of action and selection from competing solutions are based on experience and criteria provided by the system's stakeholders.

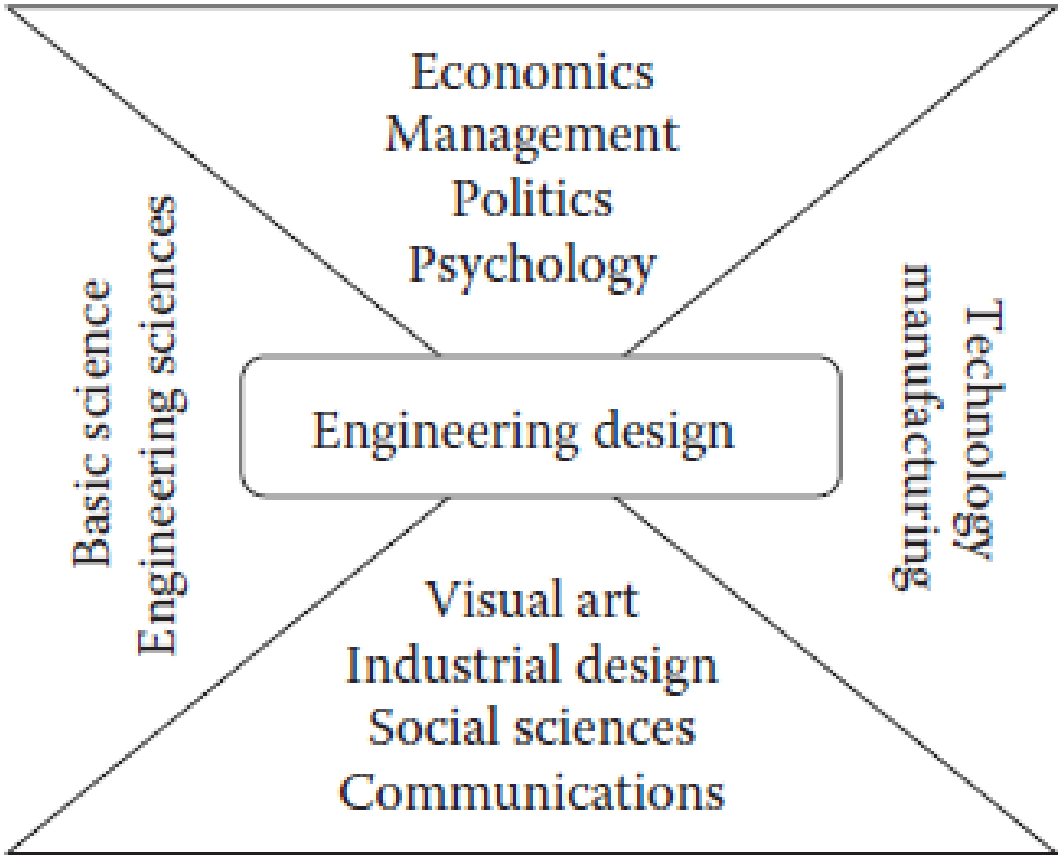
Design Paradigms



Types of Design

- **Engineering design:** “a systematic, intelligent process in which designers generate, evaluate, and specify concepts for devices, systems, or processes.
- **Product design:** Related with those items that are manufactured and ultimately to be sold to consumers.
- **Interface design:** Concerned with the processes for desired transformation and adaptation of a product.
- **Visual design:** concerned with the appearance features of an item. It reflects personal expression (artistic), concrete (realism), or abstract.

The Transdisciplinary Engineering Design

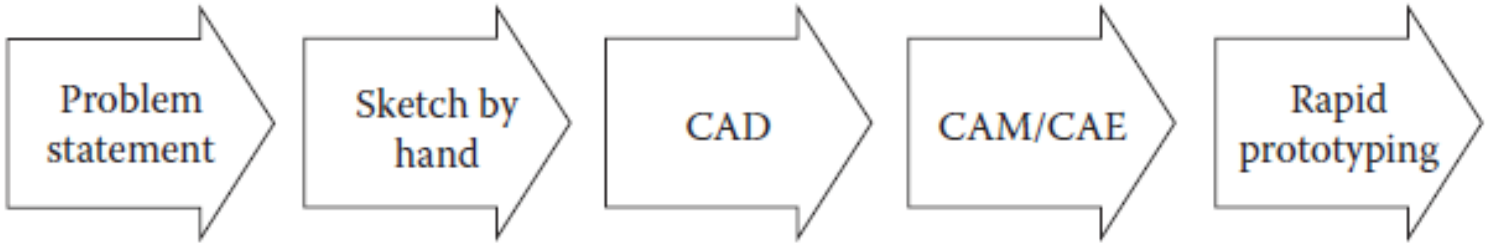


Classes of Design Problems

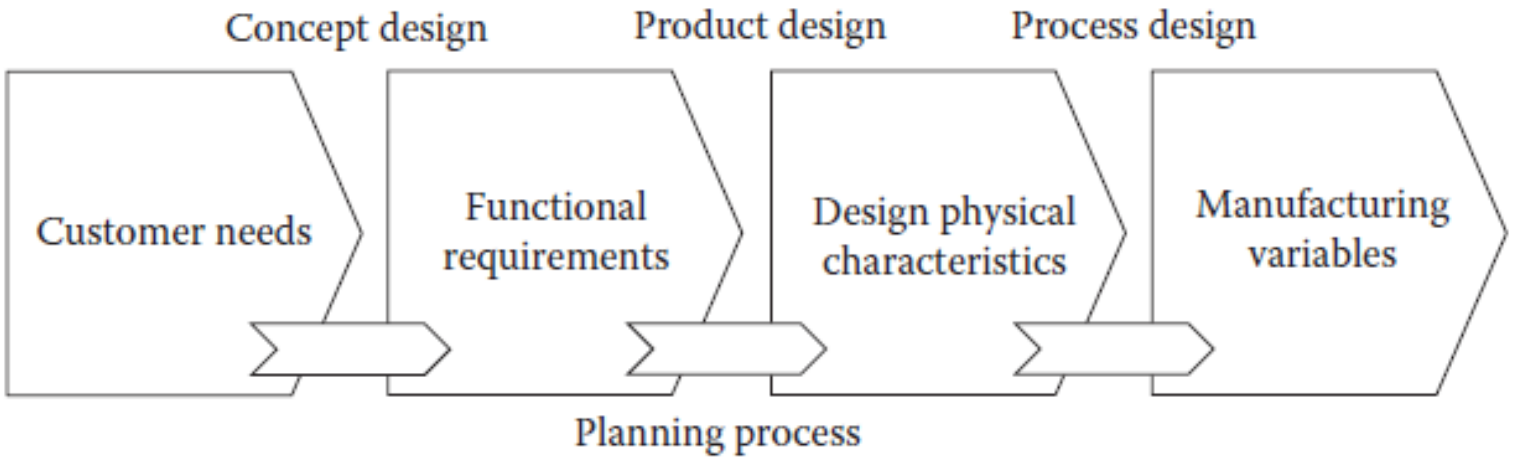
Class 1	Open-ended, nonroutine creative activities where the goals are ill structured, and there is no effective design plan specifying the sequence of actions to take in producing a design model
Class 2	Existing, well-developed design and decomposition plans (e.g., designing a new product)
Class 3	Routine where design and decomposition plans are known as well as customary actions taken to deal with failures (e.g., writing a computer program)

Engineering Design Communication

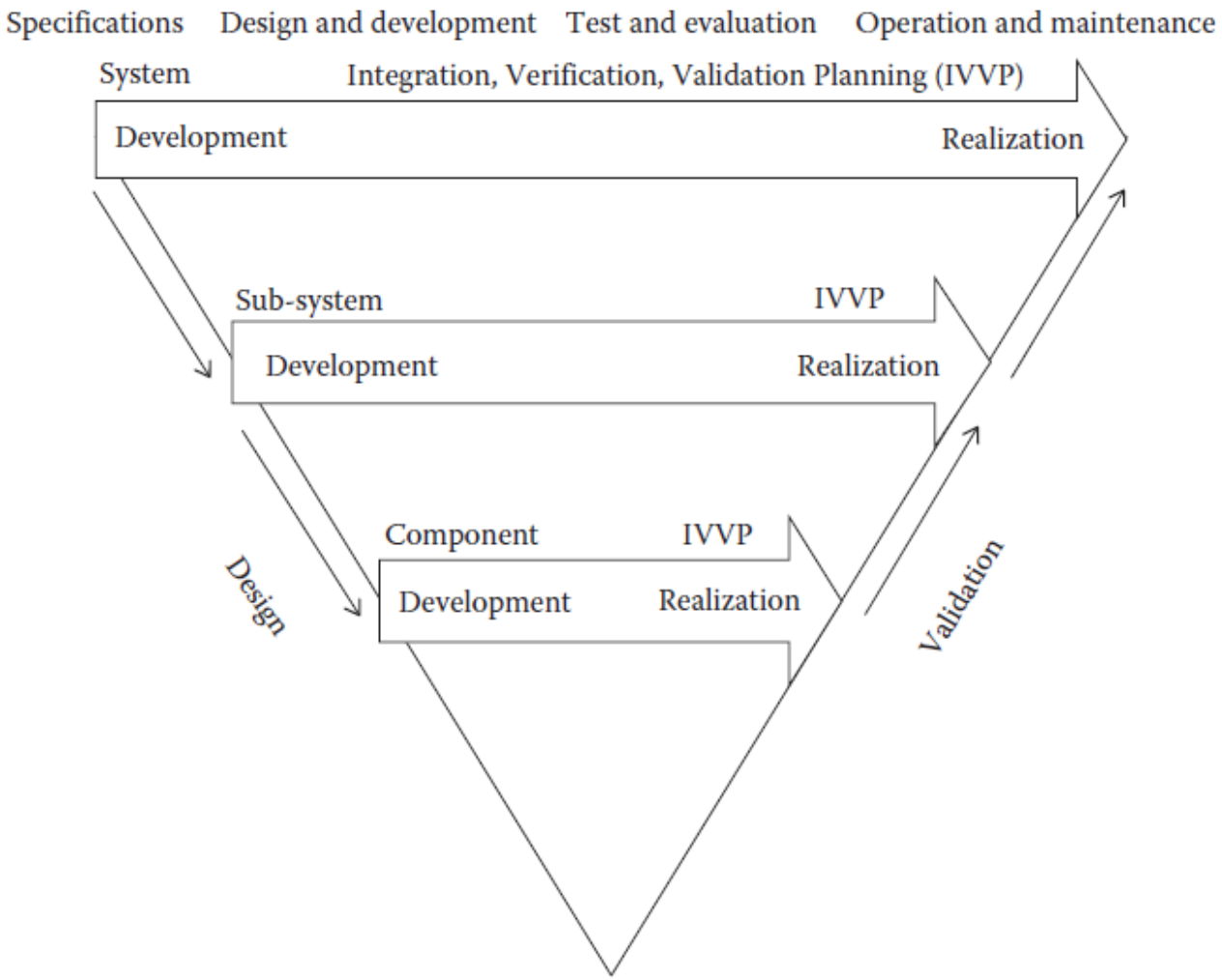
In their most basic form, engineering drawing is the major tool used to communicate information about a design to others who will be engaged in producing or Realizing the design.



Design Variables



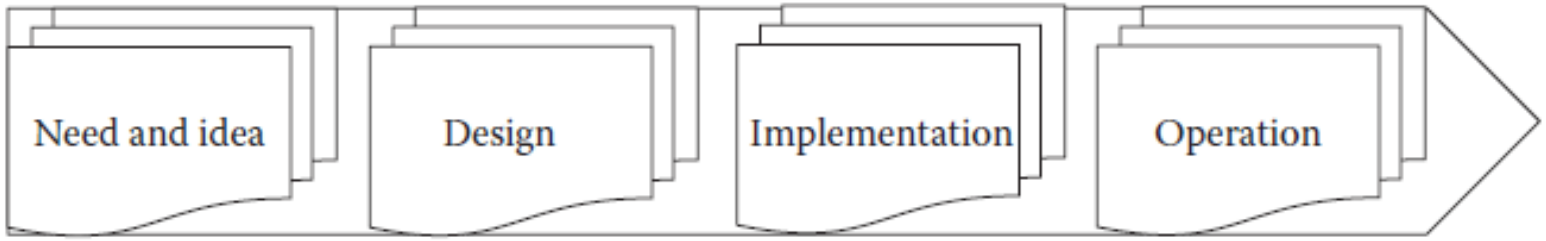
Design V-model for Project Development



Design Methodology and Design Process

- Design is an adaptable and progressing process, not very organized or a specific procedure one should follow on every project to ensure realization.
- Design methodology which is strongly process based aims at the improvement of design processes particularly by exploiting scientific techniques.
- A methodology is a body of knowledge comprising the principles, guidelines, systematic analysis, best practices, organization, and processes.

Stages of Engineering Design



Stages of Product Design