

**INSTRUCTIONS:**

- Only 1 submission is required per group. Make sure you communicate with your team-mates to ensure that everyone is clear about who will be submitting the assignment.
  - The person submitting the assignment should ensure that all of the team-mates names are on the title page.
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*For an example of how to address these questions, be sure to look at the Design Process lecture notes, slide 13.*

1. **Functions (at least 2):** At least two (2) statements are required describing the function of your project deliverable. These two statements should clearly identify the two control loops that you will incorporate and include the word “**shall**”.
2. **Performance (at least 2):** At least two (2) statements that define how the functions defined in question 1 will be measured. In other words, how will you know if your project is successful?? Again, be sure to include the word “**shall**”.

**Provide at least ten (10) requirements/constraints from any of the following categories\* (using the words “shall”, “should/may” and “will”). The listed examples are illustrative only, and are simply provided as a starting point to help you form a requirement/constraint**

**3. Economic:**

- Prices of current related or similar products on market and your cost and profit
- Available budget
- Potential impact to the local and US economy
- Designs for public use need to consider high maintenance cost
- Both over design and under design cost money

**4. Environmental:**

- Vibration induced noise to workers and product users
- Vibration induced noise to the public: large power transformers, road lamps
- Air pollution: use electric or hybrid engines
- Water pollution: toxic waste into river
- Landscape: plastic bags, computer cases
- Global warming: temperature control of exhaust gas
- Manufacturing waste collection and processing
- Space debris
- Control of energy saving devices

**5. Social:**

- Designs in favor of certain people but against others
- Worker union versus employer
- Government codes are to protect society

\* List of constraints borrowed from College of Engineering, University of Missouri's website, [http://engineering.missouri.edu/mae/files/realistic\\_constraints.pdf](http://engineering.missouri.edu/mae/files/realistic_constraints.pdf)

**6. Political**

- Designs using software/hardware developed under public funding
- Products (e.g., computer games, marks on clothes) that profile negative sides of a specific race or gender
- Products for use in space use on-earth patent protected designs/concepts
- Products for customers who are against US
- Products that are against US homeland security
- Products that are physically and/or mentally destructive for people

**7. Ethical:**

- Designs without considering safety and health of workers, consumers, and/or the public
- Products implicitly using patent protected designs/concepts
- Products use radioactive materials
- Products use materials that have better appearance but are toxic
- Under design for profit
- Products for secret survey of personal private life

**8. Health and Safety:**

- Safety of workers and consumers
- Safety of the public
- Noise causes hearing loss
- Hazardous materials and environment for workers
- Products require the use of radioactive materials
- Products use materials that have better appearance but are toxic
- Products for infants/children require special safety considerations
- Design of a control system with acceptable stability margins for machinery where safety is of concern

**9. Manufacturability:**

- Designs with an impossibly small manufacturing tolerance
- Designs with a required highly accurate first natural frequency
- Designs with an impossibly high stiffness
- Designs with a zero-friction contacting surface
- Designs with a no- mass part
- Perpetual machine
- Machines without vibration
- Can the proposed material be welded if welding is the proposed assembly method?
- Is the product's surface paintable if it is designed to have an artificial color?
- No gravity for manufacturing process in space
- Availability of chosen material
- Titanium alloy and ceramics require special cutting tools
- Design of a control system which is physically realizable with manufacturing constraints such as amplifier saturation and bandwidth

**10. Sustainability:**

- Can the business survive?
- A well defined life span under the assumed normal operation conditions

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- Consideration of actual environmental factors (extreme working temperature, corrosive fluid, abrasive air, severe radiation in space, etc.) in design
- All parts need to have a similar designed life span
- Machines require perfect suppression of vibration to function
- Reliability and durability of the product's supposed function

### 11. Legality:

- Products using concepts protected by patents
- Design by following required codes
- Products for secret survey of personal private life

### 12. Inspectability:

- Designs can be inspected during maintenance service
- Designs are easy for system health monitoring

*Think carefully about what you commit to at this stage of the project. It is always better to start a constraint as a "should/may" and move it to a "shall" later, instead of overcommitting. However, sometimes a constraint is fundamentally linked to a function or performance metric and so needs to be a "shall"!*