CS10102302
需求获取技术

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软件需求（案例）

玉兔

案例工作过程的一幅场景

- 科星公司在与国家航天局（NAA）签订“月球车控制仿真软件系统”（MCS）研发合同之后的首个工作日，科星公司的工程师王华走进NAA月球车项目主管李总的办公室，
  - 王华：李总，你对MCS在月球车移动控制方面有哪些具体的要求和期望？
  - 李总：我们希望月球车能够避开障碍，并选择最优的路径到达指定地点，……

值得思考的问题

- 王华的目的是什么？
  - 获取用户对于待开发的软件系统（也称目标软件系统）的要求和期望 ——软件需求
- 王华为什么找李总了解软件需求？
  - 李总是MCS的使用者之一，其工作与MCS项目的成败密切相关 —— 李总是MCS的利益相关方
  - 李总是筹码持有者，对目标软件系统的评价，特别是对其能否顺利通过验收拥有发言权甚至决定权。

到底什么是软件需求？

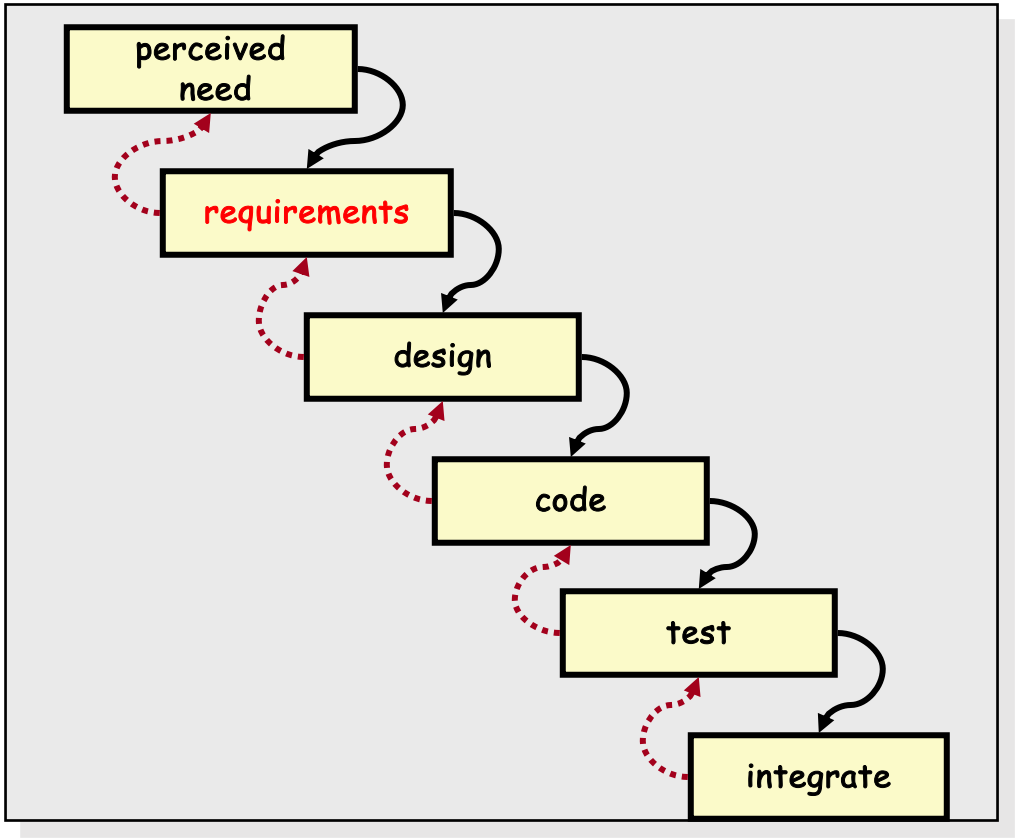
- 软件需求是利益相关方对目标软件系统的要求和期望，细分为：
  - **功能需求**：控制月球车移动并到达指定地点；
  - **性能需求**： MCS必须在1秒内完成最优路径规划；
  - **可靠性需求**： MCS平均无故障工作时间必须大于24小时；
  - **约束性需求**：MCS必须在10个月内通过验收测试；

软件需求的重要性

- 回顾案例：王华为什么在合同签订后的首个工作日就急于获取MCS的软件需求？
  - 软件需求是整个软件项目的终极目标
  - 软件需求是是后续软件开发活动（设计、编码和测试）的主要基础
    - ✓ 设计和编码都是为了实现软件需求
    - ✓ 测试是为了检验目标是否满足软件需求

需求工程活动

- 需求抽取（Elicitation）
- 需求分析（Analysis）
- 需求规约（Specification）
- 需求管理（Management）
- 需求验证（Validation）



需求抽取

目标： 主动与干系人协同工作，找出他们的需求，识别潜在的冲突，磋商解决矛盾，定义系统范围与边界

实质： 了解待解决的问题及其所属领域

关键： 确保该问题的解决是有商业价值的

注意以下问题：

- 产品设计目标不明确
- 干系人参与不足
- 干系人之间缺少共识
- 画蛇添足
- 需求快速变化
- 变更管理不足
- 需求分析不足

5W2H

需求抽取

- 抽取技术
  - 协同工作（Collaborative sessions）
  - 面谈　　（Interviewing techniques）
  - 问卷调查（Questionnaires）
  - 观察法　（Ethnography）
  - 原型法　（Prototyping）
  - 文档分析（Documentation）
  - 建模　　（Modeling）
  - 角色扮演（Roleplaying）
  - 非功能性需求列表（Checklists of NFRs）

- 冲突识别与磋商 （Conflict Identification and Negotiation）

需求分析

目标：对产品及其与环境的交互进行更深入的了解，识别系统需求，设计软件体系结构，建立需求与体系结构组件间的关联，在体系结构设计实现过程中进一步识别矛盾冲突，并通过干系人之间的协调磋商解决问题。

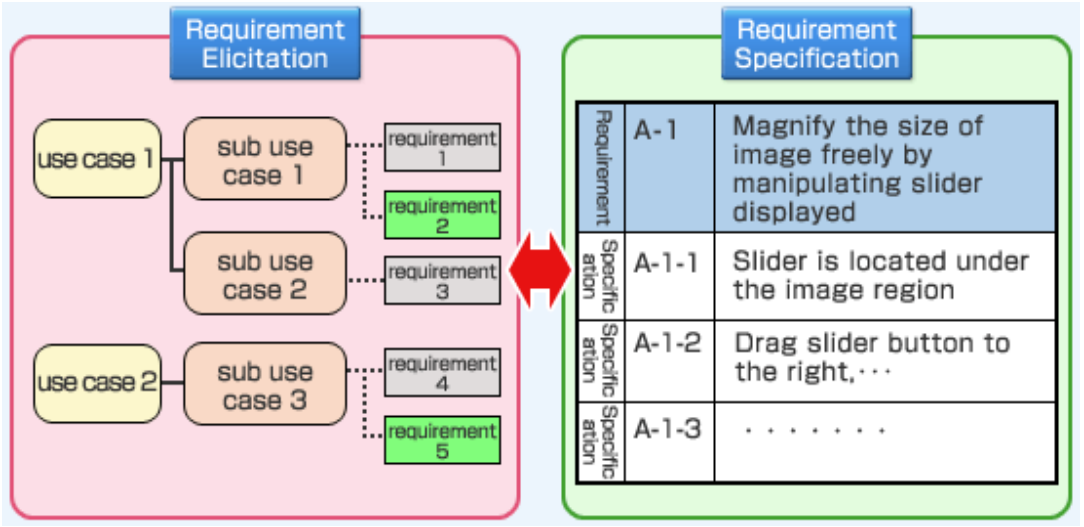
实质：概念建模———选择常用的建模语言，进行功能建模和信息建模

关键：体系结构设计与需求分配

通过评估需求的满足度来评价体系结构设计的质量

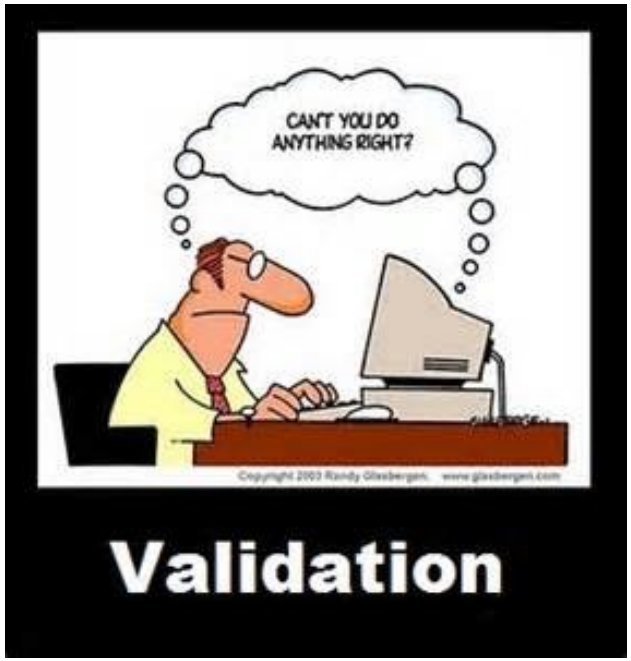
需求规约

- 系统与软件需求的文档化，以便于后续的需求及系统的正式评审，而准备的规范化文档。
- 单个需求项的质量
  - 准确（Concise）
  - 正确（Correct）
  - 明确（Non-ambiguous）
  - 可行（Feasible）
  - 可证（Verifiable）
- 整个需求集合的质量
  - 现实（Realistic）
  - 精确（Concise）
  - 全面（Complete）
  - 一致（Consistent）



需求验证

- 对其他需求工程活动的质量的保证。通过数学的形式化工具或工程化的测试过程来确保系统满足干系人的要求。
- 验证方法
  - 评审（Review）
  - 原型化（Prototyping）
  - 模型验证（Model validation）
  - 确认测试（Acceptance Tests）



需求管理

贯穿从需求获取到软件系统下线的全过程。需求管理设计软件配置管理、需求跟踪、影响分析和版本控制。

- 需求跟踪 （Requirements traceability）

  描述和追踪一条需求的来龙去脉的能力，包括向前追踪到软件制品，向后追踪到需求来源。

- 变更请求管理 （Change Requests）

  系统化的变更管理

- 需求属性管理 （Requirements attributes）

Difficulty in requirement phase

- 需求不是很明显，讲不清，细节更难
- 需求可能来自多个源头，各说各的，可能相互矛盾
- 需求内容和形式丰富，功能，性能，可靠性，安全
- 需求之间有千丝万缕的联系
- 需求不断变化
- “问君能有几多愁，从早到晚改需求”
- 需求还未出现
- 分析人员,或客户理解有误

买鞋、买衣服

有些客户心里非常清楚想要什么，但却说不明白。读者可能很不以为然。比如说买鞋子：我们非常了解自己的脚，但没法说清楚脚的大小和形状。只能拿鞋子去试，试穿时感觉到舒服才会买鞋（居然也有神通广大的售货员，看一眼客户的手，就知道应该穿什么样的鞋。）

如果客户本身就懂软件开发，能把需求说得清清楚楚，这样的需求分析将会非常轻松、愉快。如果客户全不懂软件，但信任软件开发方，这事也好办。分析人员可以引导客户，先阐述常规的需求，再由客户否定不需要的，最终确定客户真正的需求。最怕的就是“不懂装懂”或者“半懂充内行”的客户，他们会提出不切实际的需求。

有个外星人间谍潜伏到地球刺探情报，它给上司写了一份报告：“主宰地球的是车。它们喝汽油，靠四个轮子滚动前进。嗓门极大，在夜里双眼能射出强光。……有趣的是，车里住着一种叫作‘人’的寄生虫，这些寄生虫完全控制了车。”

由于客户大多不懂软件，他们可能觉得软件是万能的，会提出一些无法实现的需求。有时客户还会把软件系统分析人员的建议或答复给想歪了。

有一个软件人员滔滔不绝地向客户讲解在“信息高速公路上做广告”的种种好处，客户听得津津有味。最后，心动的客户对软件人员说：“好得很，就让我们马上行动起来吧。请您决定广告牌的尺寸和放在哪条高速公路上，我立即派人去做。”

敏捷方法 vs.传统方法

Sr #	Agile	Traditional
1	Incremental Value & Risk Management	Phased approach with an attempt to know everything at the start
2	Embracing Change	Change Prevention
3	Delivery Early, Fail Early	Delivers value at the end, fails at the end
4	Transparency	Detailed planning, stagnant control
5	Inspect and Adapt	Meta Solution w/tightly controlled procedures & final answers
6	Self Managed	Command and Control
7	Continual Learning	Learning is secondary to the pressure of delivery

需求来自何方？

- 软件是为人服务的，用户是上帝，以人为本
- 利益相关方， stakeholder，干系人
- 应用领域
- 商业和市场，竞争者
- 业务流程
- 构思，挖掘，诱导，超前意识想法，……
- 举例：ATM的干系人

需求抽取

Requirements Elicitation

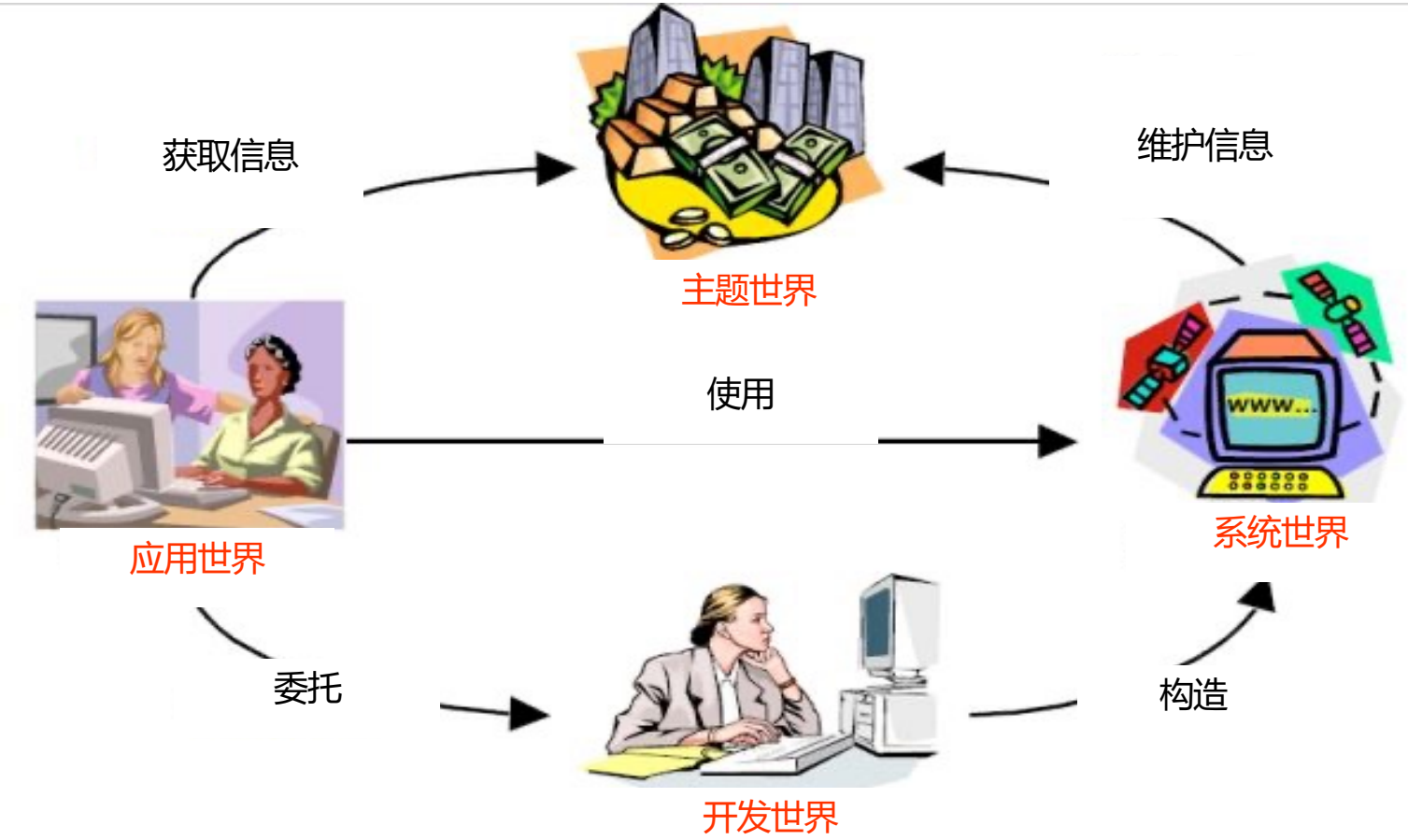
需求抽取

需求抽取过程中，最困难的不是记录用户需求，而是与用户探讨磋商，发现真正要解决的问题，确定适用的方案。

— Steve McConnell

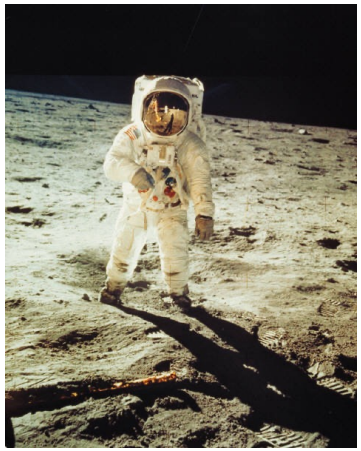
四世界模型

Adapted from Loucopoulos & Karakostas, 1995, p73



出发点

- 确定干系人
  - 这里需要强调与客户之间的联络关系
  - 系统的设计到底与谁的利益息息相关
- 定义边界
  - 怎样界定问题的范围?
- 定义目标与情景实例
  - 目标与情景实例是组织原始需求信息的有效手段
- 分析可行性
  - 如何进行可行性研究
  - 如何选择好的项目
- 分析风险
  - 风险管理应长期、持续进行，而非阶段性、一次性的任务
  - 进行灾难及事故分析，以确定风险



干系人

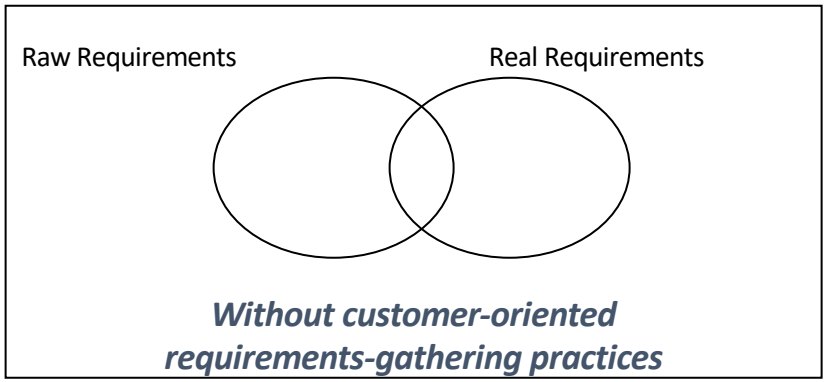
- 干系人分析
  - 找出所有干系人
  - 分析其隶属于哪个世界
- 干系人举例
  - **用户**—关心新系统特征和功能
  - **设计师**—想要构造完美的系统，尽量重用已有的代码
  - **系统分析师**—想要获取正确的需求
  - **培训与用户支持人员**—确保系统可用和可管理
  - **业务分析师**—想确保“我们做得比竞争对手好”
  - **技术文档作者**— 为系统准备用户手册及其他相关文档
  - **项目经理**—希望按时、按预算、按目标完成项目
  - **客户**—为新系统买单的人

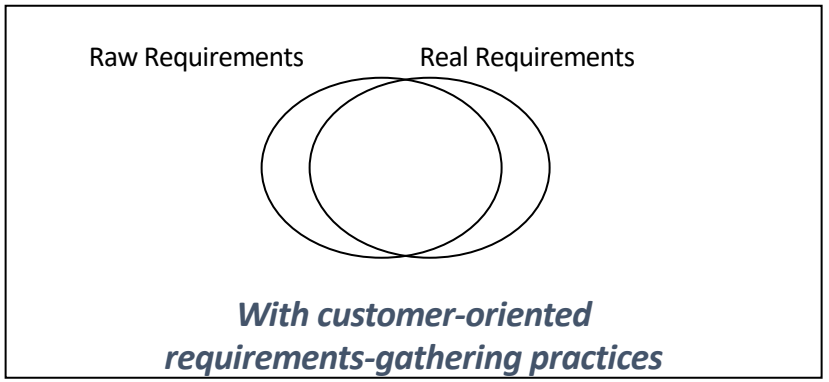
Stakeholders

- Stakeholders include anyone with an interest in the system, for example
  - Sponsors
  - Customers
  - System Users/Domain Experts
  - Project Team
- Identify stakeholders by asking questions
  - Who will use the product?
  - Who will provide the inputs?
  - Who will get the outputs?
  - Who has an oversight role?
  - Who has a related role?
  - Who will be rewarded?
  - Who will be penalized?

Stakeholders

- **Involving stakeholders in individual or group requirements sessions to define system details**
  - Results in a high quality system from the customer/user point of view
  - Results in higher end-user satisfaction
  - Helps to educate customer/user about system through their participation



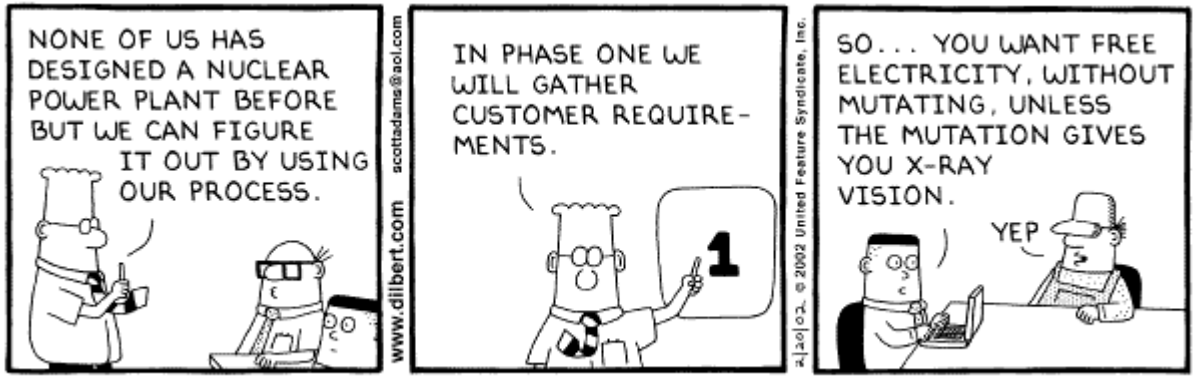


Stakeholders

- Benefits of stakeholder involvement include
  - Improved system information content
  - Improved system information quality
  - Improved system productivity
  - Improved customer/user understanding of the system
  - Creation of customer/user consensus
  - Creation of customer/user commitment to system success
  - Determination of early scoping decisions
  - Increased confidence that consensus will be reached
  - Improved quality of requirements
  - Development of an integrated team

Elicitation

- The Art of *Listening* to Stakeholders
- The Art of *Sending Appropriate Stimuli* to Stakeholders So That the Responses are Worth Listening To
- The Art of *Establishing an Environment* in Which Stakeholders Are Willing and Able to Describe Their Problems and Needs



What Is "Just Enough" Requirements Management?

- What is "just enough" life insurance?
  - Enough so you sleep well at night knowing that others will be "taken care of" if you die
  - Not so much that you stay awake at night worrying about the money you are paying for insurance
- What is "just enough" RM?
  - Enough so you can keep your customers happy
  - Not so much that your project becomes late or over-budget

- Too much
  - You would spend so much time understanding the problem that no time would be left to solve it
- Too little
  - You would build system before understanding problem, and would likely build the wrong system

Who's Smart?

- Don't Try to Convince Stakeholders that *You* Are Smart – Wrong Place to Do That!
- Instead Take Every Opportunity to Show You Think the Stakeholder is Smart
- Contrast These Two Cases

My Elevators Are Too Slow!

I See. Tell Me Why You Feel They Are Too Slow.

I Don't Think So. I Think You Have an Elevator Throughput Problem, not a Speed Problem

Maintain Glossary

- Ellen Gottesdeiner Has Observed that a Large Percentage of Requirements Miscommunication Is Caused by Word Meanings

- Appoint a Glossary Czar 词汇沙皇
  - Asks Questions Like: "What Do *You* Mean by *X*?"
  - Records All Agreements Concerning Definitions

Use Appropriate Elicitation Techniques

- One elicitation technique is not "good enough"
- Function of people involved
- Function of requirements not yet understood
- Function of application domain

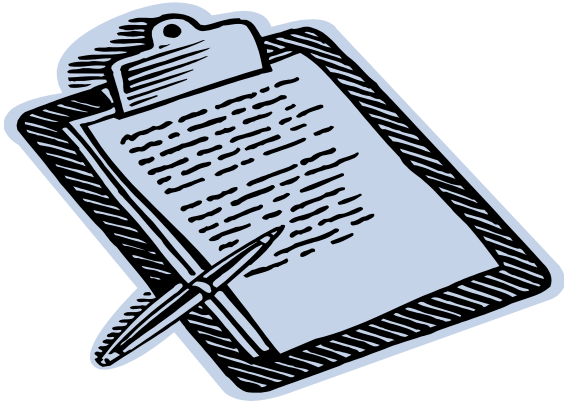
Techniques for Elicitation

- Interviews
  - Same Place, Same Time
  - Few People, Analyst-Driven
- Questionnaires
  - Different Time, Different Place
  - Many People, Analyst-Observer
- Group Sessions
  - Same or Different Place, Same Time
  - <20 People, Analyst-Facilitated
- Observation
  - Same Time, Same Place
  - Analyst-Observer

- Documentation Review
- Brainstorming
- Apprenticing
- Scenario Analysis
- Prototyping/Mock-up
- Modeling
- Workshops

Interviewing

- Purpose
  - Use interviews to clarify and validate stated requirements and elicit unstated and derived requirements
- Guidelines
  - Work with individuals first, then with groups; group dynamics change responses and feedback
  - Talk to the people who actually do the work and the people who are funding the project
  - Two analysts should attend each interview
  - Use a tape recorder, if possible



Use a Questionnaire

- Prepare interview questions in advance
- Ask open-ended questions
- Ask essential questions
  What? Why? When? Who? How? Where?

Interviews

- Asking Questions; Listening to the Answers
- When Do You Interview?
  - Ability to Meet with Them
  - When a "Few" People Each Know a "Lot"
  - When True SME's Exist
  - When the Stakeholders May Not Be Brought Together
  - When the Problem Does Not Require Interaction to Arrive at an Optimal Answer
- Best Source: Gause & Weinberg, *Exploring Requirements*, Dorset House, 1989.

Interviews

- Types
  - Structured - agenda of fairly open questions
  - Open-ended - no pre-set agenda
- Advantages
  - Rich collection of information
    - Good for uncovering opinions, feelings, goals, as well as hard facts
  - Can probe in depth, & adapt follow up questions to what the person tells you
- Disadvantages
  - Large amount of qualitative data can be hard to analyze
  - Hard to compare different respondents
  - Interviewing is a difficult skill to master
- Watch for
  - Unanswerable questions ("how do you tie your shoelaces?")
  - Tacit knowledge (and post-hoc rationalizations)
  - Removal from context
  - Interviewer's attitude may cause bias (e.g. variable attentiveness)

Interviewing Tips

- Starting off…
  - Begin the interview with an innocuous topic to set people at ease
    - e.g. the weather, the score in last night's hockey game
    - e.g. comment on an object on the person's desk: "My,… what a beautiful photograph! Did you take that?"
- Ask if you can record the interview
  - but put tape recorder in front of person
  - say that they can turn it off any time
- Ask easy questions first
  - perhaps personal information
    - e.g. "How long have you worked in your present position?"
- Follow up interesting leads
  - E.g. watch for things people say that indicate that your plan of action may be wrong,
    - e.g. "Could we pursue what you just said a little further?"
- Ask open-ended questions last
  - e.g. "Is there anything else you would like to add?"

Questionnaires

- Pre-defined Series of Questions
- Widely Used
- **Appear Scientific Due to Statistical Analysis**
- When Do You Use Questionnaires?
  - Large Base of Individuals
  - Need Answers to Well-Defined Specific Issues
  - To Verify Results of Limited Interviews
  - When You Want a Specific Outcome ☺

- Best Source: Fowler, *Survey Research Methods*, Sage, 1993.

Questionnaires

Advantages

- Can quickly collect info from large numbers of people
- Can be administered remotely
- Can collect attitudes, beliefs, characteristics

Disadvantages

- Simplistic (presupposed) categories provide very little context
  - No room for users to convey their real needs

Questionnaires

Watch for

- Bias in sample selection
- Bias in self-selecting respondents
- Small sample size (lack of statistical significance)
- Open ended questions (very hard to analyze!)
- Leading questions ("have you stopped beating your wife?")
- Appropriation ("What is this a picture of?")
- Ambiguous questions (I.e. not everyone is answering the same question)

Questionnaires MUST be prototyped and tested!

Group Sessions

- Gather (3 to 20) Stakeholders in One Room
- Everybody Shares Ideas Out Loud
- Team Answers Are Usually Better than Individual Answers
- When Conduct Group Session?
  - When Many People Each Knows a (Small) Part of the Whole
  - When Problem Needs Interaction to Optimize Solution
  - When You Can Get Them All Together
  - Anonymity Necessary? Use a Tool
  - Distributed? Use a Tool

Best Source : Gottesdeiner, *Requirements by Collaboration,* Addison-Wesley, 2000.

Group Elicitation Techniques

- Types:
  - Focus Groups
  - Brainstorming
- Advantages
  - More natural interaction between people than formal interview
  - Can gauge reaction to stimulus materials (e.g. mock-ups, storyboards, etc)
- Disadvantages
  - May create unnatural groups (uncomfortable for participants)
  - Danger of Groupthink
  - May only provide superficial responses to technical questions
  - Requires a highly trained facilitator
- Watch for
  - sample bias
  - dominance and submission

Meetings

- Used for summarization and feedback
  - E.g. meet with stakeholders towards the end of each stage
    - to discuss the results of the information gathering stage
    - to conclude on a set of requirements
    - to agree on a design etc.
  - Use the meeting to confirm what has been learned, talk about findings
- Meetings are an important managerial tool
  - Used to move a system development project forward
  - Need to determine objectives for the meeting
  - Plan the meeting carefully

Meetings

Meetings are an important managerial tool

- Need to determine objectives for the meeting
  - E.g. presentation, problem solving, conflict resolution, progress analysis, gathering and merging of facts, training, planning,...
- Plan the meeting carefully
  - Schedule the meeting and arrange for facilities
  - Prepare an agenda and distribute it well in advance
  - The meeting itself may be structured or unstructured depending on objective
  - Keep track of time and agenda during the meeting
  - Follow up with a written summary to be distributed to meeting participants
  - Special rules apply for formal presentations (and how to prepare them), project walkthroughs, brainstorming,...

Observation

- Analyst Observes Stakeholders Performing Their "Usual" Work
- Analyst Should Be As Passive As Possible
  - See Heisenberg Uncertainty Principle: Observation Affects Outcome
  - "Action Research" When Observer Participates
- When to Observe?
  - When There Exists Someone/thing to Observe
  - When Knowledge is (Believed to Be) Tacit
- The Goguen/Jirotka Story

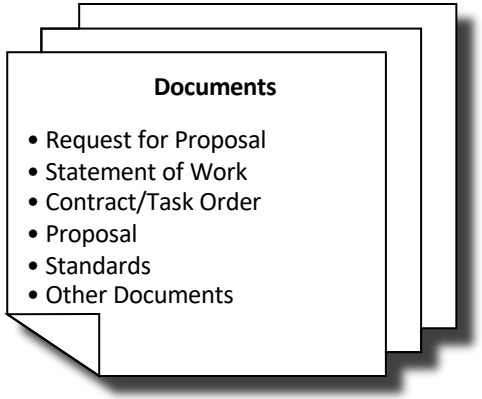
Best Source : Goguen & Jirotka, *Requirements Engineering: Social and Technical Issues,* Academic Press, 1994.

Participant Observation

- Approach
  - longitudinal studies
    - Observer spends time with the subjects, joining in, long enough to become a member of the group
- Advantages
  - Contextualized
  - Reveals details that other methods cannot
- Disadvantages
  - Extremely time consuming!
  - Resulting 'rich picture' is hard to analyze
  - Cannot say much about the results of proposed changes
- Watch for
  - going native!

Documentation Review

- Purpose
  - Understand what needs to be done
  - Use as basis for further study, business process definition, interviews, etc
- Guidelines
  - Determine what is right and wrong with the current business process or products
  - Identify opportunities to reuse existing products or information
  - Extract requirements from many diverse sources into a consolidated requirements list



Brainstorming

- Purpose
  - Use the group effect to generate new ideas for the product/system
  - Useful when there are many unstated or derived requirements
- Guidelines
  - Use in a facilitated workshop
  - All ideas are good; do not evaluate, debate or criticize
  - Do not be bounded by what is possible
  - Attempt to produce lots of ideas, novel ideas
  - Use random words to seed the session
  - Piggyback on others' ideas

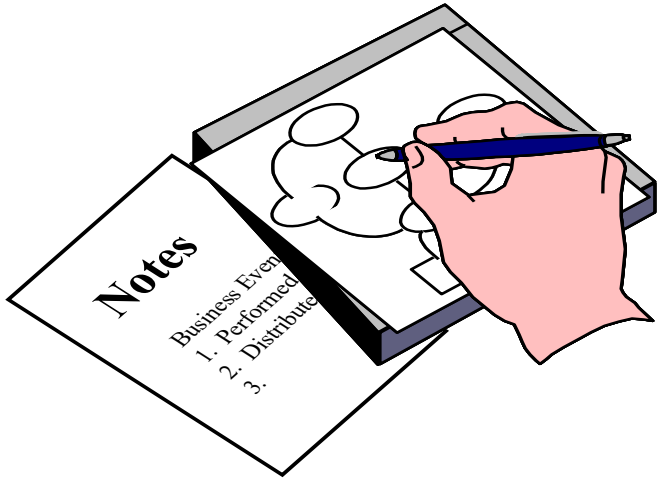
IDEA GENERATION

Broad ideas may yield good requirements or result in requirements creep

Set expectations for participants

Apprenticing

- Purpose
  - Learn the job by observation and asking questions
  - Real-time capture of work
  - Immediate feedback
- Guidelines
  - Users are too busy to take time off for interviews
  - People are not aware of what they do
  - See the same task performed many times
  - Learn the task and repeat while user is watching
  - Establish a relationship with customers/users



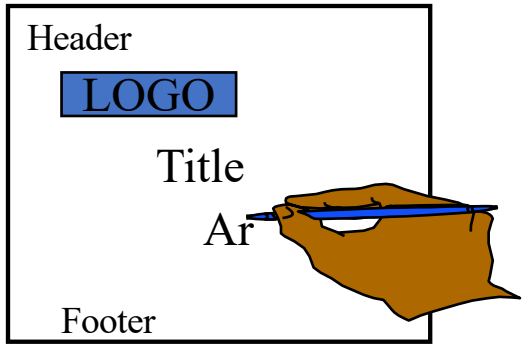
"Nobody can talk better about what they do, and why they do it, than they can while in the middle of doing it."
[Beyer and Holtzblatt]

Scenario Analysis

- Purpose
  - Clearly delineates the series of steps to complete the business event to the customer/user
  - Elicit user-recognizable actions
- Guidelines
  - Identify possible interactions between customer/user and other business events or domains of interest
  - Breakdown the business events into discrete activities or business processes

Prototyping, Mock-Ups, Outlines

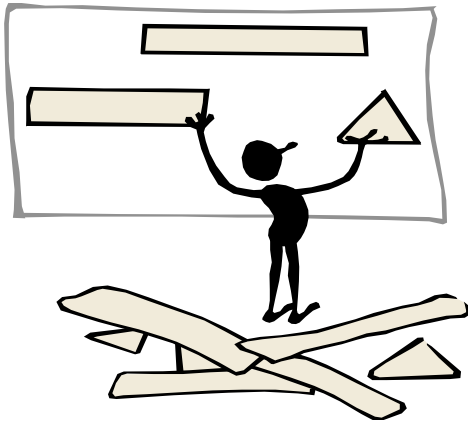
- Purpose
  - Clarify requirements that are ambiguous or uncertain
  - Simplify requirements documentation and acceptance needs
  - Provide early feedback to customer and end user
- Guidelines
  - A useful communication tool
  - Use to validate requirements
  - Use to provide sizing data for cost estimations
  - Use to assess alternative user interfaces
  - Help users visualize essential functionality



A picture says a thousand words!

Modeling

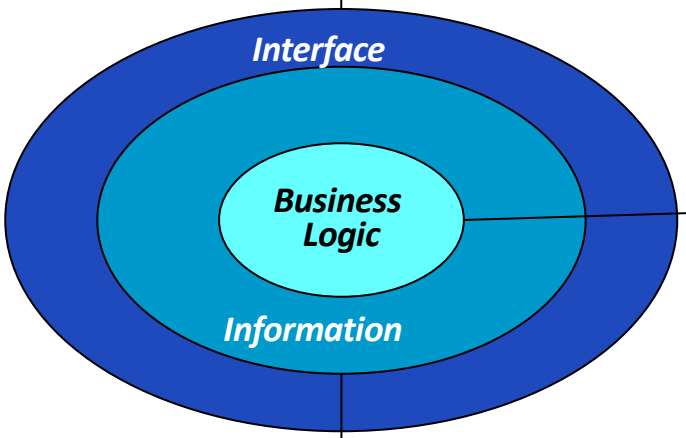
- Purpose
  - Uses pictures to represent reality
  - The analysis creates models of the system-to-be, that is, abstract representations of what will eventually become the system
  - Modeling facilitates the evaluation, extension, and clarification of raw requirements to make them clear, complete, correct and consistent
- Guidelines
  - Model Types
    - Activity
    - Decomposition
    - Data
    - Object Oriented
    - Process
    - Use Case



Workshops

- Purpose
  - Introduce the project team and project stakeholders
  - Gather a comprehensive requirements "wish list" from stakeholders of the project
  - Provides a framework for applying the other elicitation techniques, such as brainstorming, storyboarding, role playing, review of existing requirements
- Guidelines
  - The facilitator leads the session, which includes:
    - Giving everyone an opportunity to speak
    - Keeping the session on track
    - Gathering input for applicable Requirement Attributes
    - Recording the findings
    - Summarizing the session and working out conclusions

Technique Selection



Interface to humans/user interface
Use prototyping, scenarios, modeling

Essential operating activities
Use apprenticing, interviews, scenarios

Policy architecture, stored data
Use interviews, existing systems analysis

- Rigorous modeling of everything is likely not feasible
- Prototyping everything is likely not feasible
- Match requirements/analysis techniques to needs and situations

- Questions?

Business Processes

- Analysis of the existing business processes facilitates identification of business problems and potential improvements
  - Identify and list problems with the current business process
  - Consider problems (missing, not working, needed)
  - Consider opportunities for improvement
  - Consider improvement activities
    - Improvements may involve opportunities for automation (system requirements) and/or changes to the current business process (business process improvements)

Policies and Procedures

- **Policies and procedures define work practices and how things are done in the workplace**
- Review and analysis of policies, procedures, protocols and technical standards aid in determining business rules and constraints
  - Business Rule: a statement that defines some aspect of the business process. It is intended to assert structure or to control or influence the behavior of the business processes surrounding the system
  - Constraint: restrictions in the way a system is developed. Constraints can be economic, political, technical, or environmental and pertain to project resources, schedule, target environment, or to the system itself
- Organizational documentation may also explicitly define requirements for process automation, including workflow, relationships, and interactions

Existing Automated Systems

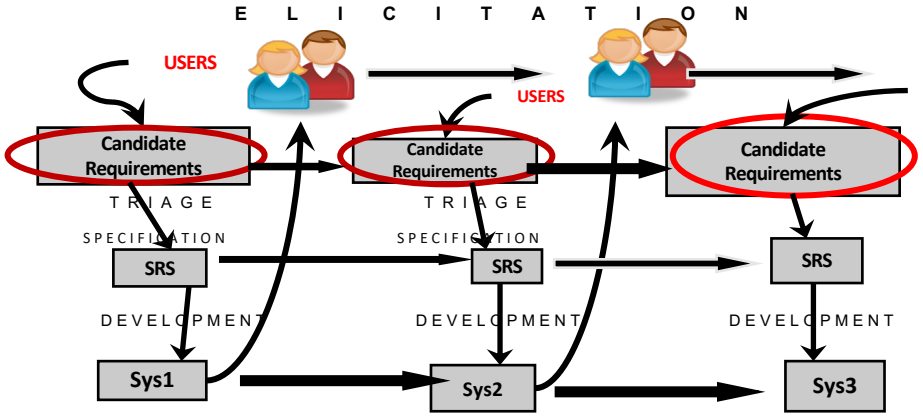
- Analysis of existing automated systems provides insight into data that might be used by the new system
  - Data objects
  - Data relationships
  - Database structure and architecture
  - System reports

Prepare for Change

- This is an “attitude”
- The more stakeholders are involved, the more features they will want
- Don’t solve this “problem” by eliminating stakeholders
- Stakeholders have the right to change their minds
- Don’t Ever Ask: “Ok, Is that Your Final Requirement?”
- See suggested changes as opportunities, not threats

Prepare for Prioritize

- This is an "attitude"
- Elicitation's purpose is to gather all *candidate* requirements
- Make sure everybody knows that triage will follow in order to select *the* requirements



Summary

- Many experts have a standard technique used for many years (Okay because often invariant domains)
- When faced with new situations or domains, many experts simply alter their standard approach without changing its name
- Almost all concur that collaborative sessions and interviewing are fundamental
- Most experts driven by "create this model" rather than "follow this technique"
- Almost all analysts use models

练习

- 现在由于食品安全问题出现，急需开发一个“食堂食品溯源管理系统”
  - 如何开展需求抽取？

Reference

- 清华大学国家级精品课程 《软件工程》主讲人 刘强 副教授 刘璘 副教授
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谢谢大家！

THANKS