On the design of software

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What is software?

- A collection of computer programs, procedures, rules, and associated documentation and data (IEEE, 1987).

Creating software consists of:

- Software Development Process (requirements, design, coding, testing, etc.)
- Software Management Process (schedule, time, cost, quality, etc.)

Development Process

- Consists of various phases
- Each phase has a defined output and input
- Phases help to break the big problem and ease the review of smaller problems
- Any process consists of requirements analysis, design, coding, and testing phases

Software design

Why is good software design important?

- Economics!
- It is more expensive to maintain software than to create it
- Some studies have indicated almost 80% of the total cost

Enterprise level software

- In big companies, schools, retailers, governments
- Day-to-day running of the business, customer relationships, projects, HR, office automation
- Eg. Indian Railways online booking system
- Developed and maintained by large teams, possibly across several locations

Good design

- However, good design principles can be applied to any software
- Several open-source examples:
  - LaTeX typesetting system
  - Unix/BSD Unix
  - emacs, awk, python

Documentation

- Critical and very important!
- Casual developers never understand the need
- Includes:
  - Requirements specs (SRS)
  - Design document(s)
  - Bug reports, release logs, test cases
  - Comments in code
  - User manuals, technical support

SRS sample (from Prof TAG)

/home/paddy/pappu/courses/feb2015/designPracticum/SRS_Brief_Template_v1_1.odt

Design document sample

/home/paddy/pappu/courses/feb2015/designPracticum/Design_Brief_Template_v1_0.odt

Activity

- Create at least one document (text/Word whatever) for your DP software (if you have a software component)
- Serves as a guideline for future developers

Take-home message

- Always think:

  what if someone want to use my code?

Some design aspects

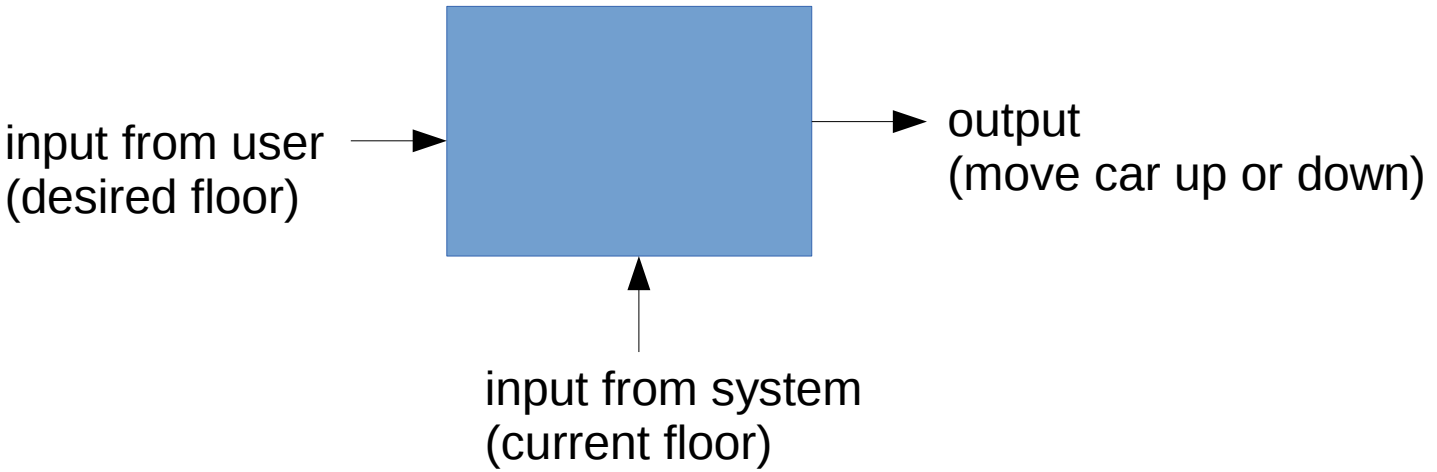
- Structured programming
  - Use of subroutines, block structures
  - Typically states a single entry and exit into a block
    - Common exception: early exit (eg. assertions)
- Object-oriented programming
  - Objects: extended data structures that hold data and functions
- Encourages code reuse

Unix philosophy

- Small programs, for specific tasks
- Easy to combine with other commands
- Eg. `cat` command
  - `$ cat a.txt | wc`
- Separate commands for filesystem tasks: renaming files, moving files, deleting them or determining how big they are
- Contrast with Windows file manager
- *“Do one thing, and do it well”*

Code abstraction

- Abstract data types
- Hide the details, show the interface
- Abstraction for elevator controller



```
Elevator e;

i = e.getUserInput()
cf = e.getCurrentFloor()

if i < cf
    // user wants to go down
    e.goDown(cf-i)
else
    // user wants to go up
    e.goUp(i-cf)
```

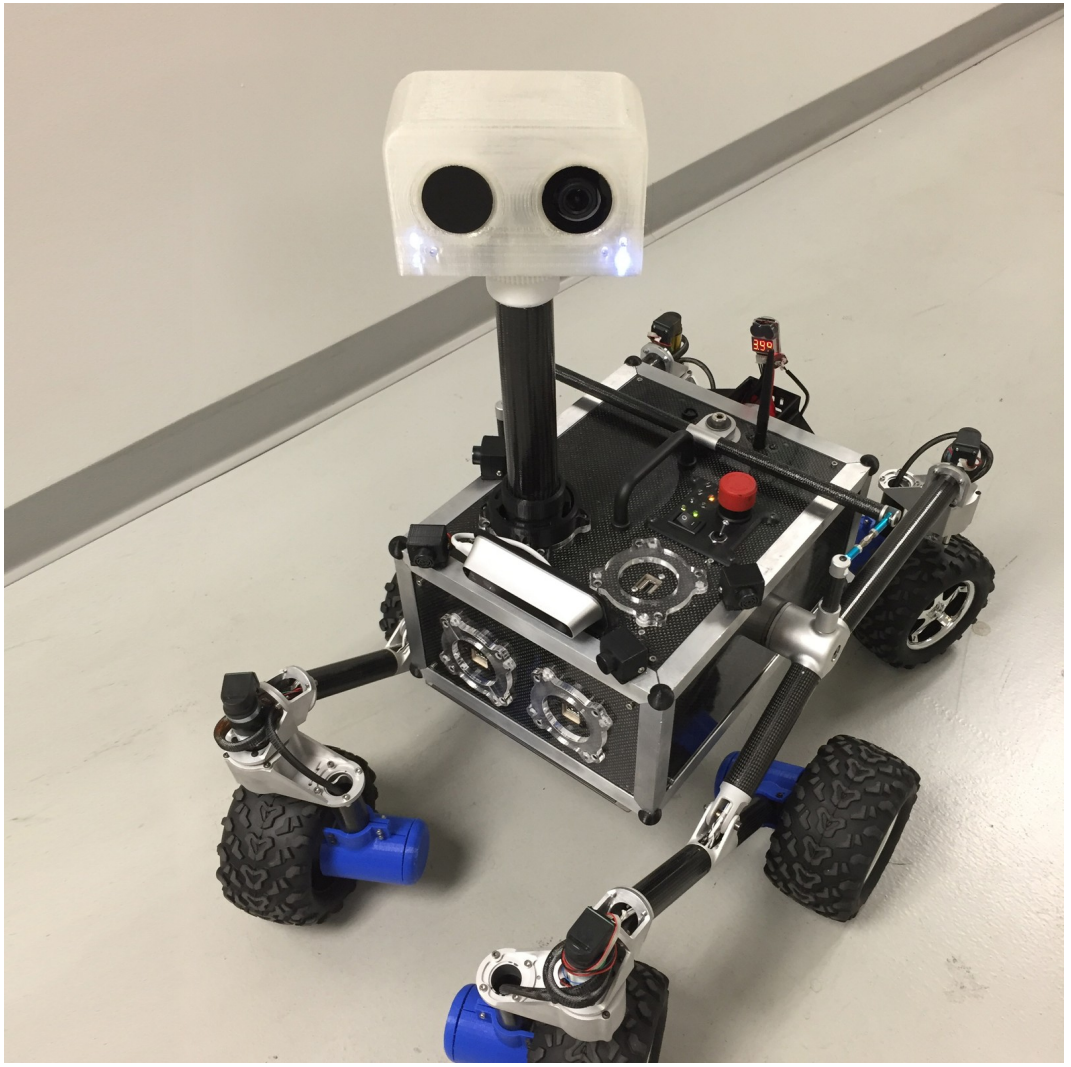
- The code abstracts the details
- Gives a “big picture”

Class activity

- Give abstractions for a remote-controlled toy car controller
- Assume user input: front, back, left, right
- Going front: headlights on
- Going back: reverse lights on
- Door open only if car is stopped

```
Car c;

repeat:

    if (c.front()||c.left()||c.right())
        c.headlight(1)
        c.revlight(0)
        c.running = 1
    elseif c.back()
        c.revlight(1)
        c.headlight(0)
        c.running = 1
    else
        c.running = 0

    if ((!c.running) && c.doorOpen())
        c.openTheDoor()

forever
```

NASA’s ROV-E project

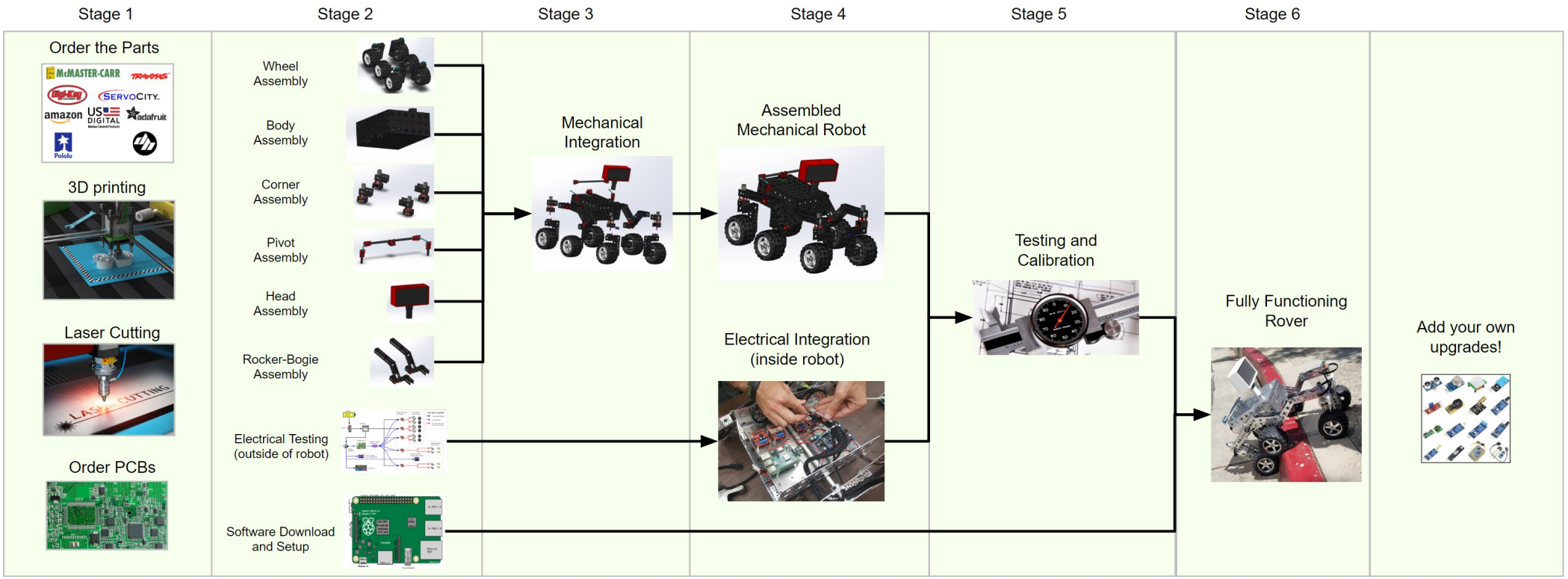


Open-source Mars rover

For $2500 = 1.75 lakh

Detailed design, documentation, software available for download

Roadmap


Stage 1
Stage 2
Stage 3
Stage 4
Stage 5
Stage 6
Order the Parts
McMASTER-CARR
TRAXXAS
Digi-Key
SERVOCITY
amazon
US DIGITAL
adafruit
Pololu
3D printing
Laser Cutting
Order PCBs
Wheel Assembly
Body Assembly
Corner Assembly
Pivot Assembly
Head Assembly
Rocker-Bogie Assembly
Electrical Testing (outside of robot)
Software Download and Setup
Mechanical Integration
Assembled Mechanical Robot
Electrical Integration (inside robot)
Testing and Calibration
Fully Functioning Rover
Add your own upgrades!