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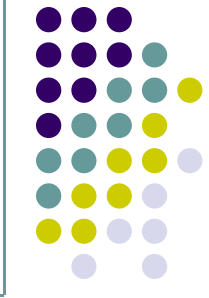
Requirements: *What* vs. *How*?



- Requirements do not specify **How**!
  - **What:** Nurse must be informed if heart stops
    - **How:** audible, visual, buzzer
  - **What:** Account accessed only by authorized person
    - **How:** PIN, password, retina scan, fingerprint
  - **What:** Reverse thrust only enabled when the aircraft is moving on the runway
    - **How:** Altitude measure, wheel pulses, pilot control
  - **What:** User must pay to get into the park
    - **How:** Manned booth, coin/card-operated turnstile

Midterm Question 1

Requirements: *What* vs. *How*?

- Requirements do not specify **How**!

Midterm Question 1

Key Findings from Last Lecture

- During requirements elicitation and analysis carefully separate the following concerns
  - eDesign and iDesign
  - Problem data and solution data
  - *What* and *How*
- Requirements do not specify *How*
- Always ask *Why* instead of *When or How*?
- Do not restrict design with unnecessary requirements ➔ unwanted solutions
- For a functional requirement, describe the requirement but not how it is done
- Requirement types: functional and non-functional

Midterm Question 1

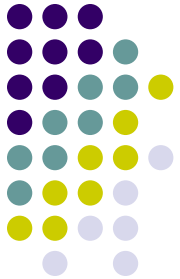
Always Ask Why?!

- Ask “Why” instead of “When or how would you do that”?
- Ignorance of the domain is usually preferred
  - The designated ignoramus usually asks questions whose answers are “obvious” to experts, but often expose hidden knowledge that might otherwise not be modeled explicitly.

Professor Dan Berry, Waterloo suggests that one day, requirements engineers will advertise their areas of ignorance (rather than expertise) to get jobs ☺

Midterm Question 1

Ask Why



Neural diagnostics

System shall have mini keyboard with start/stop button, . . .

Why?

Possible to operate it with "left hand".

Why?

Both hands must be at the patient.

Why?

Electrodes, bandages, painful . . .

Midterm Question 1

Recommendation: Why & How

Measuring neural response is a bit painful to the patient. Electrodes must be kept in place . . .
So both hands should be at the patient during a measurement.

R1: It shall be possible to perform the commands *start, stop, . . .*
***. . .* with both hands at the patient.**

Might be done with mini keyboard (wrist keys), foot pedal, voice recognition, etc.

Domain
- why

Requirements

Example
- how

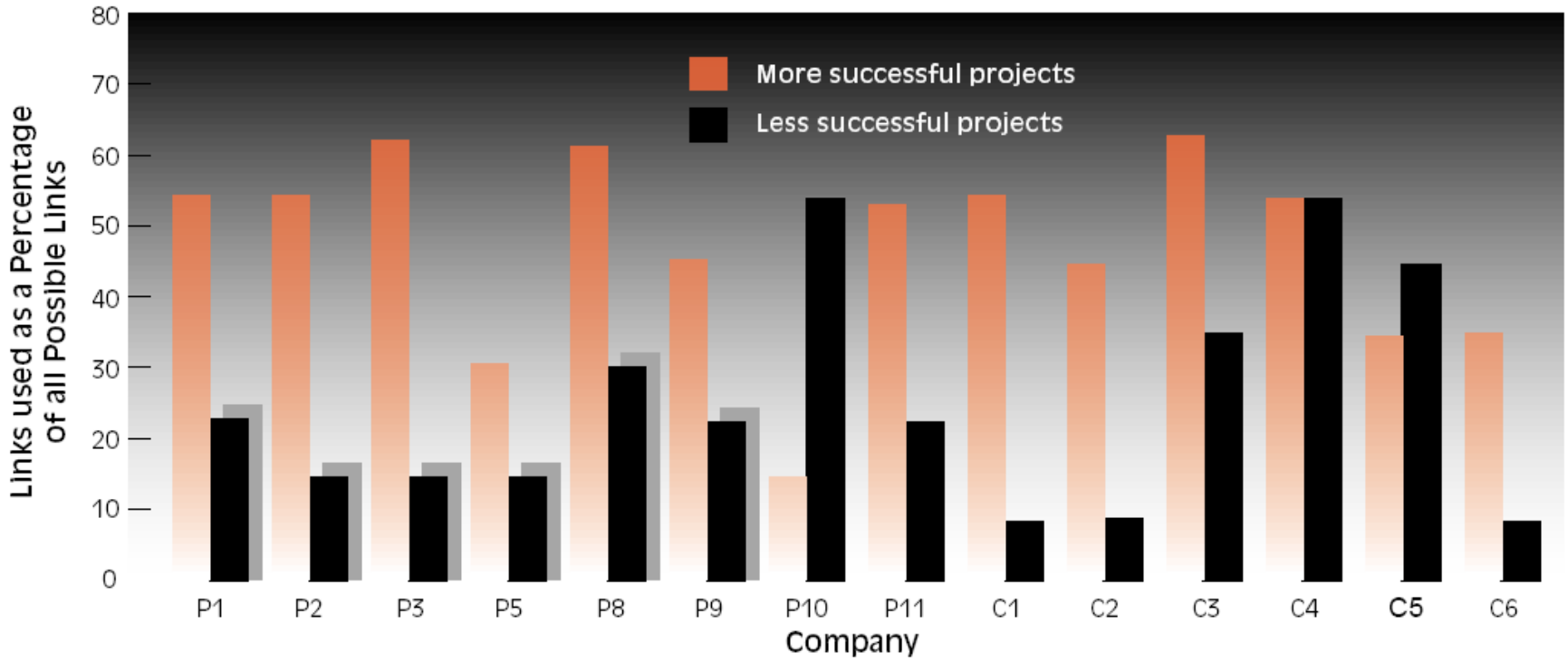
Midterm Question 1

Do Not Constrain Range of Solutions with Unnecessary Design Requirements

- Requirements with unnecessary design can restrict the range of solutions or result in bad solutions.
- Example:
  - Need capability to drink hot liquids and analyst writes:
    - The thing shall contain up to 8 ounces of hot liquid.
    - *The thing shall have a handle.*
  - In response to a requirements quality review analyst writes:
    - *The thing shall allow a person to hold it without getting burned.*
  - This requirement allowed multiple solutions including
    - a cup with handle, carton sleeve, a Styrofoam cup, or a thermos mug

Midterm Question 1

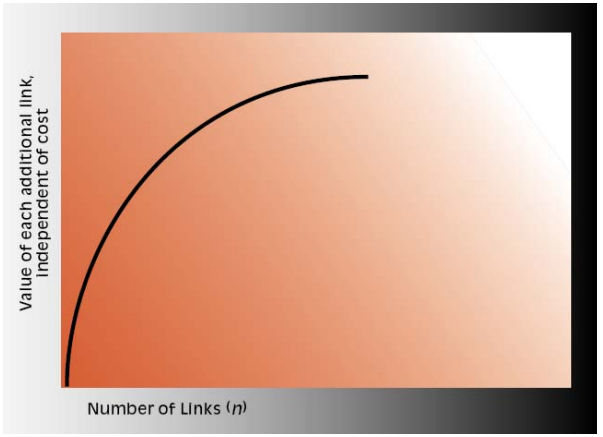
Project Success ↔ C-D Links



Midterm Question 2

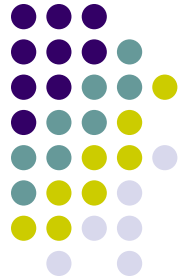
Lessons Learned
More Links Are Better

- More links are better
  - Err on the side of providing more rather than fewer links
- But each additional link adds less value
  - Law of diminishing marginal returns



Midterm Question 2

Lessons Learned
More Links Are Better



- Successful projects: 5.4 C-D links
- Unsuccessful projects: 3.2 C-D links

- Statistically significant: paired t-test, $p < 0.01$
- Anecdotal evidence from project managers

- Rule of thumb: 4..7 C-D links

Midterm Question 2

Direct vs. Indirect Links

- Direct links
  - Direct contact between customer and developer
  - Decreases filtering and distortion
  - Richer communication (body language in face-to-face communication)
  - Particularly important when there are high levels of ambiguity

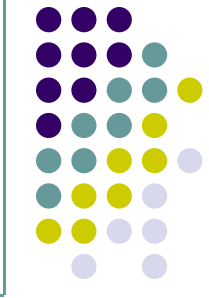
Midterm Question 2

Direct vs. Indirect Links

- Indirect links
  - Customer and developer do not deal directly with one another
  - Communication through intermediaries or customer surrogates
  - Some C-D links are inherently indirect
    - Marketing and sales link

Midterm Question 2

Ex: Supervisors as Surrogates



- Customer support system for centralized distribution center
- Developers were instructed by the customer to gather requirements only from supervisors rather than workers

We had union issues to deal with. We were actually shutting down shipping facilities and consolidating them into one distribution center. Plants were losing certain jobs. It was all very hush hush…a secretive project. So the core group [of supervisors] that continued to meet was instructed to keep this under their hat and not to let it out [to the workers]. Unfortunately, we never involved the people who would be using the system. They were not aware of the project and there was no ability f… "Hey, you haven't thought ab… down their throats.

Midterm Question 2

Lesson
Reduce Reliance on Indirect Links

- Problems of indirect links
  - Intermediaries intentionally or unintentionally filter and distort messages
  - Intermediaries may not have a complete understanding of customer needs
  - Meetings are less effective if attended by
    - Customers: buyers rather than users
    - Suppliers: marketers rather than developers

Midterm Question 2

Lesson
Reduce Reliance on Indirect Links

- Anecdotal evidence from interviews:
  - Use of indirect links were seen as a significant factor in explaining why projects failed

*The person who helped us define the requirements was an MIS intermediary who had been involved with the programming of [another application on the same hardware] in a different area of the business. From a usability/functionality standpoint, the MIS intermediary didn't have much knowledge…**she wasn't a very good user** [emphasis added] because she didn't understand the complexities of what they were asking for.*

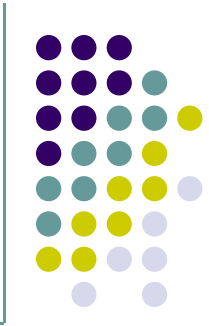
Midterm Question 2

Lesson
Reduce Reliance on Indirect Links

- Web of intermediaries
  - As many as 6 layers
- Despite the problems with indirect links they are frequently relied upon
  - MIS intermediaries used in 7 of 12 projects
  - Unsuccessful projects: 10 of 14 companies used 0 or 1 direct link
- Rule of thumb: Have multiple direct links

Midterm Question 2

Rating of C-D Links



Custom Company

Customer-developer Link	Mean Rating	Number of Projects
Facilitated Teams	5.0	4
User-Interface Prototyping	4.0	5
Requirements Prototyping	3.6	5
Interviews	3.5	4
Testing	3.0	3
MIS Intermediary	2.8	4
Email/Bulletin Board	2.5	3

Package Company

Customer-developer Link	Mean Rating	Number of Projects
Support Line	4.3	8
Interviews	3.8	6
User-Interface Prototyping	3.3	3
User Group	3.3	4
Requirements Prototyping	2.8	4
Testing	2.8	6
Marketing and Sales	2.8	9
Trade Shows	2.5	4

Midterm Question 2

Rating: 1 = very ineffective, 5 = very effective

Elicitation

- Lacks a prescriptive solution and depends largely upon the expertise of the elicitors
- Expertise is built upon knowledge of various elicitation techniques and heuristics
- Information exists somewhere but is hidden
  - Latent knowledge: hidden knowledge not readily accessible
  - Tacit knowledge: well known and accessible by one party, but considered to be too obvious to mention
  - Externalising internal head models

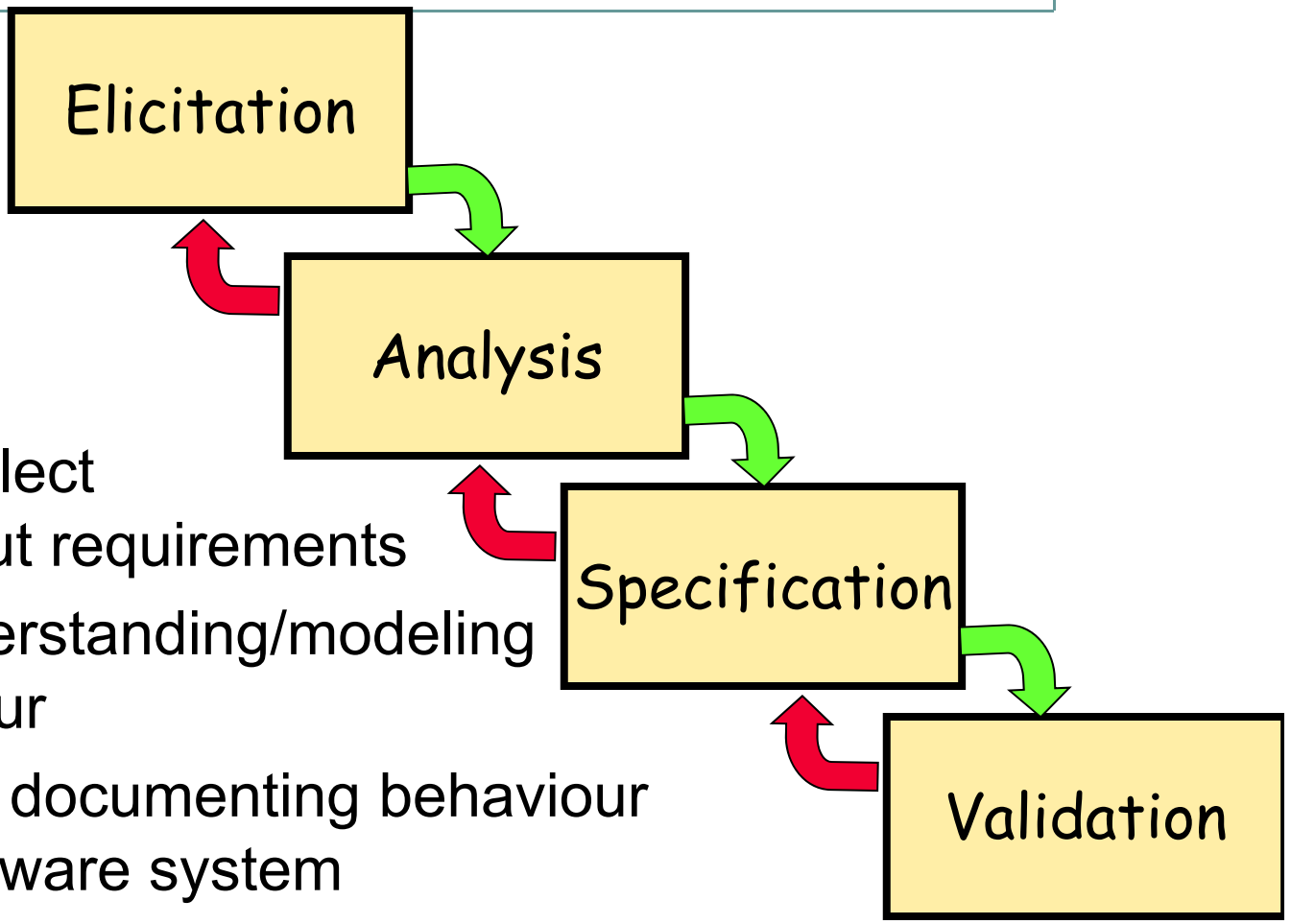
Midterm Question 3

Requirement Engineering Process

- **Elicitation:** Collect and extract requirements from stakeholders
- **Analysis:** Understand and Model desired behaviors
- **Specification:** Document the behavior of the proposed system with a Software Requirements Specification (SRS)
- **Validation:** Check that the documented behavior (i.e., SRS) satisfies the clients real requirements

Midterm Question 4

Requirement Engineering Process



- **Elicitation** − collect information about requirements
- **Analysis** − understanding/modeling desired behaviour
- **Specification** − documenting behaviour of proposed software system
- **Validation** − check ted specification accomplishes customer's requirements

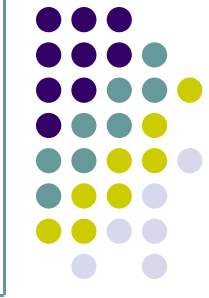
Midterm Question 4

Role of Requirements Analyst

- Articulates and defines the business needs with the customer
  - Why are we undertaking the project
- Identifies project stakeholders and user classes
- Elicits requirements
- Analyzes requirements
  - Derives new requirements
  - Investigates and documents implicit requirements
  - Resolves ambiguity and confusion
  - Points out conflicting requirements
- Writes requirements in an SRS (software requirements specification)
- Models requirements using graphs, tables, prototypes
- Validates that requirements satisfy customer needs and are clear, complete, correct, feasible, necessary, traceable, unambiguous, and verifiable
- Facilitates prioritization of requirements
- Manages require
- Interface betwee rs

Midterm Question 4

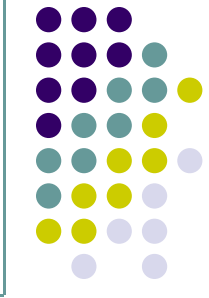
Requirements analyst may discover better ways to do things



- Clients notion may be limited to past experience
- Requirements analyst may know better approaches and solutions
- Ask and understand why documented requirements are desired
- For example, consider whether the system should give the user more creative control over his or her transactions
- Brainstorm to elicit undreamt-of requirements

Midterm Question 4

Discover better ways to do things



- Past experience of manual system or another's system.
  - Business process reengineering
  - Central repository, networks
- Ask why – is their a more fundamental goal than the stated requirement?
- Consider a customer that uses an ATM to withdraw cash. *Why* does (s)he want cash?
  - Is it to buy something?
    - If so, then why not extend the ATM card to act as a debit card in retail outlets so that (s)he doesn't have to go to the ATM in the first place.
  - Is it to pay her electricity bill on her way to work?
    - If so, the why not offer the opportunity to pay bills at the ATM.
  - Does (s)he j[illegible]ount balance?
    - If so, then [illegible] do this over the phone or on the Internet?

Midterm Question 4

Discover better ways to do things

- Consider giving the user more creative control over his/her transactions
  - Layout
  - End-user programmability
- People would rather do some of the work themselves, if they think they would do a better or faster job.
  - CAD software allows users to design their own furniture, houses.
  - Investors trade stock over the Internet without the advice or intervention from a broker or trader.
  - Shoppers are using self-scanners to scan and pay for groceries, rather than queuing for the checkout.

Midterm Question 4

Requirements Analyst Needs Soft Skills

- Listening
  - Must read between the lines
  - Should not impose his or her own ideas
  - Watches out for underlying assumption
- Interviewing and Questioning
  - Clarifies uncertainties, disagreements, assumptions and unstated expectations
- Analytical
  - Reconciles conflicts
  - Separates user wants from needs
  - Distinguishes *How (solution) vs. What (requirements)*

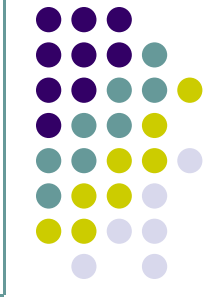
Midterm Question 4

Requirements Analyst Needs Soft Skills

- Facilitation
  - Acts as a neutral facilitator and negotiator in requirements elicitation workshops
- Observation
  - Detects subtleties and unstated requirements by watching users
- Writing
  - Strives for clarity and avoid ambiguous words
- Organization
  - Can rapidly structure *changing* information into a well written document

Midterm Question 4

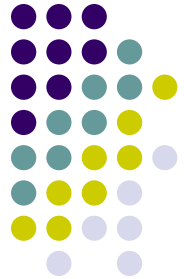
Skills Needed by a Requirements Analyst



- A good detective, interviewer and facilitator
  - Identify contexts
  - Spot ambiguities and evasion tactics
  - Get people to open up
  - Instill guilt
  - Encourage people to participate and brainstorm

Midterm Question 4

Elicitation Techniques



1. Reuse old requirements or existing system
2. Questionnaire
3. Interviews
4. Observation and apprenticeship
5. Ethnographic studies
6. Brainstorming
7. JAD: Joint Application Design

Midterm Question 5

Analyze Existing Systems

- Examine currently deployed system, find out:
  - What is used, what isn't, what's missing?
  - What works well, what doesn't?
  - How is the system is actually used, how was it intended to be used, what new ways do we want it to have?

SENG 371
Software Evolution

Midterm Question 5

Analyze Existing Systems

- It is easier to learn from an existing system than starting from scratch; may be a manual, non-computerized system or process

- Risks if you don't
  - Users may not be happy with too much change compared to the old system.
  - May miss real usage patterns, human issues, common activities, relative importance of tasks/features.
  - May miss obvious possible improvements (features that are missing or don't currently work well).
  - May miss which "legacy" features can/can't be left out.
  - May miss latent knowledge

Midterm Question 5

Analyze Existing Systems

- Example of inadequate analysis before implementation.
  - Hot air hand dryers are neat! Therefore, we need them.
  - They eliminate paper waste, cleaner washrooms, cheaper in long run. So let's install them; they do just the same task as paper towels.
  - But if you had spent a day in a washroom, you might have noticed different usage patterns of paper towels: dry face, clean up spills, dry coffee pots, blow noses, etc.
  - These days, almost all public washrooms have paper towels once again, even if they also have hot air dryers.

Midterm Question 5

Analyze Existing Systems

- Review all available documentation
  - If there exists an automated system, review its requirements specifications and user manuals, as well as development documentation, internal memos, change histories, etc.
    - Of course, often these are out of date, poorly written, wrong, *etc.*, but it's a good starting point.
  - If the existing system is a manual system, review any documented procedures that the workers must follow.
  - Watch for business process reengineering opportunities
    - Data centralization to avoid document mismatches (purchase order and invoice)
- The goal is to gain knowledge of the system before imposing upon other people's time, before bothering stakeholders.

Midterm Question 5

Analyze Existing Systems

- Observation
  - Go out into the field, and observe the “IT specialists in the mist”.
  - Documentation rarely describes a system completely, and it often is not up to date. The current operation of the system may differ significantly from what is described.
  - Besides, no matter how bad a reputation the existing system has for doing the work, the system is not worthless. It contains a lot of useful functionality that should be included in any future system. The objectives of observing the current system is to identify what aspects to keep and to understand the system you are about to change.

So, how many people will gon

Midterm Question 5

Analyze Existing Systems

- Observation
  - Ideally, you are a silent observer, at least initially. Otherwise, you risk getting a non-standard view of what is usually done.
  - Later on, you can start asking questions OR interview people OR use questionnaires.
  - Perhaps if someone had spent one day in a washroom observing how paper towels were being used, he or she would have discovered the secondary functions that paper towels provide that hot-air dryer do not.
  - When new computer systems are implemented, remnants of the old system often linger on, because the designers of new system overlooked a function provided by the old system.

Midterm Question 5

Analyze Existing Systems

- **Questionnaires**:
  - Most useful when large number of users and you want answers to specific questions.
    - "How often do you use feature XXX?"
    - "What are the three features you would most like to see?"

- **Interviews**
  - At the end, when you have a better idea of what you will be doing and have some good questions that requires detailed answers. Interviewing is very labour intensive. So it is important to wait until the end, so you won't waste your own or other's time
  - [Goguen] – watch for the "say-do" problem - or what is called tacit knowledge – when you know how to do something but can't describe it, *e.g.,* like tying your shoe

Midterm Question 5

Questionnaires

- Good for large groups when you have specific questions
- **NOT** appropriate as the only way, they suffer from being a *one way* communication technique and suffer *time lag*:
  - You cannot do follow up questions
  - You cannot follow users down interesting paths/points that they might raise during their answer

Midterm Question 5

Good Usages of Questionnaires

- Good uses of questioners include:
  - Survey of currently used features
  - Reasons for not using specific features
- Questionnaire can be used to establish usability requirements and priorities of features
- You should use interviews to create useful questionnaire for example:
  - "What new features would you like to see?" Open ended and needed... but then you can create a questionnaire and send to users for voting

Midterm Question 5

Common Questionnaires Mistakes

- Bias in sample selection
- Bias in responding users
- Small sample size
- Untested questions that are ambiguous

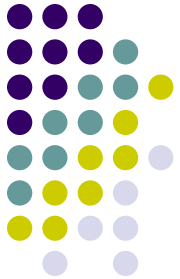
Midterm Question 5

Interviews

- Key point is to pick the right people to interview!
- Users usually do not know what they want:
  - You built EXACTLY what I asked for!
  - But not what I wanted

Midterm Question 5

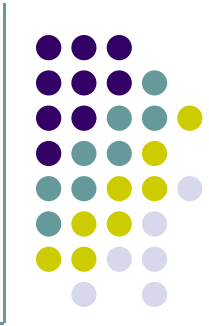
Interviews



- The people you interview should fill different user/stakeholder roles
- Select users that are:
  - Have authority and motivated to see the project succeed
  - Accountable and knowledgeable
- Interviews should be done in person and not through email/surveys:
  - Observe body language
  - helps build rapport

Midterm Question 5

Interviews



- Interviews permit us to listen and understand better the problems faced by customers
- Before the interview, research the background of the stakeholder to avoid boring them with questions you easily answer
- You can quickly review some answers if needed
- During the interview, jot down the answers
- Make sure the interview schedule is not overly constraining
- Once rapport is established the interview likely will take a life of its own (horror stories and true/root causes)

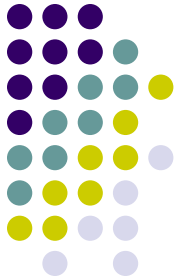
Midterm Question 5

Interviews: Types of Questions

- You should start with open-ended and context free questions then move to more specific questions as you learn more and gain a better understanding of users needs and requirements:
  - Open Ended: “How will you search for a job?” vs.
  - Context Free: "Will you search using title?"
- Make sure you remove context from question:
  - You would not really give up features and performance just to have it run on a browser - would you?!! (What would the answer be…)
  - Instead ask questions like:
    - How fast should the search be? What kind of performance is required?
    - *Is performance more important than other features like usability?*

Midterm Question 5

Examples of Questions



- Example of closed-ended question
  - Would you like the new system to work in your web browser? Y/N (This question does not mention the alternatives and associated costs! What would one give up to get such a feature?)
- Example of open-ended question
  - Would you like the new application be in your web browser even if it means fewer features, and less interactivity?
  - What would you be willing to give up to use your application in your web browser?

Midterm Question 5

After Interviews

- Using the analyst's summary we are likely to get 10-20 top requirements or needs that should be explored in more detail

Midterm Question 5

Questions to be asked indirectly

- Are you opposed to the system?
- Would you benefit from delaying or obstructing the system?
- Do you feel threatened by the proposed system?
- Is your job threatened by the new system?
- Is anyone else's?

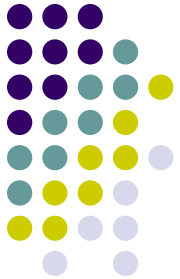
Midterm Question 5

Common Interviewing Mistakes

- Missing to interview people
- Assuming stated needs are correct (Why?)
- Letting one person in a group interview dominate the interview
- Not conducting group interviews

Midterm Question 5

UML 2.2 Seven Behavioural Modeling Diagrams



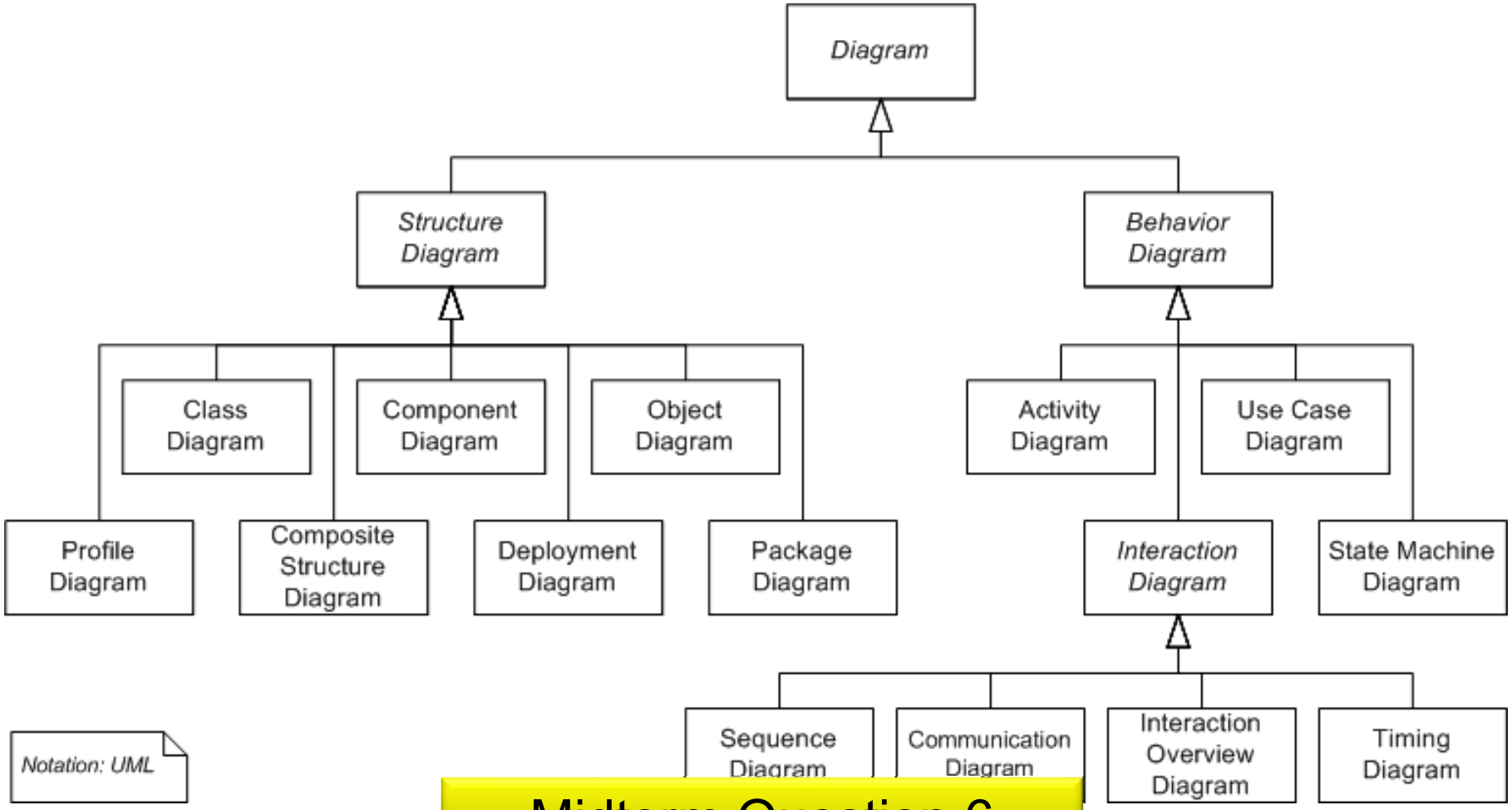
- Capture the varieties of interaction and instantaneous states within a model as it 'executes' over time
  - Track how the system will act
  - Observe the effects of an operation or event, including its results

8. Use Case diagrams
   - Model user/system interactions
   - Define behavior, requirements and constraints in the form of scripts or scenarios
9. Activity diagrams
   - Many uses; define basic program flow, capture decision points and actions
10. State Machine diagrams
    - Essential to understanding the run state of a model when it executes
11. Communication diagrams
    - Show the interactions between objects or parts in terms of sequenced messages
12. Sequence diagrams
    - Show the sequence of messages passed between objects using a vertical timeline
13. Timing diagrams
    - Fuse sequence and state diagrams to provide a view of an object's state over time
14. Interaction Overview
    - Fuse activity and sequ

Midterm Question 6

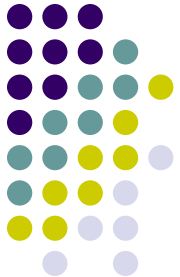
Interaction Diagrams

UML Diagram Types



Midterm Question 6

Lessons Learned
More Links Are Better



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- Rule of thumb: 4..7 C-D links

Midterm Question 7