上海交通大学
SHANGHAI JIAO TONG UNIVERSITY

软件工程原理与实践
SOFTWARE ENGINEERING

需求工程

沈备军

饮水思源 · 爱国荣校

问题

- 需求创新和产品定位很难
- 用户提不出需求
  - I'm not sure, but I'll know it when I see it
- 需求经常变化，项目没有时限
- 开发人员不得不大量超时工作，因为误解或二义性的需求直到开发后期才发现
- 系统测试白费了，因为测试者并未明白产品要做什么
- 功能都实现了，但由于产品的低性能、使用不方便或其它因素用户不满意
- 维护费用相当高，因为客户的许多增强要求未在需求获取阶段提出

程序员的愤怒

大 纲

01-软件需求概述

02-需求获取

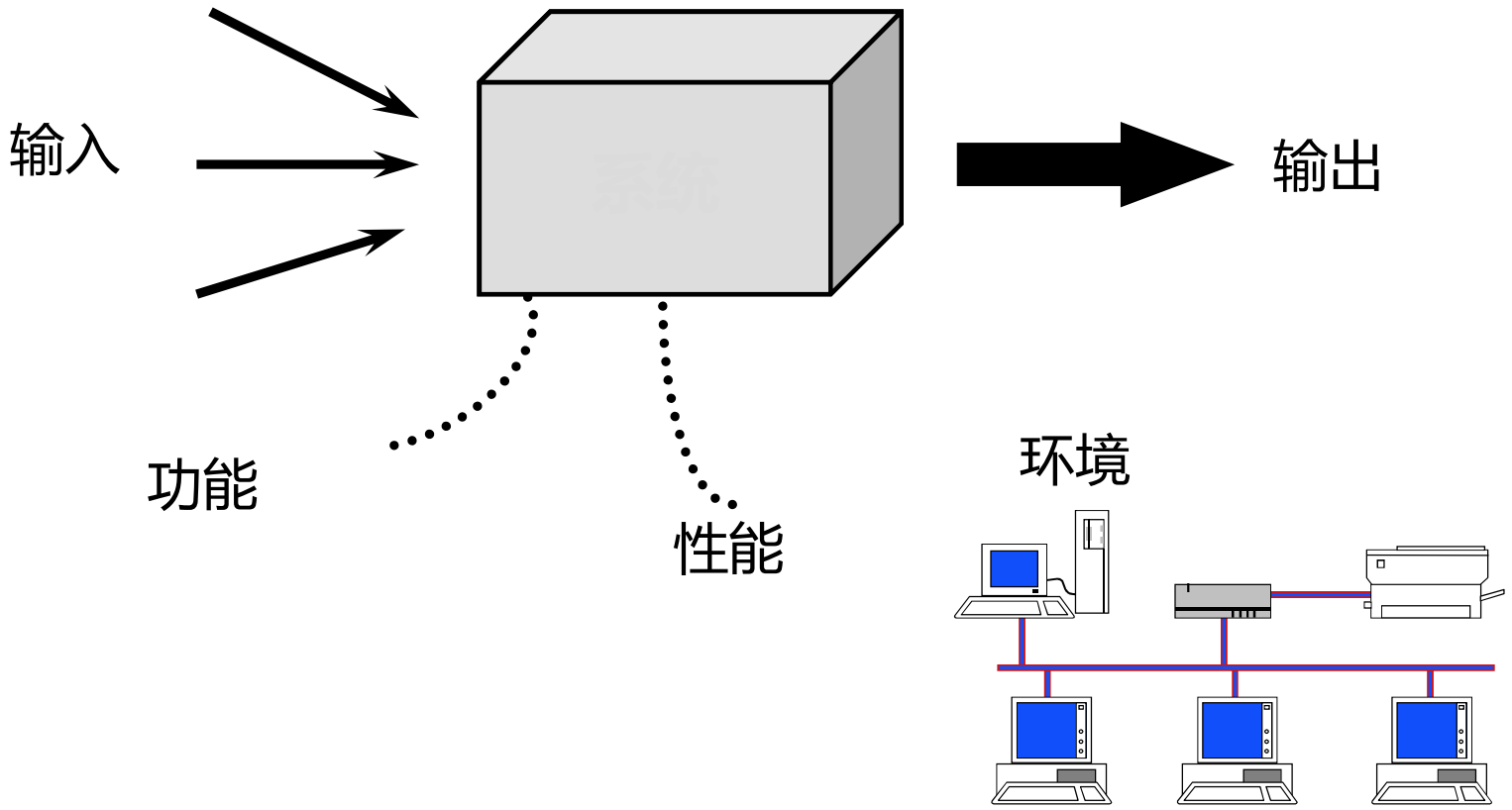
03-需求分析和建模

04-需求定义和验证

05-需求管理

@第5章.教材

什么是软件需求?



定义

- 需求
  - 系统必须符合的条件或能力
- 软件需求
  - 用户对目标软件系统在功能、行为、性能、设计约束等方面的期望。
  - 内容包括：FURPS +

关注**What!**

FURPS

Functionality	Feature Set Capabilities	Generality Security
Usability	Human Factors Aesthetics	Consistency Documentation
Reliability	Frequency/Severity of Failure Recoverability	Predictability Accuracy MTBF
Performance	Speed Efficiency Resource Usage	Throughput Response Time
Supportability	Testability Extensibility Adaptability Maintainability Compatibility	Configurability Serviceability Installability Localizability Robustness

功能需求

非功能需求

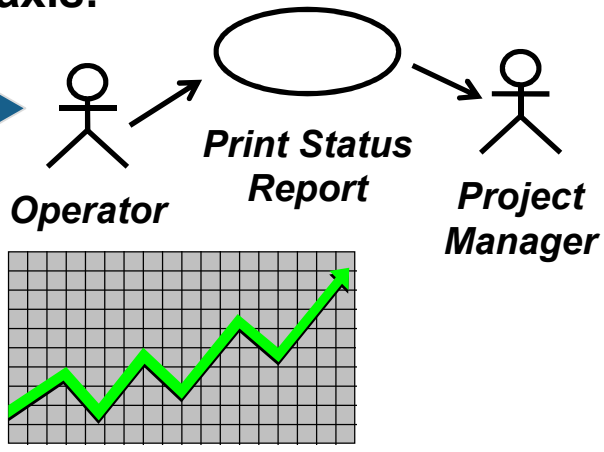
定义 Functionality 需求

概要功能需求

Feat 63 - the defect tracking system will provide trending information to help the project manager assess project status

详细功能需求

Trending information will be charted with a line graph showing time on the x axis, and number of defects found on the y axis.



定义 Usability 需求

- “usability”易用性
  - The ease with which software can be learned and operated by the intended users
- 易用性需求
  - Training time requirements, measurable task times
  - User abilities (beginner/advanced)
  - Comparison to other systems that users know and like
  - Online help systems, tool tips, documentation needs
  - Conformity with standards
    - Examples: Windows, style guides, GUI Standards

定义 Reliability 需求

- “reliability”可靠性
  - The ability for the software to behave consistently in a user-acceptable manner
- 可靠性需求
  - Availability (xx.xx%)
  - Accuracy
  - Mean time between failures (xx hrs)
  - Max. bugs per/KLOC (0-x)
  - Bugs by class - critical, significant, minor

定义 Performance 需求

- “performance”性能
  - A measure of speed or efficiency of the running system
- 性能需求
  - Capacity
  - Throughput
  - Response time
  - Memory
  - Degradation modes
  - Efficient use of scarce resources
    - Processor, memory, disk, network bandwidth

定义 Supportability 需求

- “supportability”支持性
  - The ability of the software to be easily modified to accommodate enhancements and repairs
- 支持性需求
  - Languages, DBMS, tools, etc.
  - Programming standards
  - Error handling and reporting standards
- 常常难以定义
  - If not measurable or observable, it is not a requirement
  - Is it a design constraint?
  - Is it an intent or goal?

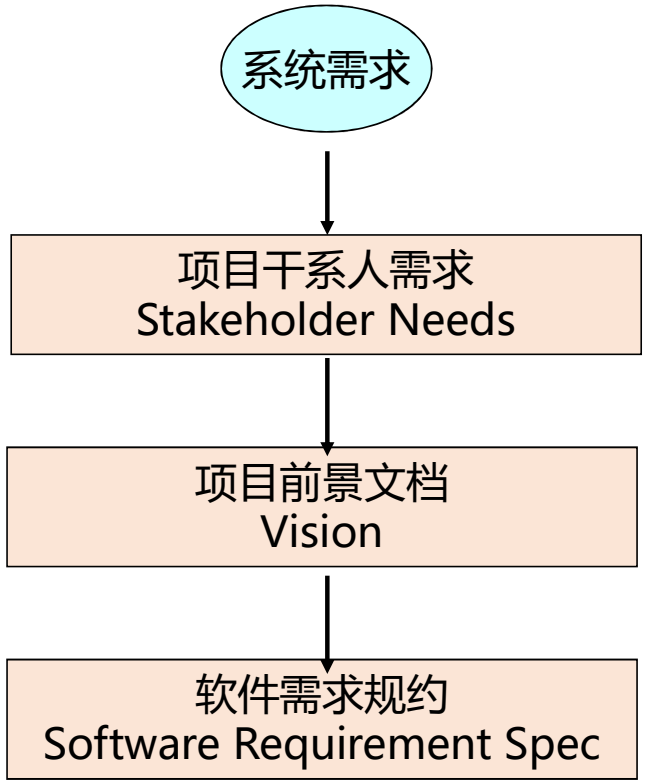
FURPS +

- 设计约束（design constraints）：规定或约束了系统的设计的需求；
- 实现需求（implementation requirements）：规定或约束了系统的编码或构建，如所需标准、编程语言、数据库完整性策略、资源限制和操作环境；
- 接口需求（interface requirements）：规定了系统必须与之交互操作的外部软件或硬件，以及对这种交互操作所使用的格式、时间或其他因素的约束；
- 物理需求（physical requirements.）：规定了系统必须具备的物理特征，可用来代表硬件要求，如物理网络配置需求。

设计约束

- 一项需求允许多种设计方案
  - 设计是在这多种方案中做出选择
- 没有选择的需求就是一个设计约束
  - 它和其它需求不同
  - 将它放在软件需求的单独一节中
  - 将每个设计约束的源标识出来
  - 记录每个设计约束的原理
- 举例
  - 必须要有某一种算法
  - 必须要用数据库

软件需求的三个层次



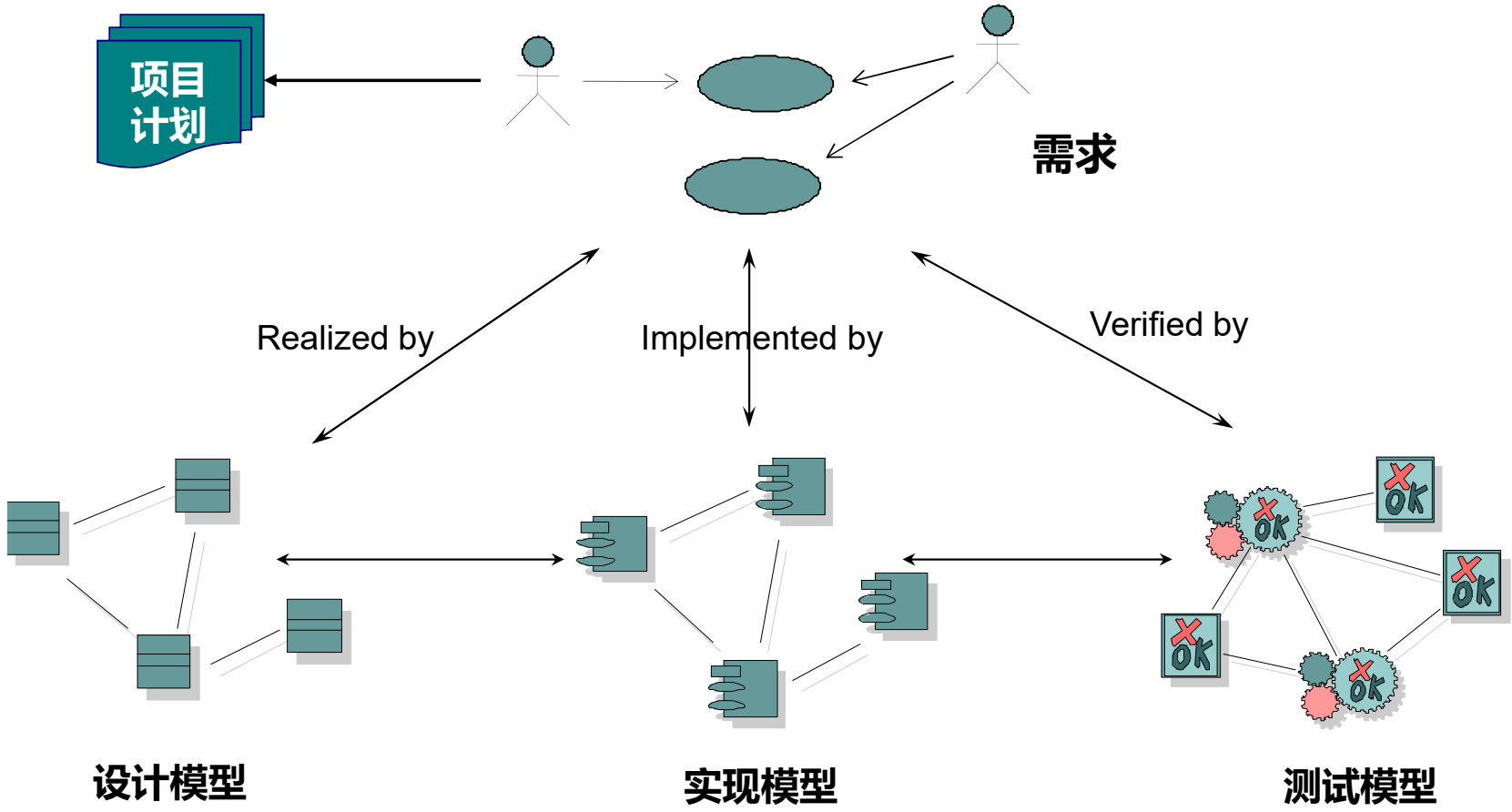
业务需求 / 产品需求

原始需求

概要需求

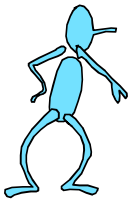
详细需求

需求驱动开发

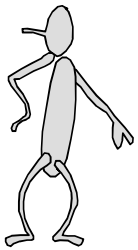

项目
计划
需求
Realized by
Implemented by
Verified by
设计模型
实现模型
测试模型

谁看需求?

客户



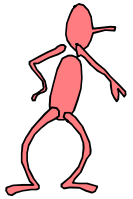
Client



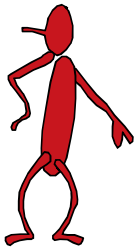
Users

开发小组

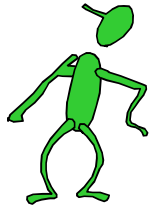
Tester



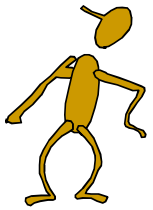
Designer



Requirements Specifier



Technical Writer



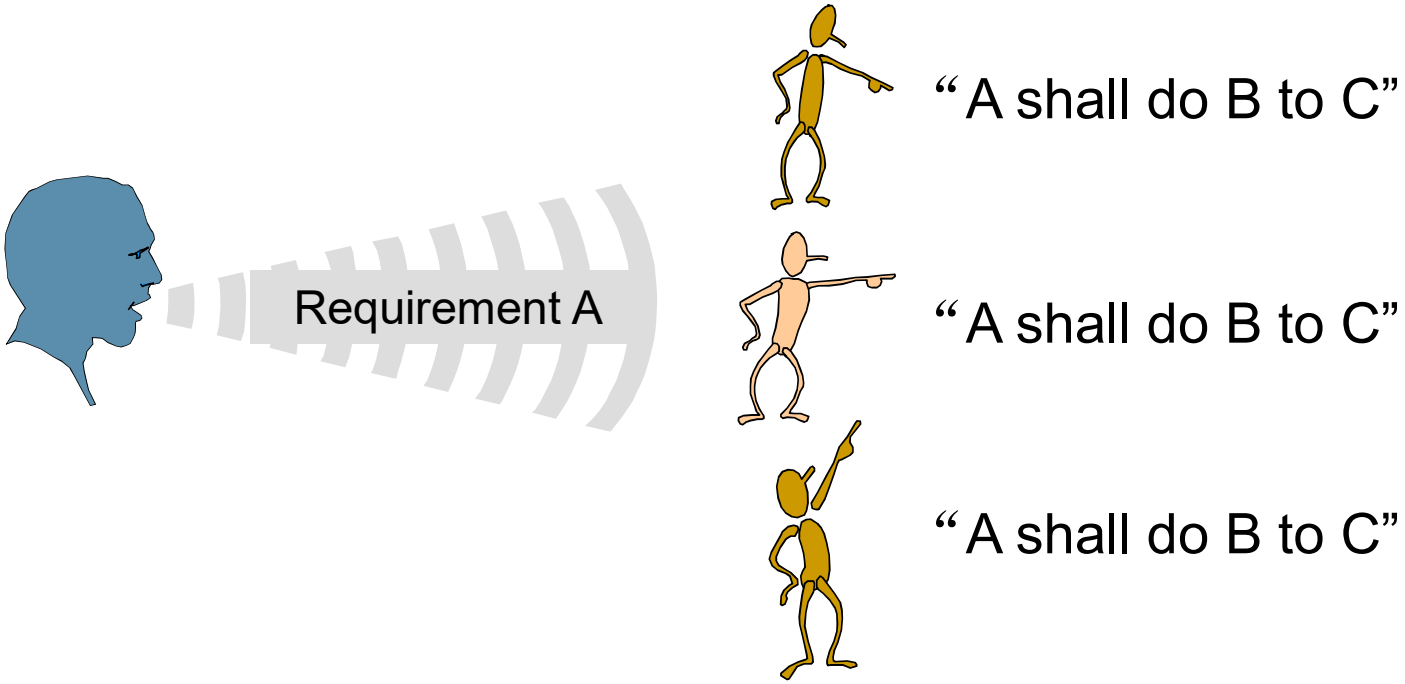
Project Manager

优秀需求具有的特性

- 单个优秀需求应具有的特性：
  - 完整性
  - 正确性
  - 可行性
  - 必要性
  - 划分优先级　（Why?）
  - 无二义性
  - 可验证性
- 多个优秀需求应具有的特性：
  - 完整性
  - 可理解性
  - 一致性
  - 可跟踪性

无二义性

- 需求是无二义的，如果：
  - 它只有一个解释



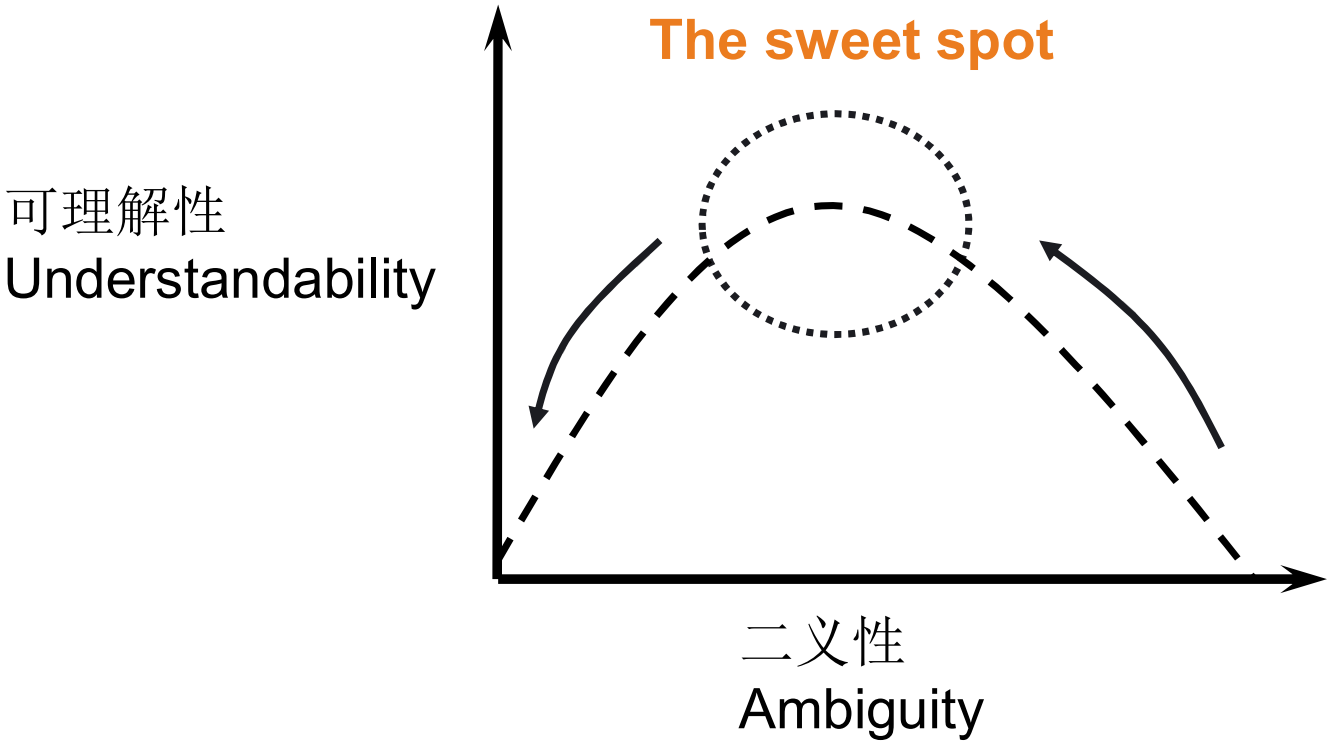
二义性练习

我没说她偷了我的钱

Mary had a little lamb

如何减少需求的二义性?

二义性与可理解性的关系



可验证性

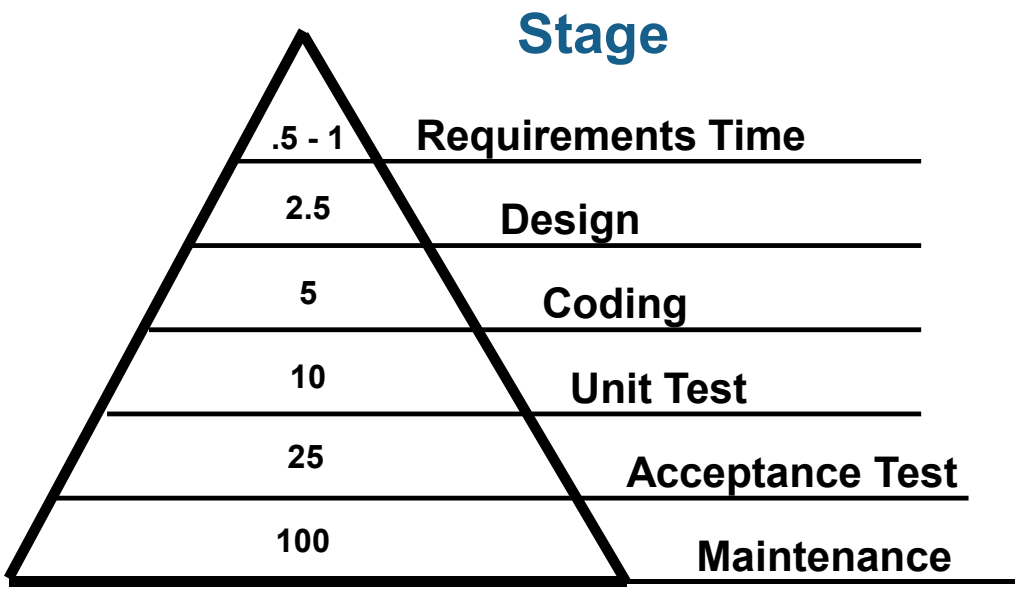
- 需求可验证的，如果
  - 可以用人工或机器方式检查产品是否满足需求

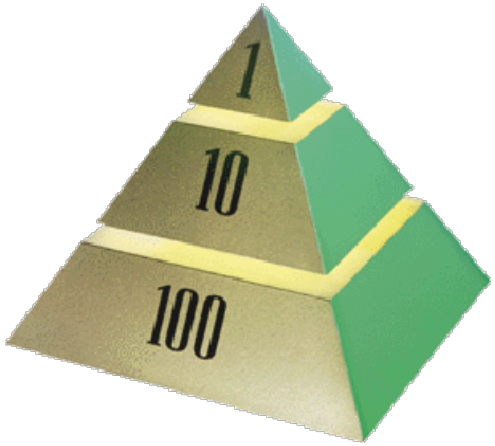
- The system supports up to 1,000 simultaneous users
- The system shall respond to an arbitrary query in 500 msec.
- The color shall be a pleasing shade of green
- The system shall be available 24 x 7
- The system shall export view data in comma-separated format

这些需求可验证吗?
如果不，如何更好地表达?

需求出错的高成本

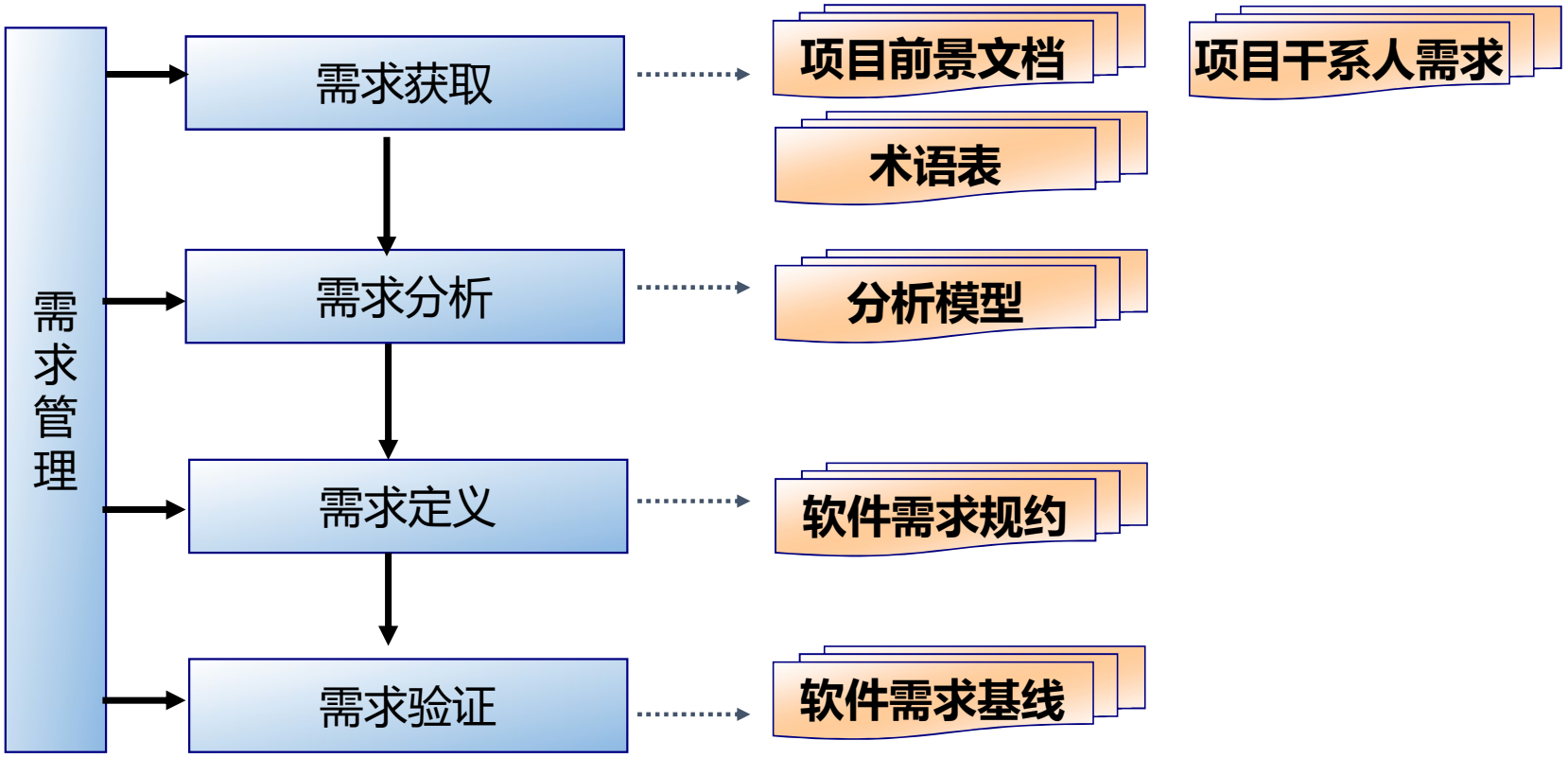
The 1-10-100 Rule





"All together, the results show as much as a 200:1 cost ratio between finding errors in the requirements and maintenance stages of the software lifecycle."

需求工程



发现、获取、组织、 分析、编写和管理需求的系统方法，让客户和项目组之间达成共识。

大 纲

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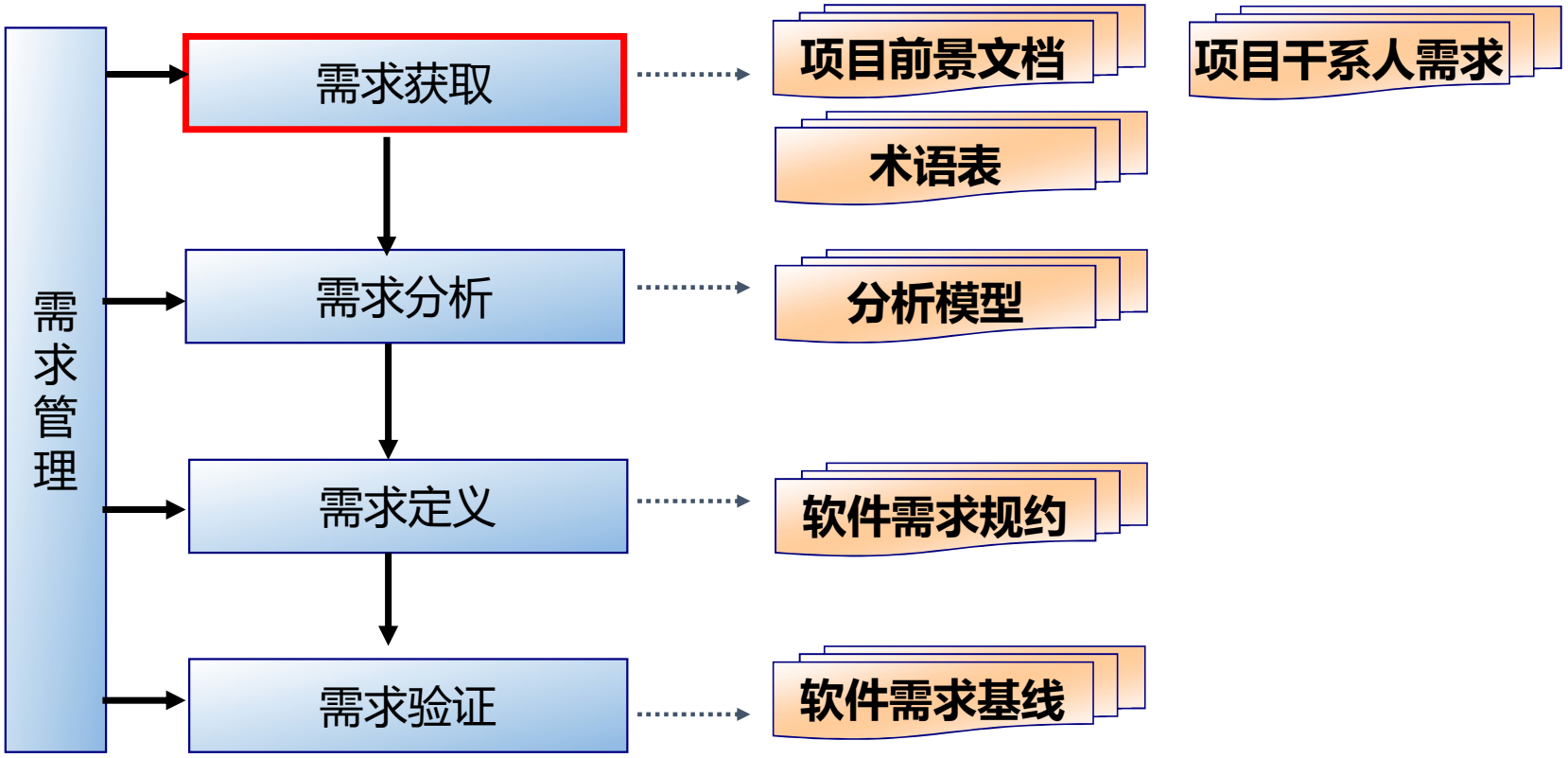
需求工程



发现、获取、组织、 分析、编写和管理需求的系统方法，让客户和项目组之间达成共识。

前景文档（Vision）

1. 简介 Introduction
2. 定位 Positioning
   - 2.1 商机 2.2 问题说明 2.3 产品定位
3. 项目干系人和用户描述 Stakeholder and User Descriptions
4. 产品概述 Product Overview
5. 产品特性 Product Features
6. 约束 Constraints
7. 质量范围 Quality Ranges
8. 优先级 Precedence and Priority
9. 其它产品需求 Other Product Requirements
10. 文档需求 Documentation Requirements

1）分析问题及根源

- 什么是问题?
  - 理解和记录客户的观点
  - 达成共识
- 什么是真正的问题?
  - 寻找问题根源，探究症结
- 避免Yes…But现象，避免IT黑洞

从业务角度

理解的　　*期望的*

识别业务解决方案

- 分析业务需求
- 提出多种解决方案
  - 技术的或(和)非技术的
- 选择最能满足业务需求的解决方案
- 启动项目,实现方案

案例研究: Course Registration System

- Review the problem statement

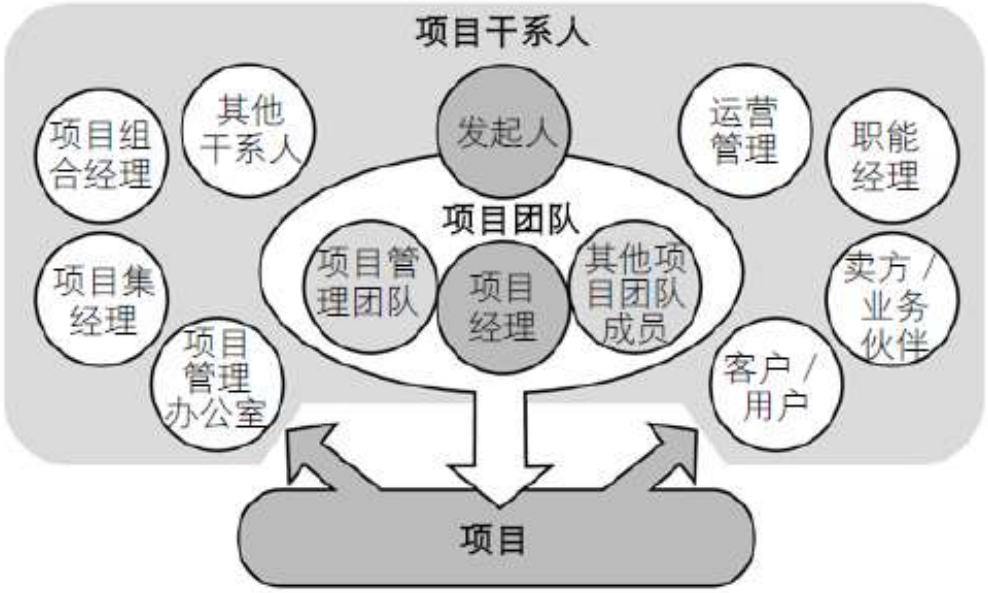
Course Registration
Requirements Document

举例：选课系统的问题陈述 @Vision文档

The problem of	The outdated and largely manual student registration process at Wylie College
affects	Students, professors, and College administration.
The impact of which is	A slow and costly process combined with dissatisfied students and professors.
A successful solution would	Improve the image of the College, attract more students, and streamline administrative registration functions.

2）识别项目干系人

- 项目干系人（Stakeholder），又称为涉众、利益相关人，是积级参与项目，或其利益因项目的实施或完成而受到积极或消极影响的个人和组织，他们还会对项目的目标和结果施加影响。

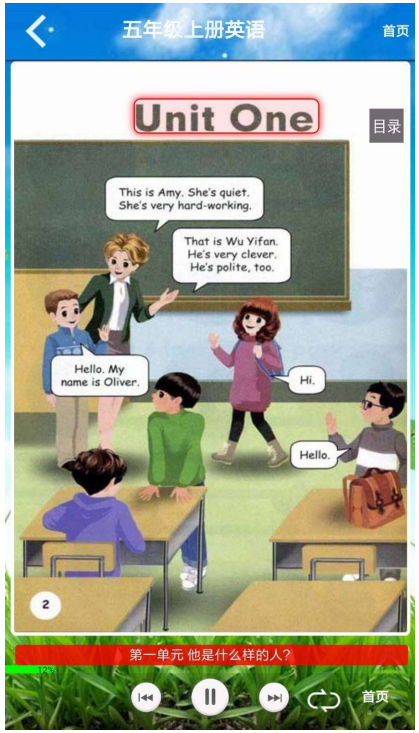


举例：选课系统的Stakeholder @Vision文档

Name	Represents	Role
IT Executive	IT Department and Wylie College as whole.	Responsible for project funding approval. Monitors project progress.
Registrar	The office of the registrar, administrative and data entry personnel.	Ensures that the system will meet the needs of the registrar, who has to manage the course registration data, including professor and student databases.
Student	Students	Ensures that the system will meet the needs of students.
Professor	Professors	Represents the interests of the faculty (professors).

讨论

- 开发一个小学生学习英语的软件，
  谁是项目干系人？

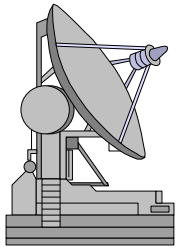


3）识别项目的约束

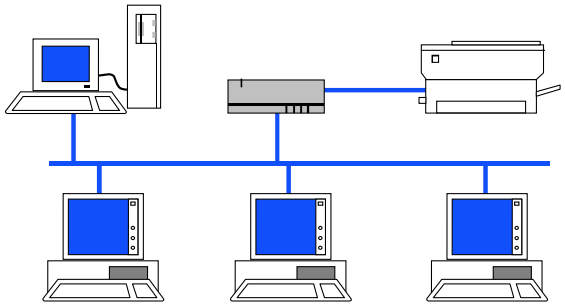
环境

政治

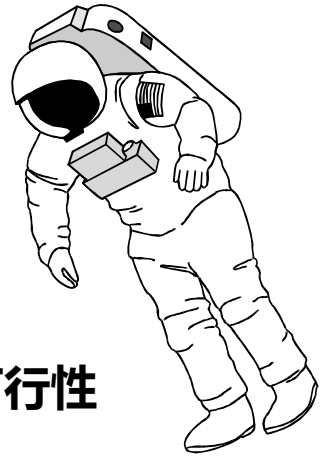
经济



技术



系统



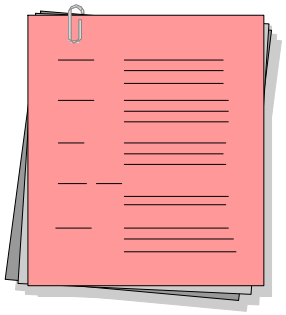
可行性

举例：选课系统的约束条件 @Vision文档

- Assumptions and Dependencies
  - The existing Billing and Course Catalog Database Systems which reside on the College DEC VAX Mainframe will continue to be supported until at least 2005.
  - The external interfaces of the Billing and Course Catalog Database Systems are as defined in [2] and [3] and will not be altered.
  - It is assumed that the College will continue to operate and support the existing UNIX Server and the DEC VAX Mainframe until at least 2005.
  - It is assumed that additional funding will be available by 2005 to replace the legacy Billing and Course Catalog Database Systems.
  - Implementation of the new registration system in time for the January 2000 school term is dependent upon funding approval by March 1st, 1999.
- Constraints
  - The system shall not require any hardware development or procurement.
  - The course information available is limited to the type of data supported by the existing Course Catalog Database.

4）获取常用术语

- 定义项目用到的术语
- 有助于避免误解
- 记录于单独的术语表文件中



术语表
Glossary

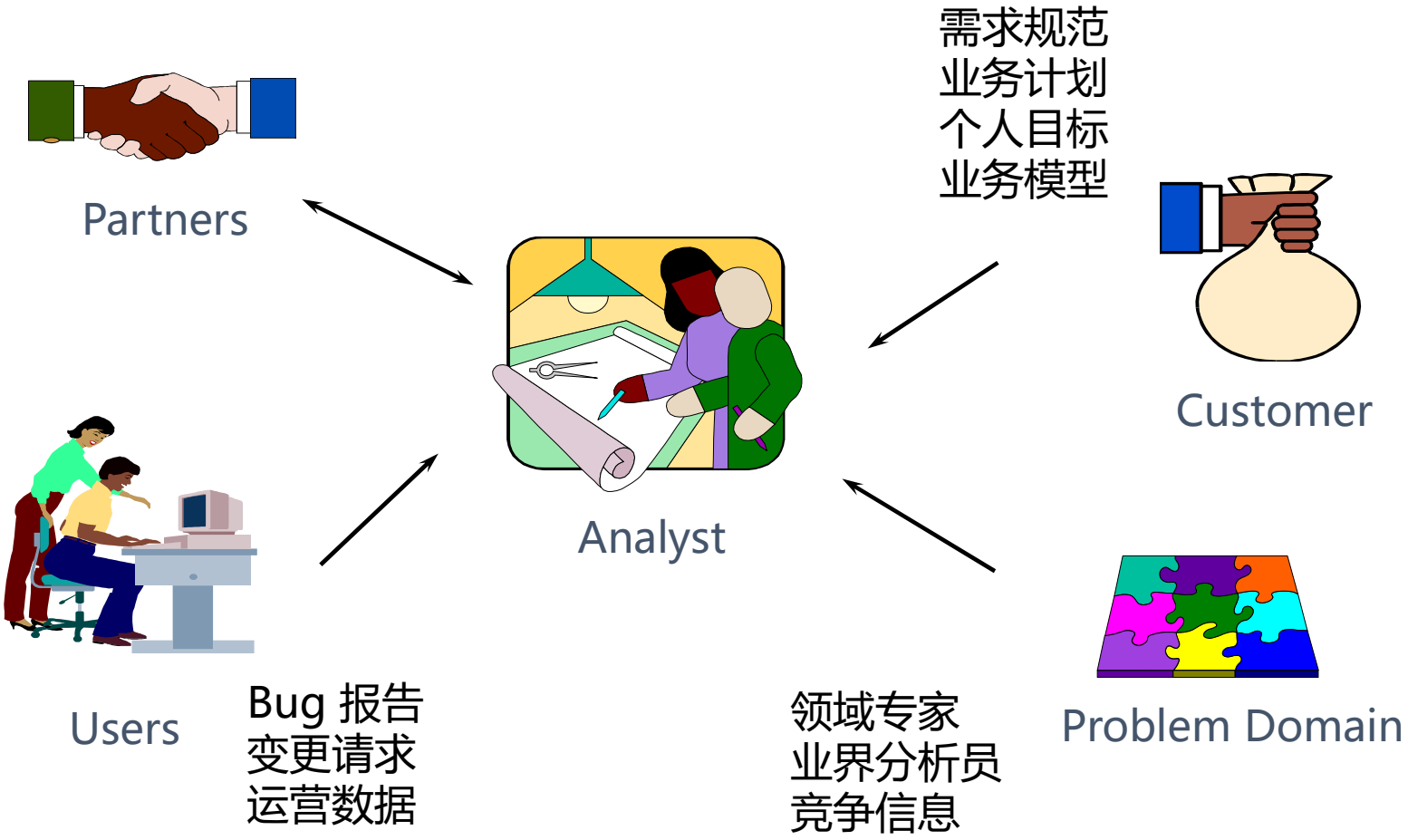
获取常用术语

- 尽早开始
- 在项目过程中持续进行

举例：选课系统的术语表 @Glossary文档

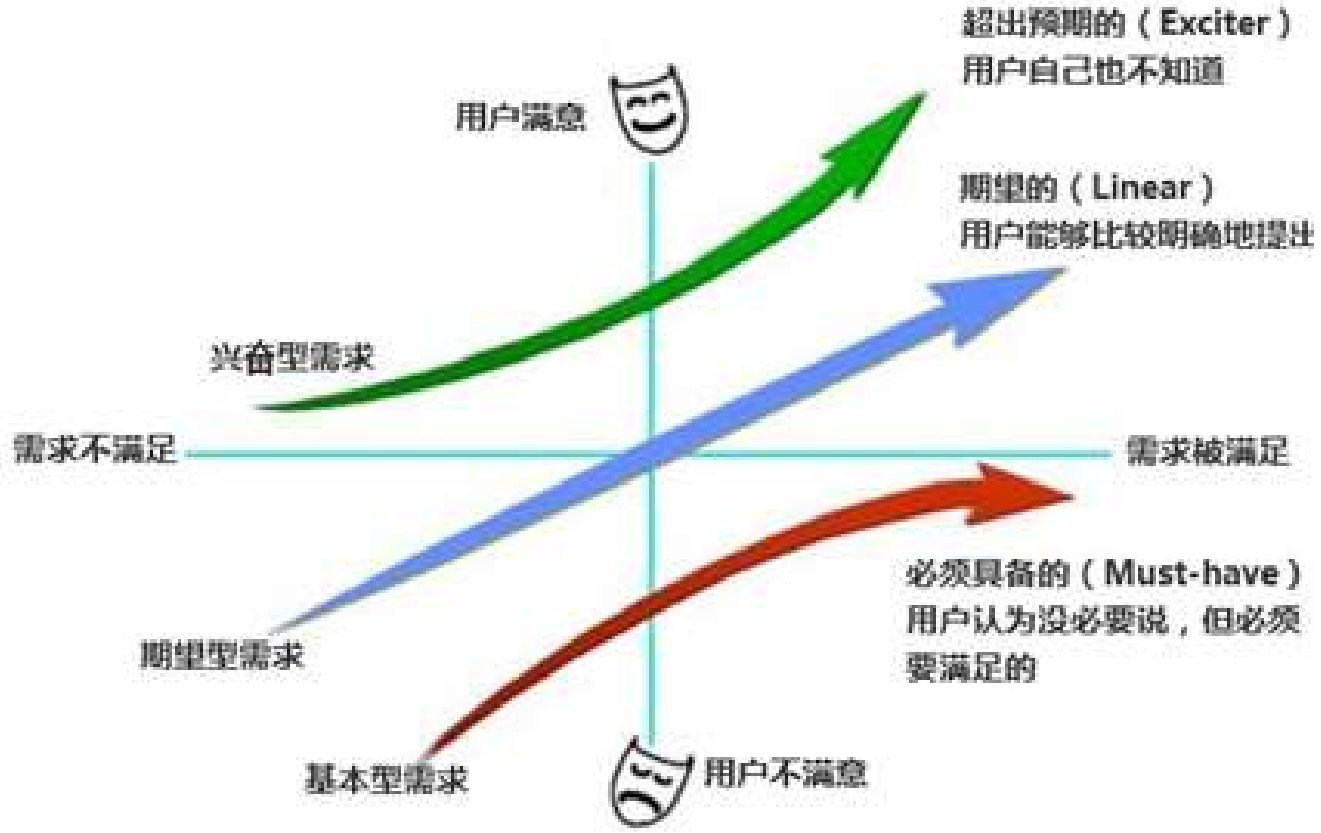
- Course
  - A class offered by the university.
- Course Offering
  - A specific offering for a course, including days of the week and times.
- Course Catalog
  - Unabridged catalog of all courses offered by the university.
- Grade
  - The grade for the student in a course.
- Report Card
  - All the grades for all courses taken by a student in a given semester.
- Roster
  - All the students enrolled in a particular course offering.
- Transcript
  - The history of the grades for all courses for a particular student.

5）识别需求的来源


Partners
需求规范
业务计划
个人目标
业务模型
Customer
Analyst
Users
Bug 报告
变更请求
运营数据
领域专家
业界分析员
竞争信息
Problem Domain

6）收集需求

KANO模型



- 示例：空调
  - 基本型需求：
    制冷、制热
  - 期望型需求：
    节能、除湿
  - 兴奋型需求：
    净化空气、远程操控

挑战

- 如何获得基本型需求？不能遗漏！
  - 用户认为没必要说
  - How: 领域专家、竞争产品分析、行业调研分析等
- 如何获得期望型需求？
  - 用户谈论的通常是期望型需求
  - How: 采用访谈、问卷、开会、观察等方法收集项目干系人的需求
- 如何获得兴奋型需求？
  - 用户不知道
  - How: 创新！

项目干系人需求的收集技术

- 访谈
- 调查问卷
- 需求研讨会
- Use-Case 研讨会
- Storyboards
- 角色扮演
- 复审现有需求
- 观察正在工作的用户
- ……

甲乙方经验影响需求获取策略

7）产品定位

举例：选课系统的产品定位　@Vision文档

For	Wylie College students, professors, and the course registrar
Who	Attend, teach, or administer college courses
The Course Registration System	Is a tool
That	Enables online course registration and access to course and grade information
Unlike	The existing outdated mainframe registration system
Our product	Provides up-to-date information on all courses, registrations, teachers, and grades to all users from any PC connected via the College LAN or internet.

8）撰写产品特性

举例：选课系统的产品特性 @Vision文档

- Logon
- Register for Courses
- Course Cancellations
- Student Billings
- Enter, Update, and View Professor Information
- View Student Grades
- Select Courses to Teach
- Enter, Update, and View Student Information
- Record Student Grades
- View Course Catalog Information
- View Course Schedule
- Monitor for Course Full

9）定义质量范围

举例：选课系统的质量范围@Vision文档

- Availability:
  - The System shall be available 24 hours a day, 7 days a week.
- Usability:
  - The System shall be easy-to-use and shall be appropriate for the target market of computer-literate students and professors.
  - The System shall include online help for the user. Student and Professor users should not require the use of a hardcopy Manual to use the System.
- Maintainability:
  - The System shall be designed for ease of maintenance. All college-specific data should be table-driven and modifiable without recompilation of the System.
- Performance Requirements
  - The system shall support up to 2000 simultaneous users against the central database at any given time, and up to 500 simultaneous users against the local servers at any one time.
  - The system shall provide access to the legacy Course Catalog Database with no more than a 10 second latency.
  - The system shall complete 80% of all transactions within 2 minutes.

10）定义文档需求

举例：选课系统的文档需求 @Vision文档

- User Manual
- On-line Help
- Installation Guides, Configuration, Read Me File
- Labeling and Packaging

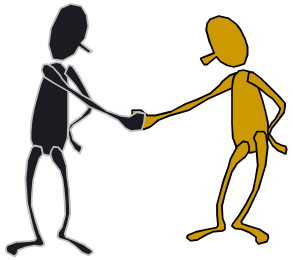
11）建立项目范围

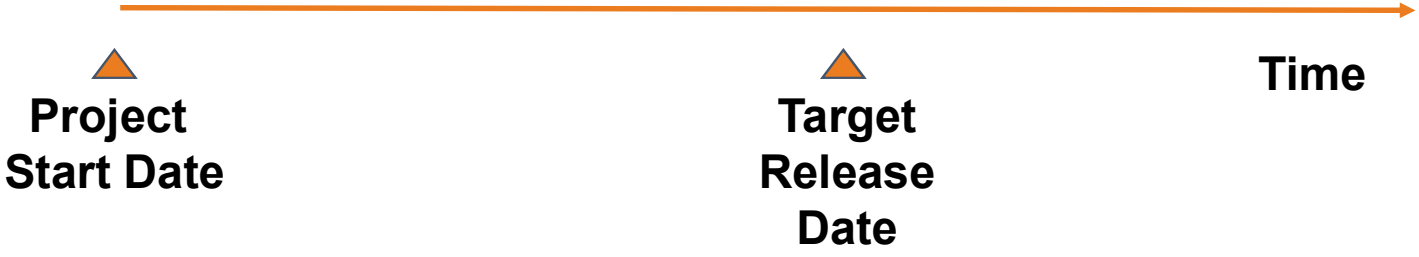
- Feature 1: The system must...
- Feature 2: The system must...
- Feature 3: The system must...
- Feature 4: The system must...
- Feature n: The system must...

How do we know what the needs are?

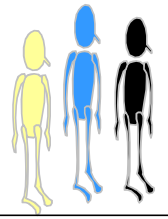
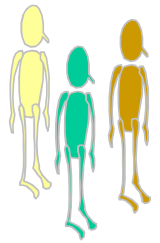
How do we determine priority?

Where do we set the baseline?





使用需求属性排列特性的优先级

	状态	风险	重要性	工作量	成本
✓ Feature Reqt. 10	Approved	Low	High		$$$
Feature Reqt. 13	Proposed	Med.	Low		$$
✓ Feature Reqt. 40	Approved	High	Mandatory		$

其他属性包括稳定性、技术难度等

12）划分特性优先级

举例：选课系统的特性优先级 @Vision文档

- Release 1 :
  - Logon
  - Register for Courses
  - Interface to Course Catalog Database
  - Maintain Student Information
  - Maintain Professor Information
- Release 2 :
  - Submit Student Grades
  - View Grades
  - Select Courses to Teach

大 纲

01-软件需求概述

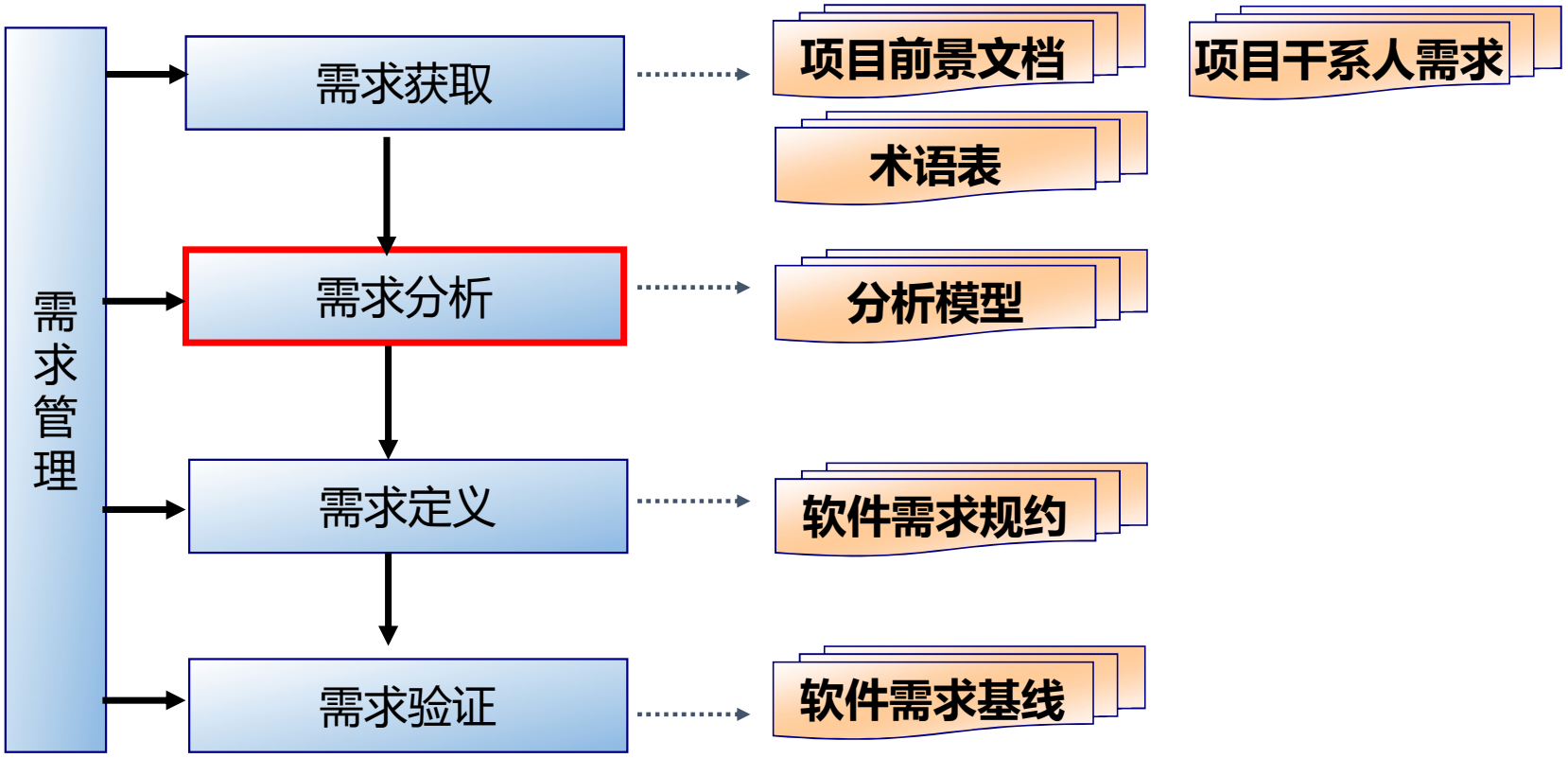
02-需求获取

03-需求分析和建模

04-需求定义和验证

05-需求管理

需求工程



发现、获取、组织、 分析、编写和管理需求的系统方法，让客户和项目组之间达成共识。

分析建模准则

- Represent the information domain
- Represent software functions
- Represent software behavior
- Partition these representations
- Move from essence toward implementation

分析模型

- 对需求进行分析，并进行图形建模，形成分析模型(平台无关模型PIM)

- 结构化分析模型
  - 数据流图（DFD）
  - 控制流图（CFD）
  - 数据字典（DD）
  - 实体—关系图（ERD）
  - 状态变迁图（STD）
  - 加工说明（PSPEC）
  - 控制说明（CSPEC）

- 面向对象分析模型
  - 用例图
  - 活动图
  - 类图
  - 时序图
  - 通信图
  - 状态机图

大 纲

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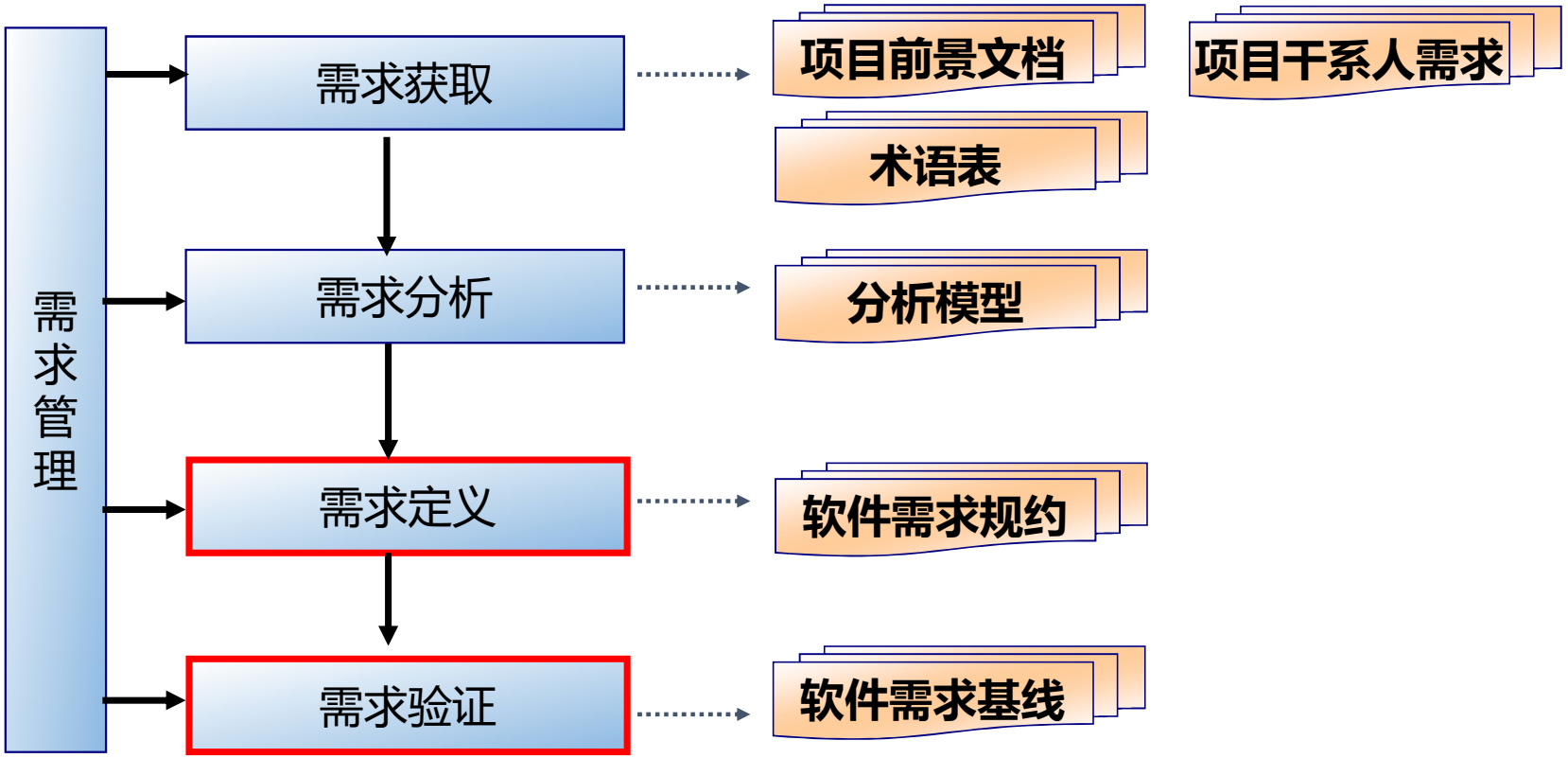
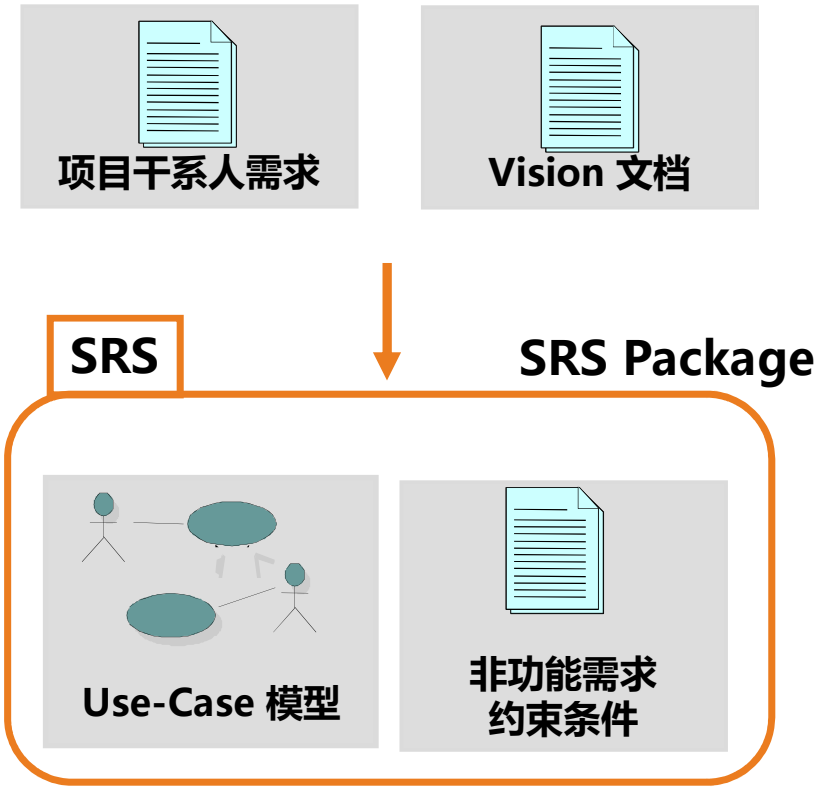


发现、获取、组织、 分析、编写和管理需求的系统方法，让客户和项目组之间达成共识。

需求定义的任务

- 定义详细需求- SRS
  - 细化功能需求
  - 细化非功能需求
  - 细化约束条件
  - 设计用户界面和接口

成果：软件需求规约



软件需求规约 (SRS) 定义了系统的外在行为和属性。

细化需求

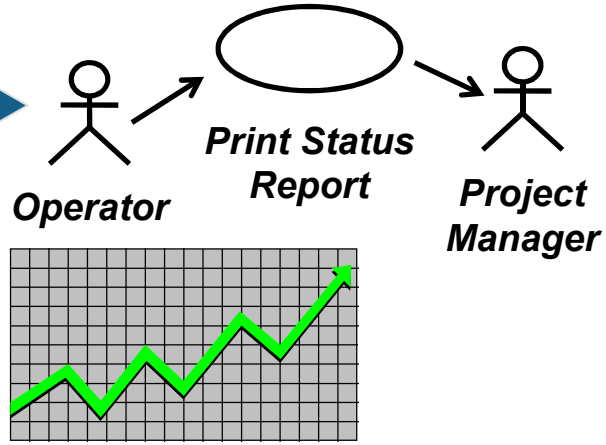
- 细化功能需求
  - 引入分析模型
- 细化非功能需求
- 细化约束条件

概要功能需求

Feat 63 - the defect tracking system will provide trending information to help the project manager assess project status

详细功能需求

Trending information will be charted with a line graph showing time on the x axis, and number of defects found on the y axis.

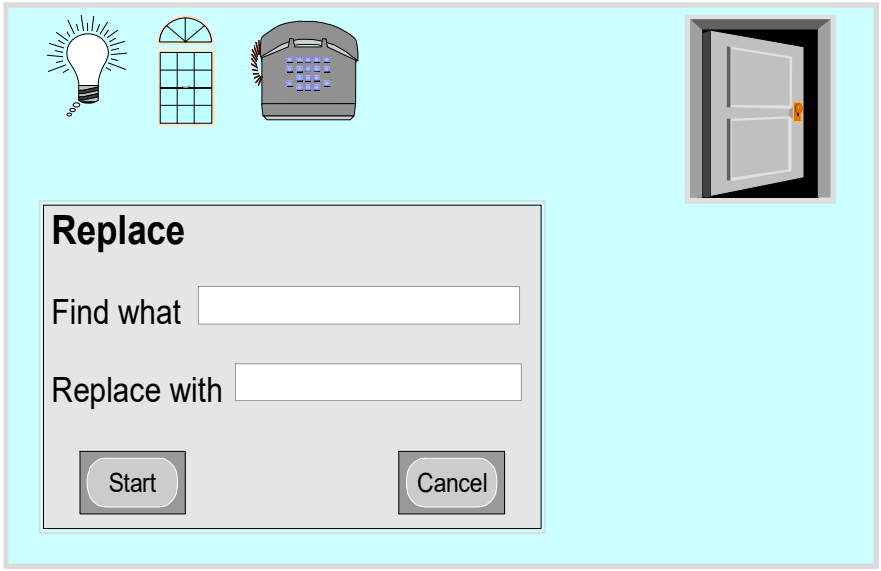


设计用户界面和接口

- 如果和外界的软件系统或硬件进行交互，则需定义通讯协议
  - 如果采用现有的协议，在功能说明中描述
  - 如果采用新的协议， 在设计时进行完整描述
- 如果和用户交互，则需简要设计用户界面
  - 图纸（在纸上）
  - 位图（采用绘图工具），或
  - 可执行代码（交互式的电子界面原型）

如何描述用户界面

- 可在功能说明中纳入屏幕框图，也可以是一个独立的用户界面原型
- 注意不要关注太多的界面设计细节



SRS模板

采用传统技术

- 1. 简介
- 2. 整体说明
- 3. 具体需求
  - 3.1 功能
  - 3.2 易用性
  - 3.3 可靠性
  - 3.4 性能
  - 3.5 可支持性
  - 3.6 设计约束
  - 3.7 联机用户文档和帮助系统需求
  - 3.8 购买的构件
  - 3.9 接口
  - 3.10 许可需求
  - 3.11 法律、版权及其他声明
  - 3.12 适用的标准
- 4. 支持信息
- 索引、附录等

采用Use-Case技术

- 1. 引言
  - 1.1 Purpose
  - 1.2 Scope
  - 1.3 Definitions, Acronyms, and Abbreviations
  - 1.4 References
  - 1.5 Overview
- 2. 综述
  - 2.1 Use-Case Model Survey
  - 2.2 Assumptions and Dependencies
- 3. 具体需求
  - 3.1 Use-Case 报告
  - 3.1.1 <Use Case 1>
  - 3.1.2 ...
  - 3.2 补充说明
  - 3.2.1 易用性需求
  - 3.2.2 …
- 4. 支持信息
- 索引、附录、用户界面原型等

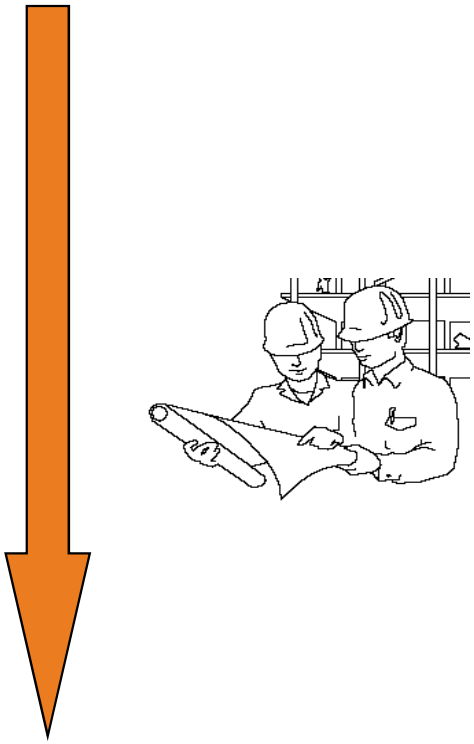
需求验证

- 原型确认
  - 抛弃型原型确认
  - 演进型原型确认

- 需求评审
  - 评审需求文档（Vision和SRS等），及时发现缺陷，寻找改进的契机，同时从评审反馈中获得知识，补充了正规的交流和培训机制，帮助团队建立对产品的共同理解

需求评审方法

- 审查
- 小组评审
- 走查
- 结对编程
- 同级桌查
- 轮查
- 临时评审



正式化程度

需求评审的输入和输出

- 输入
  - 待评审的需求文档
  - Check list
- 输出
  - 评审结论
    - 通过
    - 有条件通过
    - 不通过
  - 缺陷清单

大 纲

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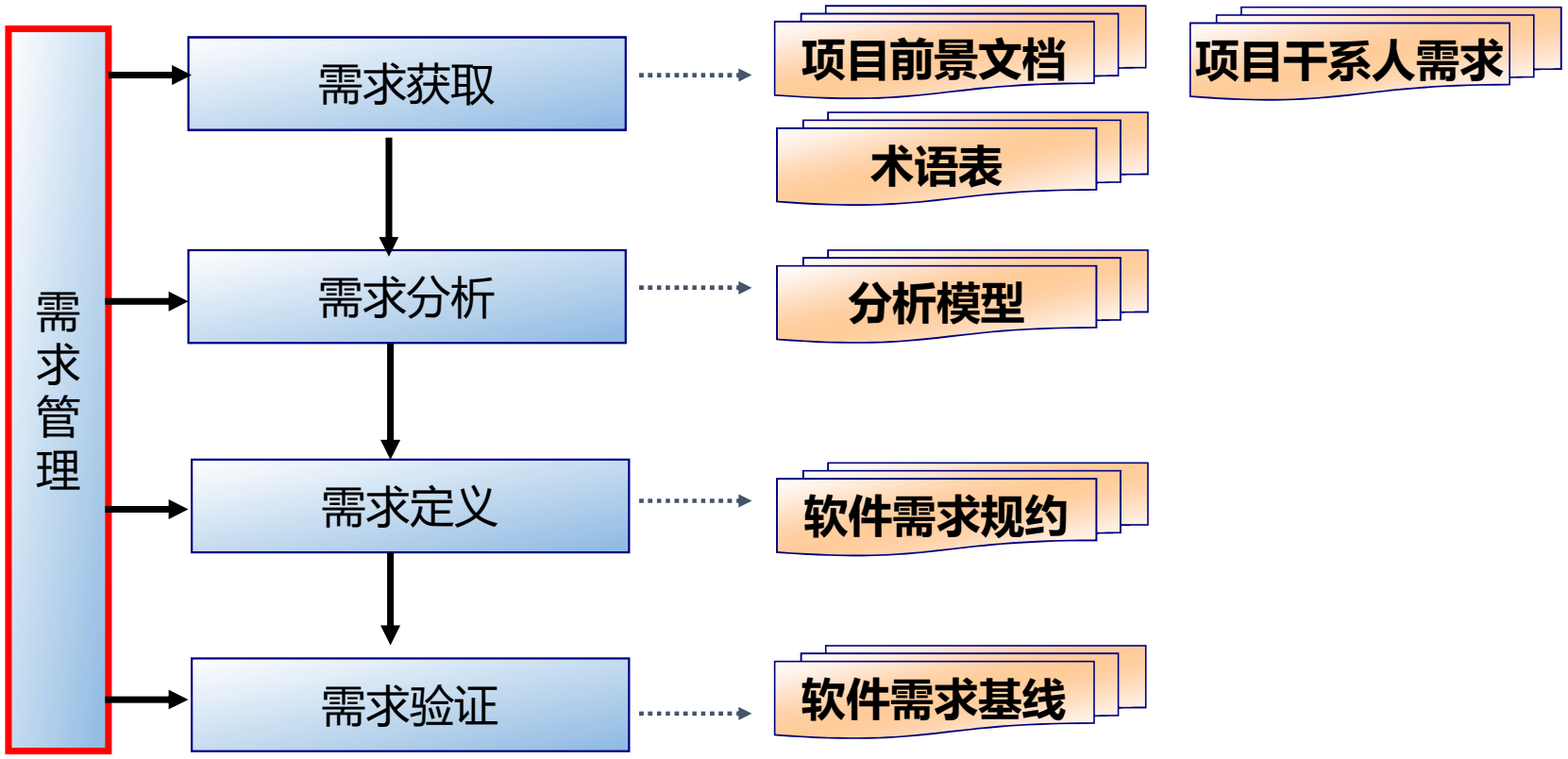

发现、获取、组织、 分析、编写和管理需求的系统方法，让客户和项目组之间达成共识。

需求管理

- 1）定义需求基线
- 2）需求变更控制和版本控制（建立新的需求基线）
- 3）需求跟踪

1）建立需求基线

- Feature 1: The system must...
- Feature 2: The system must...
- Feature 3: The system must...
- Feature 4: The system must...
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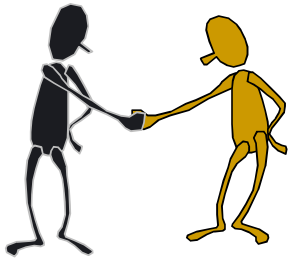
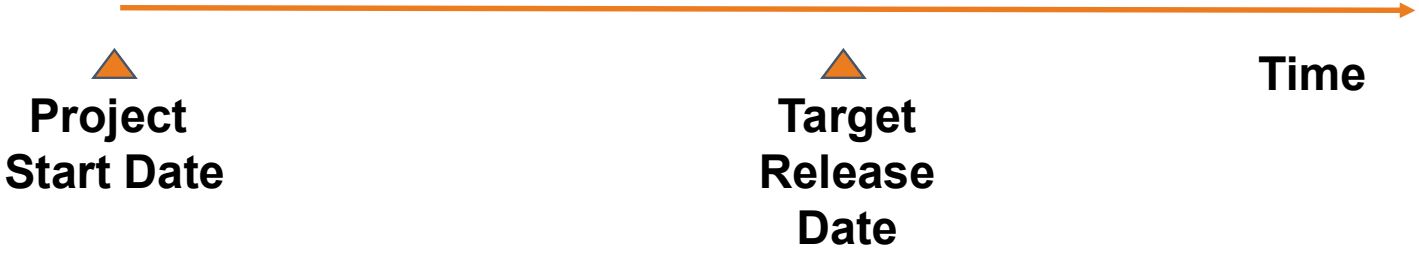
How do we know what the needs are?

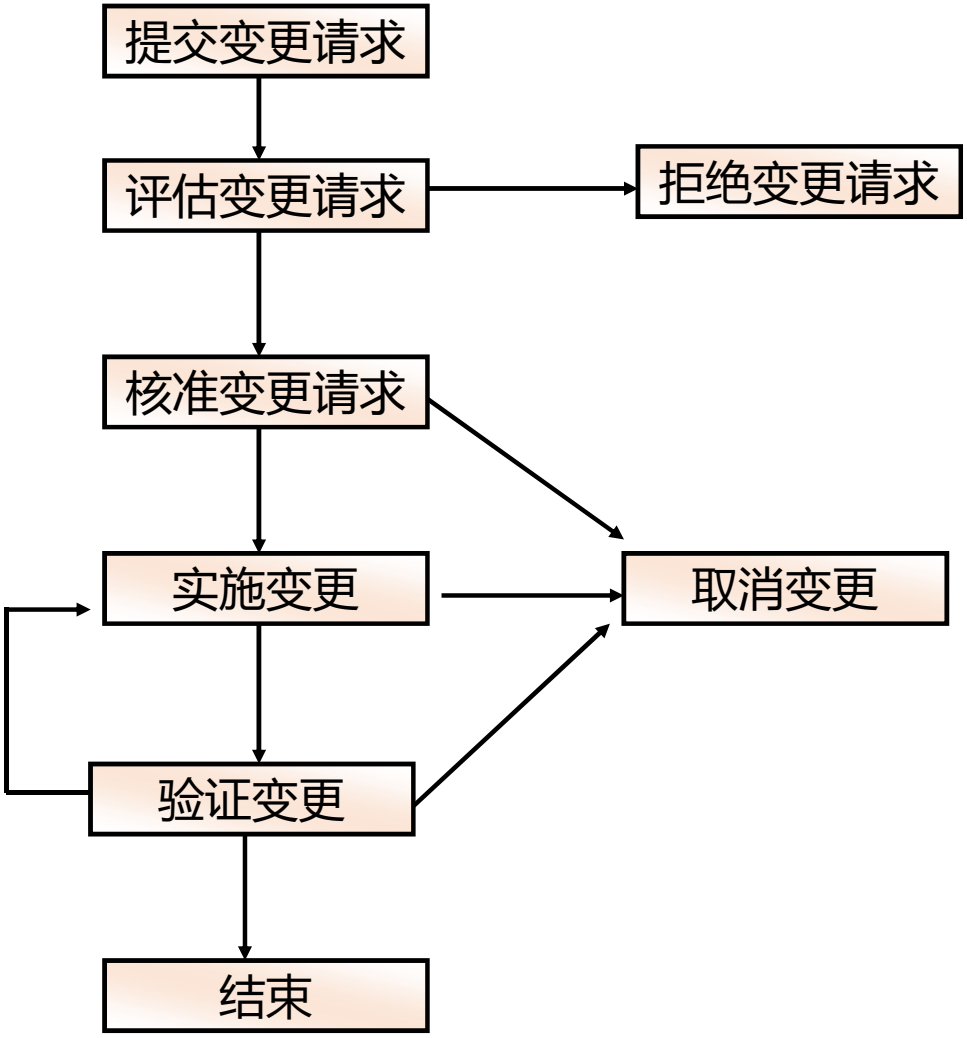
How do we determine priority?

Where do we set the baseline?

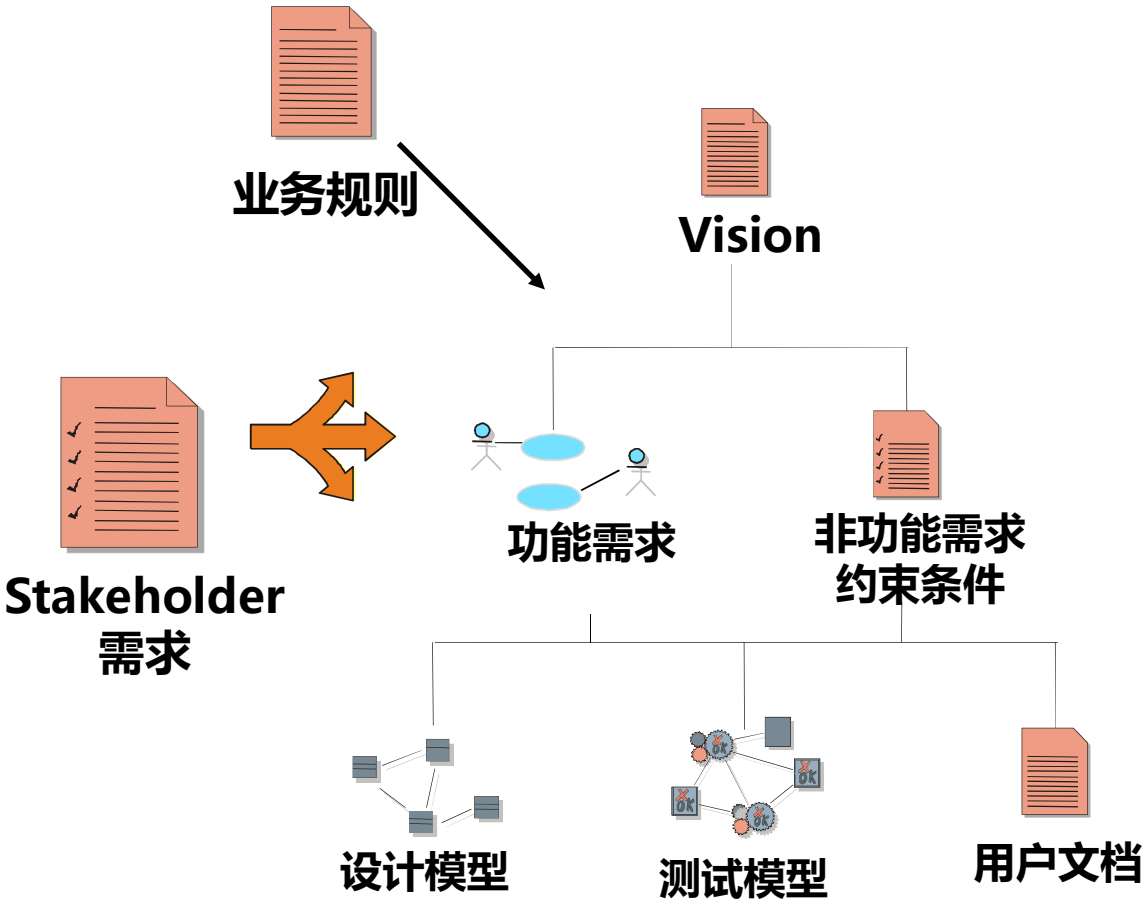


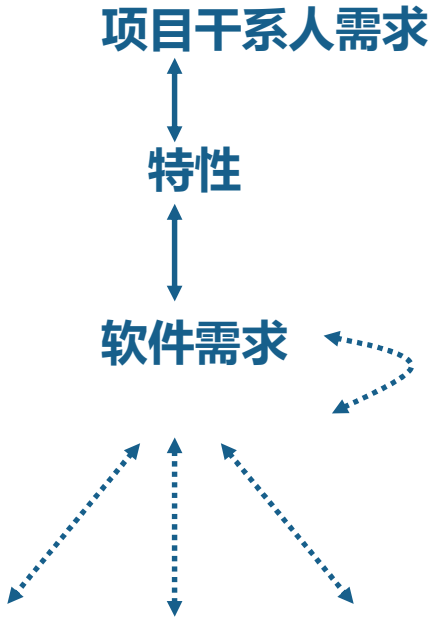


2）需求变更控制



3）需求跟踪


业务规则
Vision
Stakeholder
需求
功能需求
非功能需求
约束条件
设计模型
测试模型
用户文档


项目干系人需求
特性
软件需求