Overview and current status of embedded system

- What's Embedded system?
- What's Computer?
- What's Software?
- What's Software quality?
- What's Debugging?
- What's Testing?

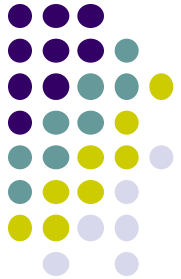
Debugging and Testing

- **Debugging** : A process to prove that a program works correctly
  - Done by programmer
- **Testing** : A process to prove that a program DOES NOT work correctly
  - Done by QA

Debugging and Testing Con't

- Debugging : Find bug and debug (Daily exercise)
  - (like find guilty and correct)
- Testing : Find just one bug that program can't work, So REJECT!! (Final exam)
  - (like find guilty and Vo la! → reject)

Debugging and Testing Con't



- Both start from what's our purpose to test or debug?
- Generate test cases and test it.

Test cases

- General rule 1 test case / 10 LOC
  (job of project manager)

Such as

- Func A 200 LOC/20 test cases
- Func B 500 LOC/50 test cases

If they built

- Func A 50 test cases → less bugs
- Func B 5 test cases → Huge bugs

Test cases con't

If they built

- Func A 50 test cases → less bugs
  - Know Func A very well, So they built plenty of test case
- Func B 5 test cases → Huge bugs
  - He don't know function very good enought

Project management

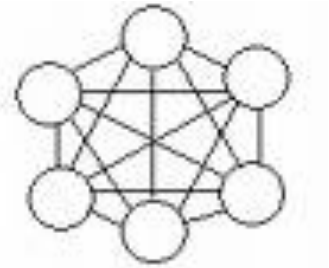
If Program A

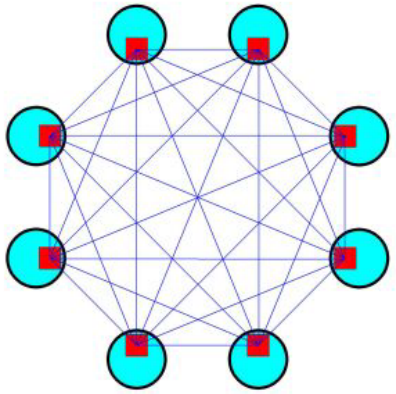
- 10 Engineers, 1 Manager, 1 Year project
- But 2 months delay

- 5 Engineers add more →
  - The project will be bigger delay, Why???

Project management con't

- 5 Engineers add more →
  - The project will be bigger delay, Why???
- Educational problem
  - Some engineers have to teach the new ones.
- Communication complex
  - More people, more complex





Test case guide line

- A approx 1 test case/ 5 – 15 LOC
  - Language processor : 1 / 8 – 12 LOC
  - Online system : 1 / 5 – 10 LOC
  - Batch system : 1 / 10 – 15 LOC
- B
  - Normal cases : 60%
  - Abnormal cases : 15% (error case)
  - Boundary cases : 10% (0-10, test -1,11)
  - Environment cases : 15% (other: driver, OS)

Admission fee

- Below 6 years old : Free
- 7 – 12 years old : 500 yen
- 13 – 18 years old : 800 yen
- 19 years and older : 1,000 yen

  - ***Do you find any bug?***

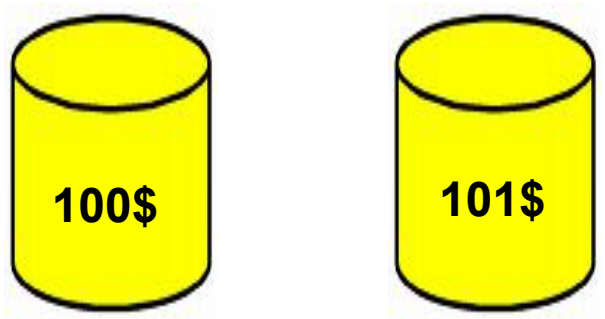
Bug collected

- Developers must report all the bugs.
- What must be reported?
  - When detected
    - ID number, Symptom of the bug, Who find out, When, Seriousness
  - When fixed
    - Which modules, Explain of the bug, Who fixed, When and What was test, By whom, Code before and after.

Example of bug

- Banking system,

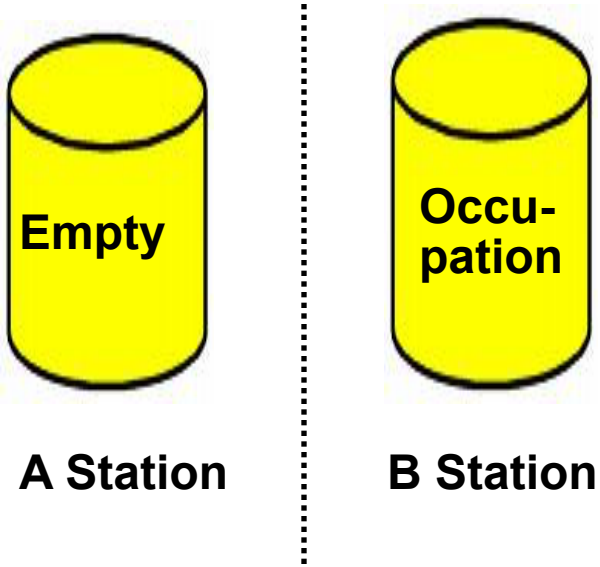
- Crashing in 1 system is ok,
  - But difference system is also crash cos that bug is TERRIBLE. (outta world)



unmatched money

Hitachi railway database

Mirror disk of booking system



Seat C27, Train 0749

- Stop system and analyze for 6 hours and fix for 2 hours
  - Loss million$, cos stop system → no business
- Or else ?

When program ready for release?

- All test case are tested.
- The growth of bugs get flat.
- All the bugs are fixed.
- 48 hours continuous operation success fully complete

Independent QA engineer

- Around 8% of all engineers.
- They test (requirement spec, design doc, program, test case, etc.)
- A product CAN NOT be released without their “Go ahead” (So powerful)
- From customer viewpoint, They design, Write and test the test cases.
  - (completely difference from the developer, not use the test cases from developer.)

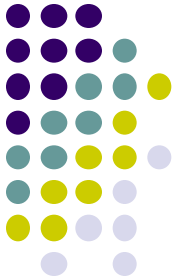
The cost of the quality

- Assumption 12 months project with 10 developer on C with 100 KLOC

Phases

- Requirement spec : 2 Months
- Designing : 3 Months
- Coding : 2 Months
- Debugging : 3 Months
- Testing (By QA) : 2 Months

Testing phase (3M)



- 100 KLOC need 10K test cases (1K/Develpoer)
- 10 days to design 10K test cases
- 10 days to check 1K test cases in code inspection
- 40 days to check 10K test cases in machine testing

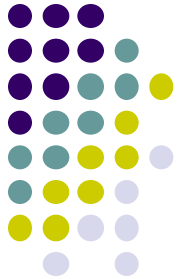
We built software for product

3 main concerns

- Quality → must be good
- Schedule → must be quick
- Cost → must be cheap

  - Quality is the big problem to obtain.

Engineering VS Science



- Eng : built something that really worth to use
- Sci : Just possibility.

Example : Built a little gold from huge sea water

- Eng : Don’t worth enough → so much cost
- Sci : Great new way of technology

Student VS Professional Programming

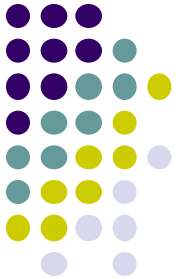
Student program

- **No quality assurance/control**
- **Profitability** : 1 LOC = 50 – 100&

  1 person-month = 1KLOC

  student don't care, is it worth enough, or how many day to built, just program for fun
- **Estimation** : How many days, money, people need? Cost, schedule, person/month

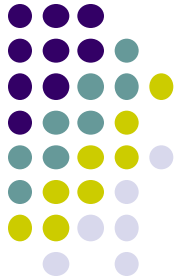
Student VS Professional Programming con't



- **Project management** : student don't care
- **Risk management** : such as heart control in hospital, The worst case, how to manage

  or one day top of project manager quit, how to run project.
- **Error cases** : boundary, abnormal

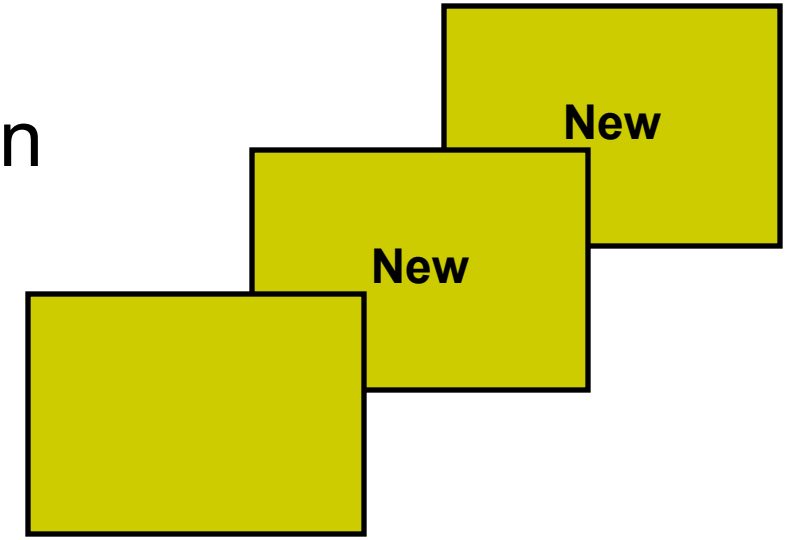
Student VS Professional Programming con't



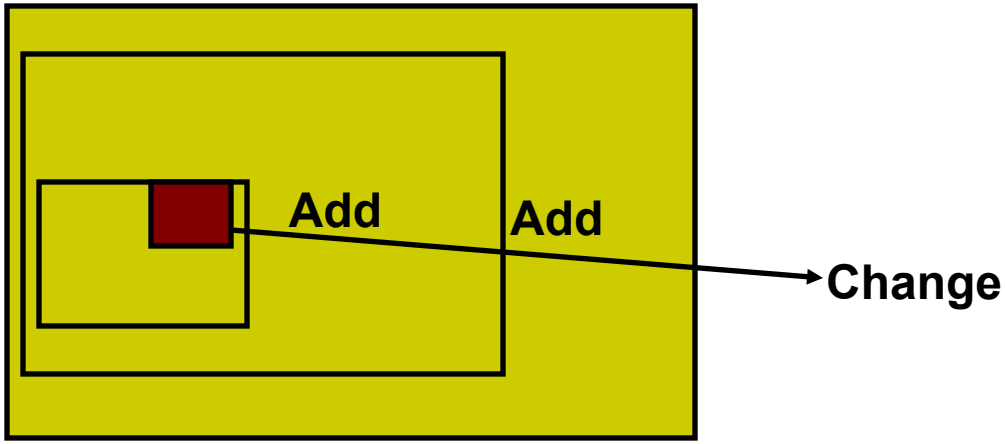
- **Reusability** : (make sure not much more modify, < 20%)
- **GUI** : This is real direct of user (non comp expert)
- **Documentation** : Student always jump to coding But professional do for reusable later, Adding, Modifying.

Reusability concept

- Old fashion



- New fashion : 1 time code, 100 modify

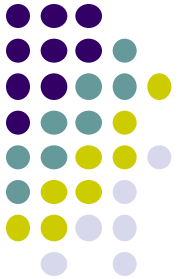


Resource usage

- 1 programmer = 1 KLOC
- 1 line = 50 – 100 $
- 1 programmer = 100,000$ (Japan - US)
- 10 – 20 programmers is ok
  - More than this project may be fail.
- 1 year project

Req.	Spec.	Design	Code	Debug	Test
2M	1.5M	1.5M	3M	2M	2M

Fact.

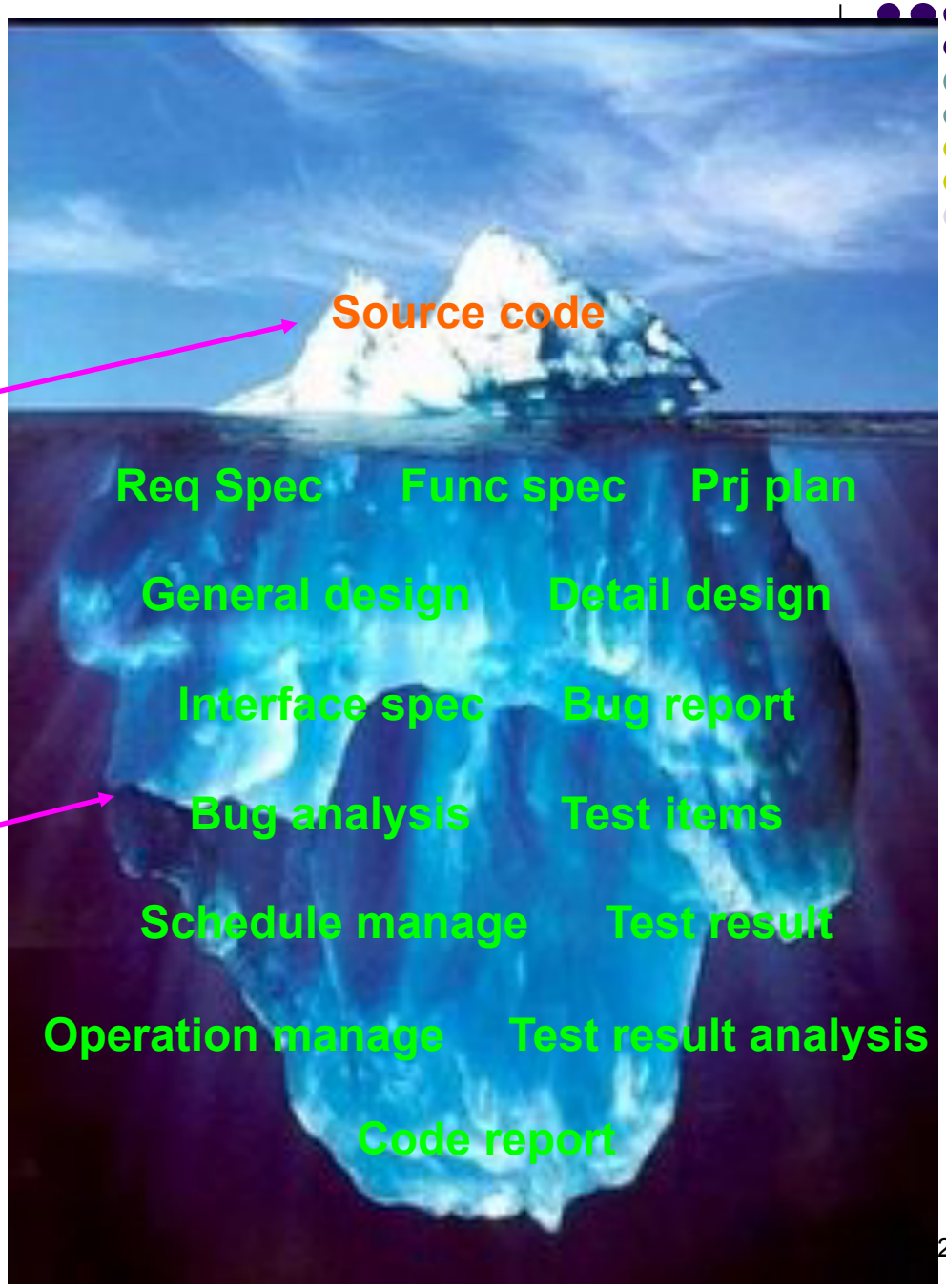


- Software engineering/ Embedded system
  - The most important is not coding (you can use any fresh graduate school)
  - But Requirement spec.
  - Specification
  - Design

Iceberg Tip

Outcome from user viewpoint

Outcome actually



Popular models

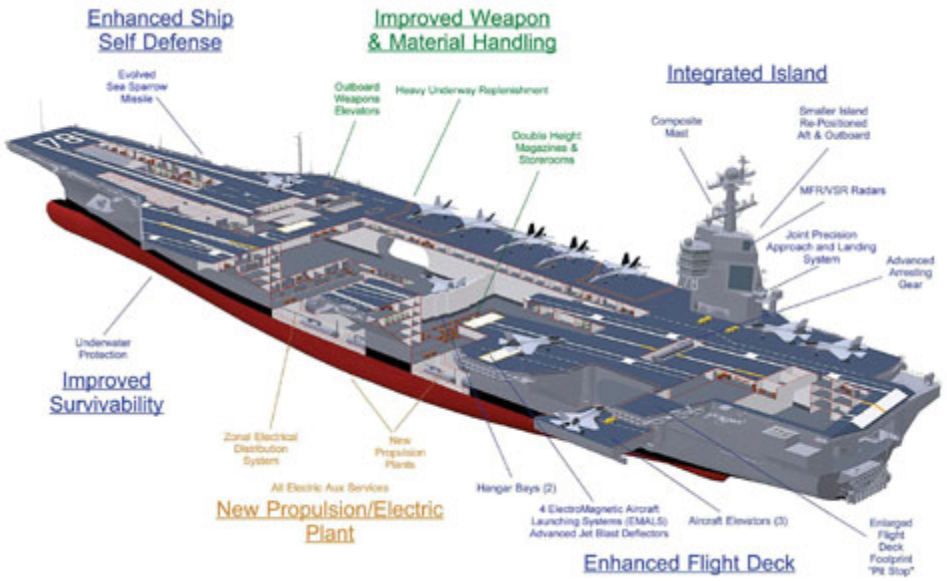
- Waterfall model
  - Advantage : Finish phase and go on
  - Disadvantage : No outcome in early stage
    User always know what they want
    In prototype use (final stage)
    If it not ok, So waste time
- Spiral model
  - Disadvantage : First version always make bugs, so hard to add function

Software Quality

- Software is the far more complex artificial thing that human ever built.
- 4 things make software very complex

4 complex attributes

1. Software is HUGE!



Easy to built **So hard**

Software is Huge!

VS

Software is Huge!

vs

How big is the software?

- Mobile phone → 10 MLOC
- Xerox multi function → 100 MLOC

- Example

1 line of page = 1 LOC, So 10MLOC is so big library

4 complex attributes con't

2. Software is Invisible/intangible/in touchable

   Can't feel the hard

   Non-programmer think it is easy to built

3. Software is easy to change

   If it hard to change such as building,
   Developer will pay more attention to build

   → But software is not, so the careless lead to many bugs.

4 complex attributes con't

4. Software has too much Flexibility

   If you think ok, There are plenty of ways to code.

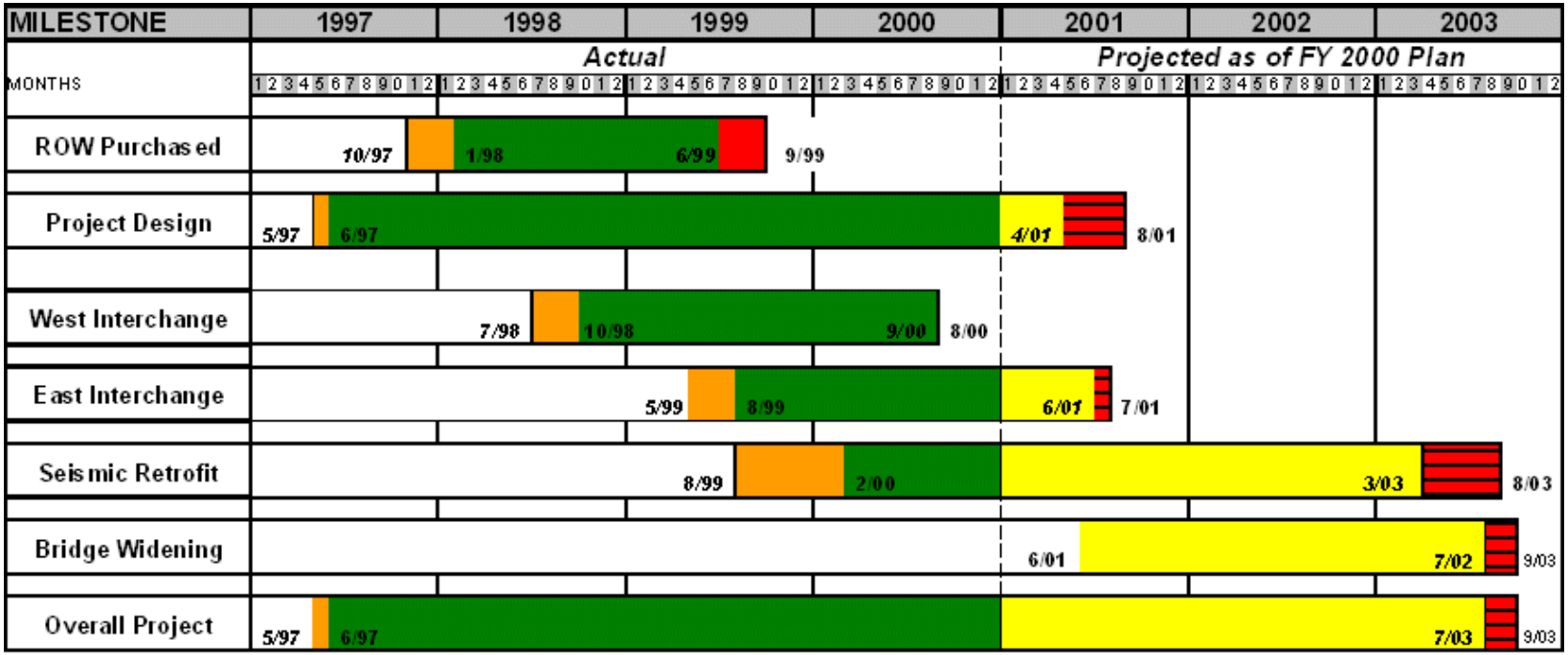
   No rules/regulation like Ohm's law

Software Development Criteria's

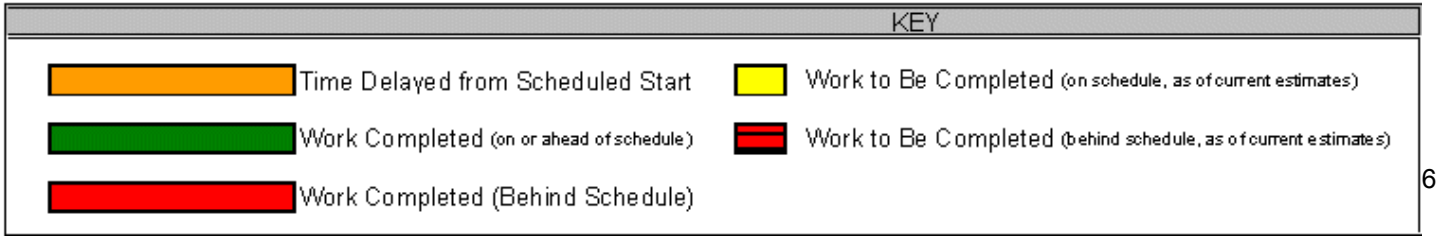
- Schedule → Quicker
- Cost → Cheaper
- Quality → Better

Schedule

- Easy, Just plan and mark actual



Note: Italics Represent Estimated Start and Completion Dates: Dates in Regular Font Are Actual Start and Completion Dates

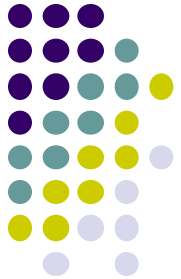


Cost

- Easy too, Just add people to do job and cost

  In software : Almost money go to salary of manpower (a little for PC, Network)

Quality



- What is software quality? → hard to measure

  (It is difficult to tell as What's life/happiness?)

  A program without bugs → not good answer

  A program with 1KLOC should be bug free if you have 100 years to test, BUT you have to make it in 2 – 4 weeks, HOW CAN?

Software compared to real life

- In peaceful society
  - Arrest criminals → debugging
  - Avoidance → design for avoid bug

  (teach young to do good)

Software Quality

= Customer satisfaction? (partial true)

Customer criteria
Developer criteria
} **Depend on domain**

- **Beat maker**
- **Cell phone**
- **Xerox**
- **Games**
- **Watch**
- **Vending mach.**
- **TV**
- **Car**

If you have to launch, cos customer request

So, **Beta** release

Schedule delay

- If your plan delay, But customer said, “We need it on that day, No delay!”

- How to manage?
  - Deadline shift
  - Reduce function

ISO 9126

1. Functionality → User require, Bugs
2. Reliability → Continue work after face bugs
3. Usability → Easy to use or not (GUI)
4. Efficiency → Performance, Resource usage, Network
5. Maintainability → How easy you can change, add func.?
6. Portability → How easy to change environment?

Exercise

What is a good restaurant?
In ISO 9126