Kinematics & Dynamics of Linkages

Lecture 1: Introduction

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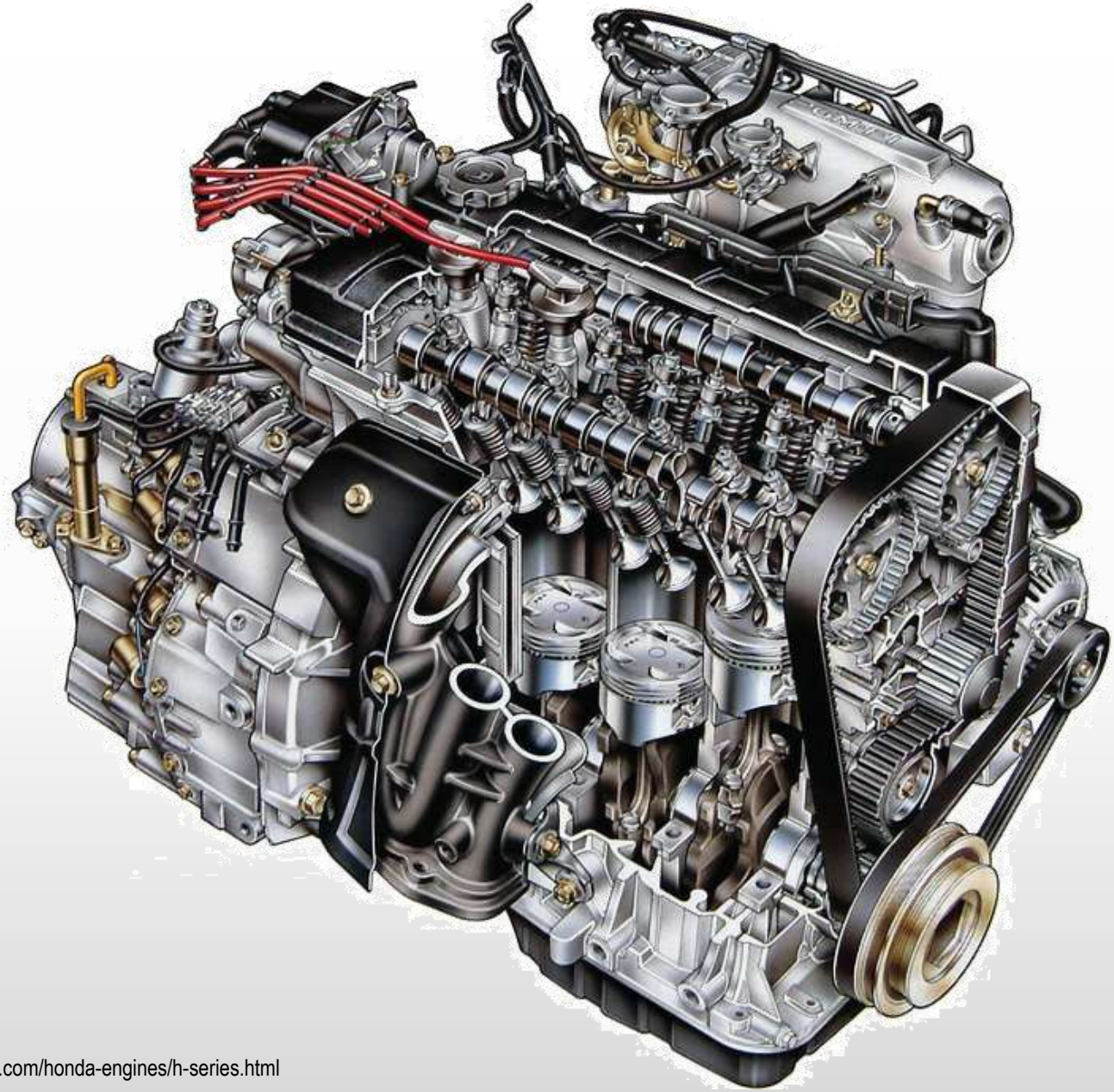
LAU



http://www.jdmspecengines.com/honda-engines/h-series.html

Honda Engine

Definitions

- Kinematics
  - Study of motion without regard to forces
  - Concerned with the geometric aspect of motion)

- Kinetics
  - Study of forces on systems in motion
  - Dynamics of machinery

Kinematics & Kinetics are inseparable

Newton's Second Law

- If there is a motion (acceleration – a) associated with a body with mass m, then a dynamic force F is produced.

- If a force **F** is applied to a body with mass **m**, then that body will undergo a motion with acceleration **a**.

- F = m x a

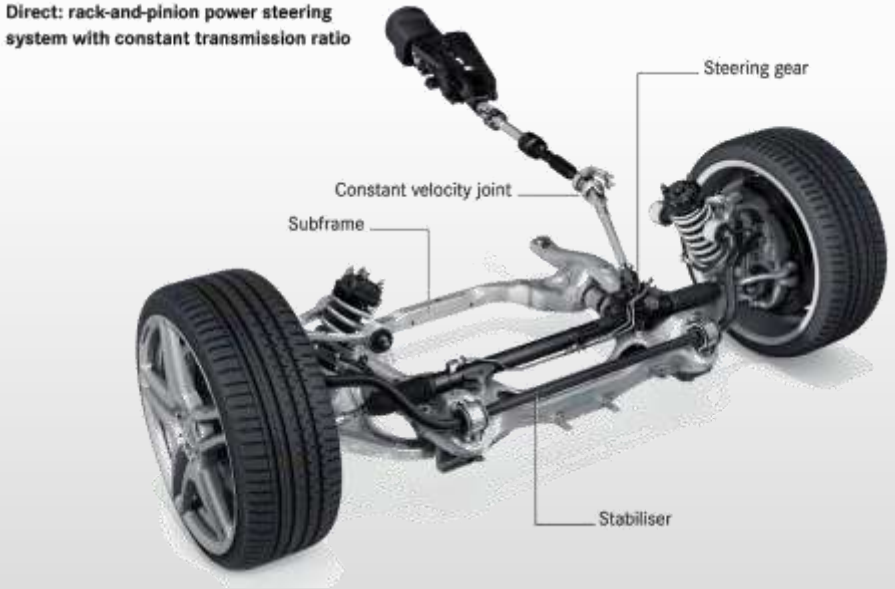
Mechanism vs. Machine

- Mechanism
  - A system of elements arranged to transmit motion in a predetermined fashion
  - Examples: pencil sharpener, umbrella, folding chair

- Machine
  - A system of elements/mechanisms arranged to transmit motion and energy in a predetermined fashion
  - Examples: food blender, automotive transmission

Wikipedia

Sample Mechanisms

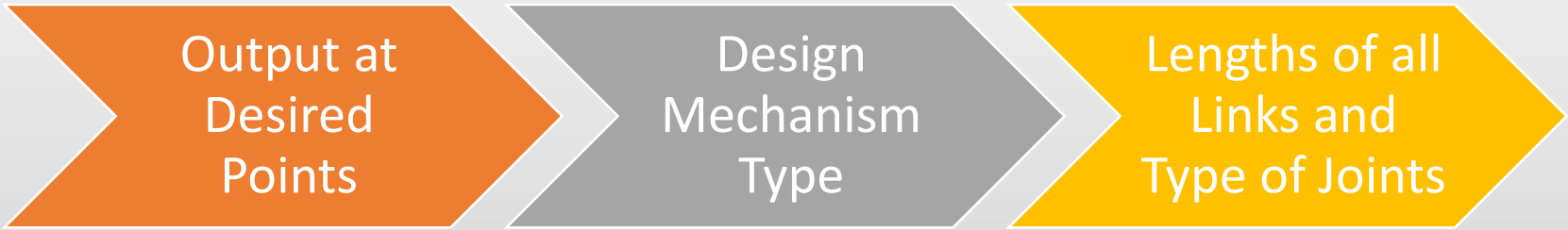


http://www.statewidehydraulics.com.au/winches-and-gearboxes/

Wikipedia

Synthesis

- Qualitative Synthesis
  - The creation of potential solutions in the absence of a well-defined algorithm that configures or predicts the solution.
- Analytical Synthesis
  - The analytical generation of one or more solutions of a particular type in a well defined synthesis algorithm



Analysis

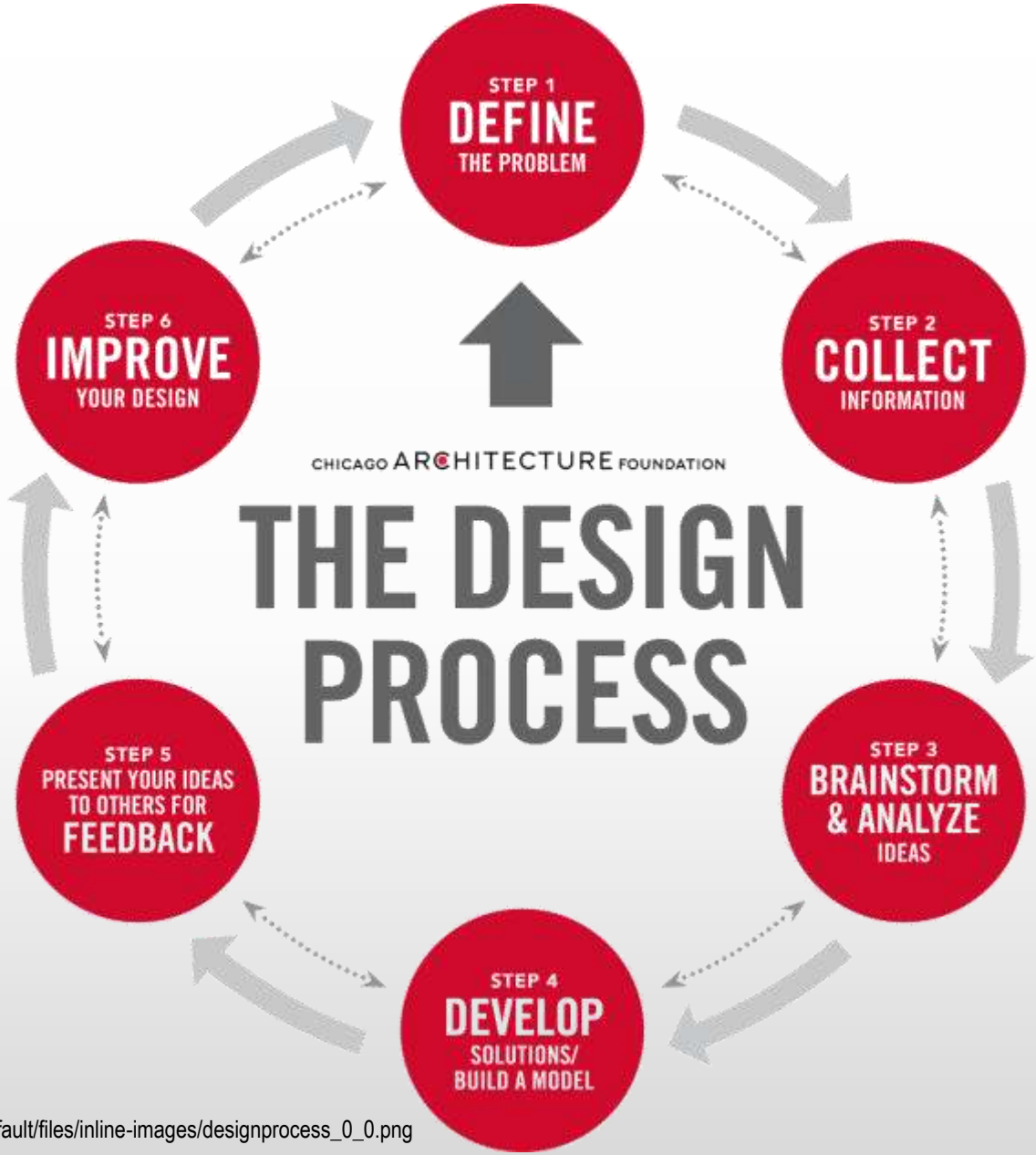
- Analysis is applied to existing or newly synthesized mechanism
- Analysis is to calculate the output of a defined mechanism

The Iterative Design Process

1. Identification of need:
   What the customer wants (We need a winning race car)
2. Background research
   Benchmarking and existing solutions (How do others do it)
3. Goal or mission statement
   Concise problem definition (We need a very fast car)
4. Task specification
   What should the system have (light weight, aerodynamic, etc…)

The Iterative Design Process

5. Ideation & Invention
   Idea generation: brainstorming and judgment
6. Analysis
   Check performance against design objectives
7. Selection
   Select optimum solution based on decision matrices
8. Detailed design
   Dimensions, computer models, execution drawings, materials
9. Prototype & Testing
   Test actual performance
10. Production



https://www.discoverdesign.org/sites/default/files/inline-images/designprocess_0_0.png

Important Issues in the Design Process

- Multiple solutions will exist
  - Select optimum solution using optimization tools
- Human factors and ergonomics must be considered
  - Designed for comfort, efficiency, safety, and productivity
- Reporting & documentation is required
  - Written & oral communication of ideas & results
- Engineering units must be clear
  - US – gravitational system
  - SI – absolute system

Brainstorming

- Brainstorming is an individual or group process for generating alternative ideas or solutions for a specific problem.

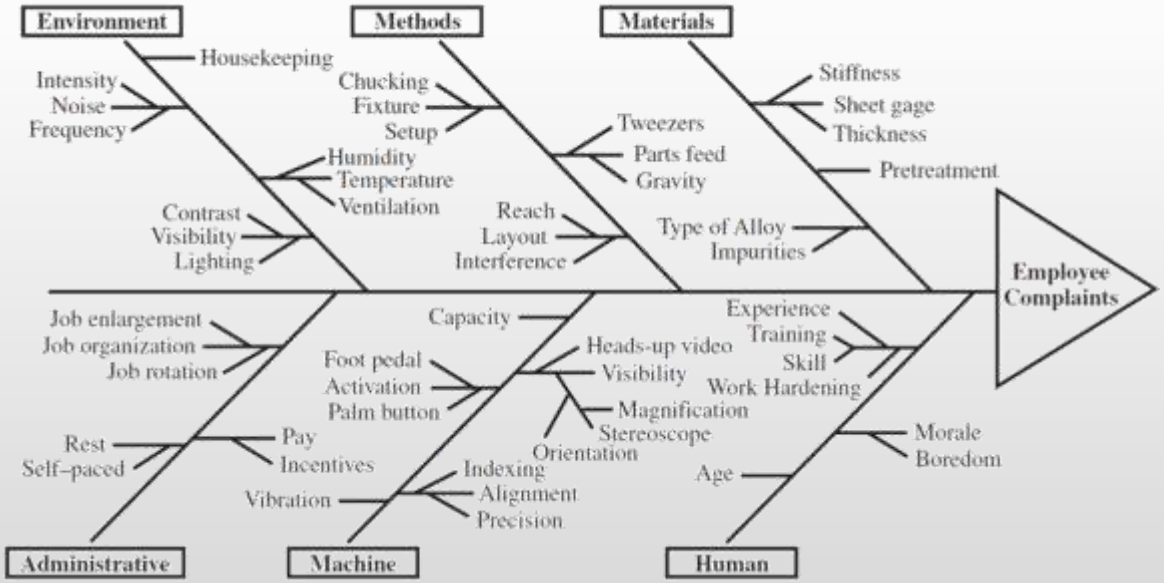
https://www.fastcompany.com/3062476/does-brainstorming-really-work

Brainstorming

- The Outcome of Brainstorming is:
  - A list of ideas or solutions related to a particular problem.
- There are Four basic rules for brainstorming:
  - Focus on quantity: Diverge the solutions
  - Withhold criticism: Extend Ideas
  - Welcome unusual ideas: New perspectives
  - Combine and improve ideas: Associate and jump to new ideas
  - Clarifications are ok, but not too elaborate and long
- How brainstorming works?

Tools: Fishbone Diagram

- Break down root causes that contribute to a particular effect



Tools: Decision matrix

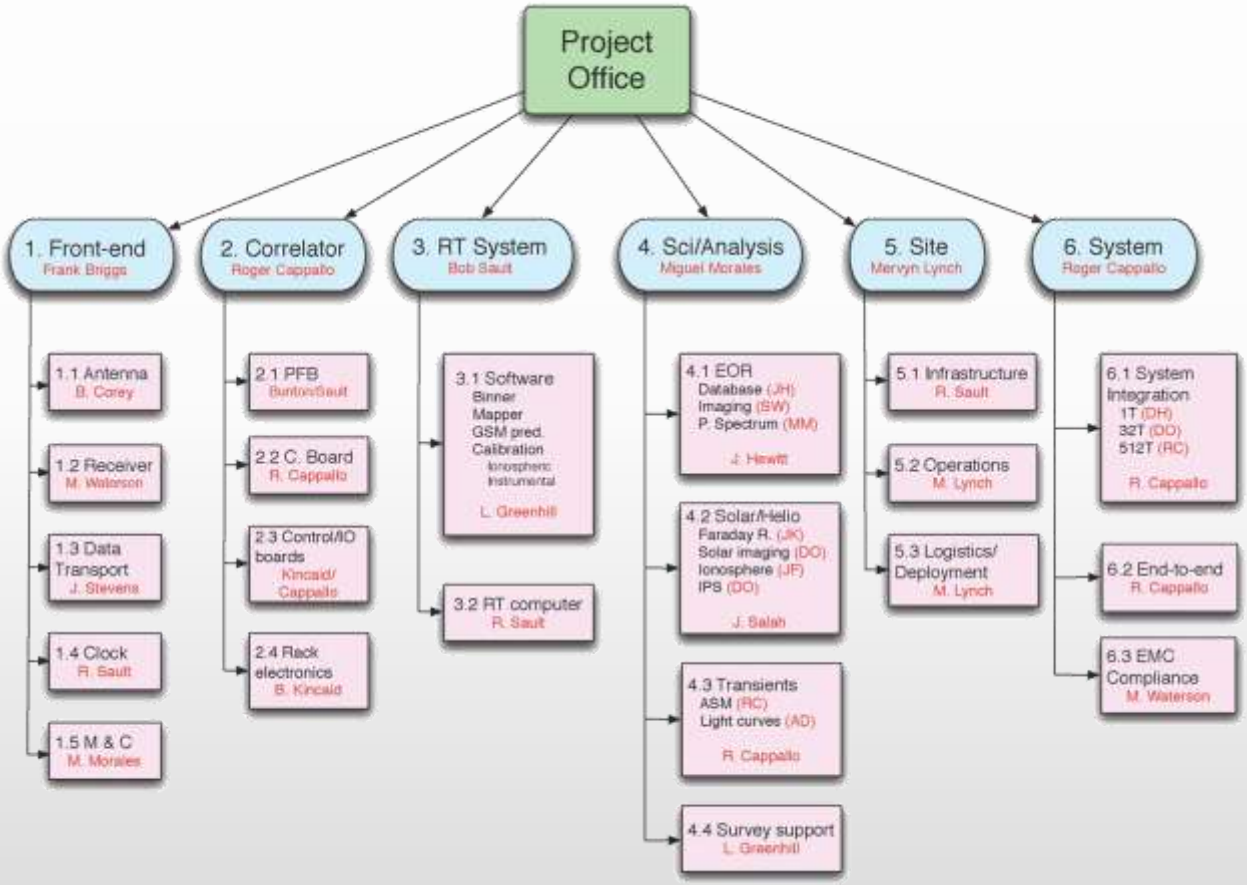
NEW RESTAURANT BRANCH					
Factors	Rent (Lower is Better)	Market Share (Higher is Better)	Owner Commute (Shorter is Better)	Employee Base (More is Better)	Score
Weights	4	5	2	3	
Location 1	2 x 4 = 8	3 x 5 =15	3 x 2 = 6	4 x 3 = 12	41
Location 2	3 x 4 = 12	3 x 5 = 15	2 x 2 = 4	2 x 3 = 6	37
Location 3	1 x 4 = 4	5 x 5 =25	3 x 2 = 6	4 x 3 = 12	47
Location 4	4 x 4 = 16	2 x 5 = 10	5 x 2 =10	3 x 3 = 9	45

https://www.businessnewsdaily.com/6146-decision-matrix.html

Tools: SWOT analysis

http://www.sixsigmatrainingfree.com/uploads/2/1/7/9/21795380/swot-analysis.gif

Tools: Work breakdown structure



https://tex.stackexchange.com/questions/81809/work-breakdown-structure-wbs-tikz