Requirements Completeness, Enterprise Goals and Scenarios

Colin Potts

College of Computing, Georgia Institute of Technology

January, 1995

Requirements Completeness

"The degree to which the specified system meets / will meet the customer's intent"

(Approximately) "The degree to which the system's behavior fulfills the goals of the enterprise"

But how can you measure or increase "completeness"?

How can you derive specified behavior from goals?

Why is requirements completeness important?

Functionality + flexibility

Contents:
A strategy for representing and refining goals using scenarios

1) Representational and process concepts of the strategy.

2) Structure and content of scenarios

3) Expression and refinement of goals.

4) Derivation and use of efficient scenarios in elaborating requirements.

5) Examples: collaborative meeting scheduler (toy and real), electronic commerce

6) Discussion

Some definitions

Enterprise

Portion of real world with application-oriented or business goals

Required system (RS)

Planned to-be-automated IS embedded in enterprise

Environment

Remainder of future enterprise (outside of RS)

Goal specification

Description of enterprise or RS+Environment in terms of goals

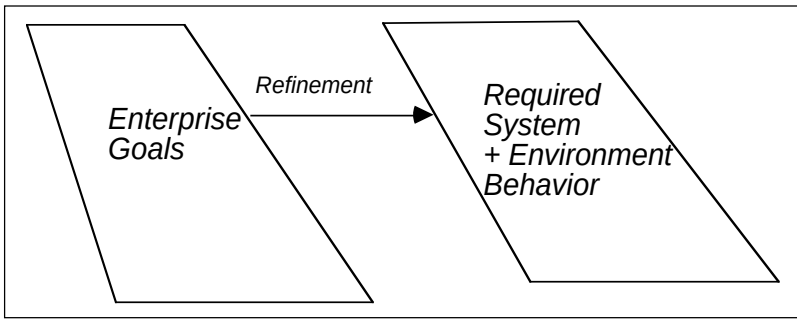
Design specification

Description of RS behavior in terms of actors and their actions

Actor

Component of RS + environment responsible for actions

Goals and Requirements



Goals (e.g. security policies) are fulfilled by Required System + Environment

The organizational problems of building and managing secure systems are so severe that they will frustrate any purely technical solution.

[Anderson, R.J. “Why Cryptosystems Fail” CACM, Nov. 1994.]

Nearly every major accident of the past 20 years (e.g. Three Mile Island, Chernobyl, Challenger, Bhopal, and Flixborough) involved serious organizational and managerial deficiencies.

[Leveson, N. “High Pressure Steam Engines and Computer Software” ICSE-14, 1992.]

Goal Refinement

Goal Decomposition

Replace a goal with subgoals that collectively fulfill it

Goal Elaboration

Replace an idealized goal with subgoals that overcome real-world obstacles

Boundary Establishment

Establish the RS/Environment boundary by allocating goal-fulfillment responsibilities to agents

Operationalization

Replace a goal with state-changing actions that accomplish it

Goal Refinement

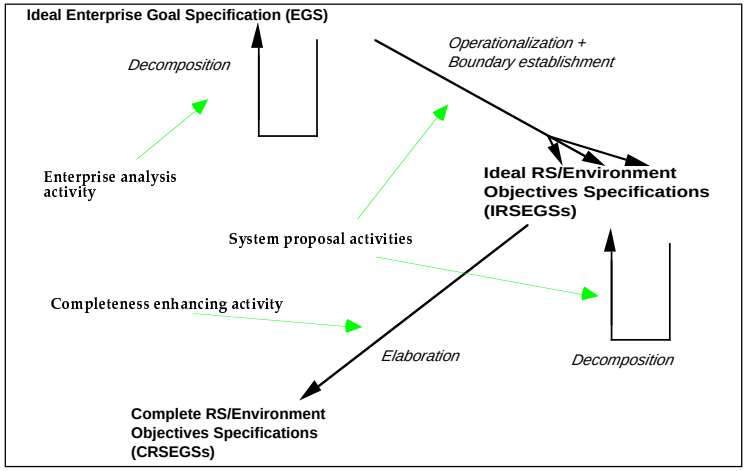
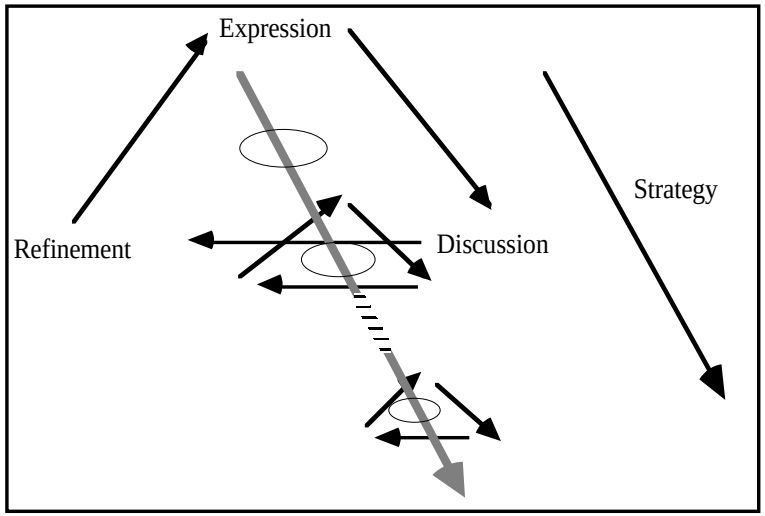
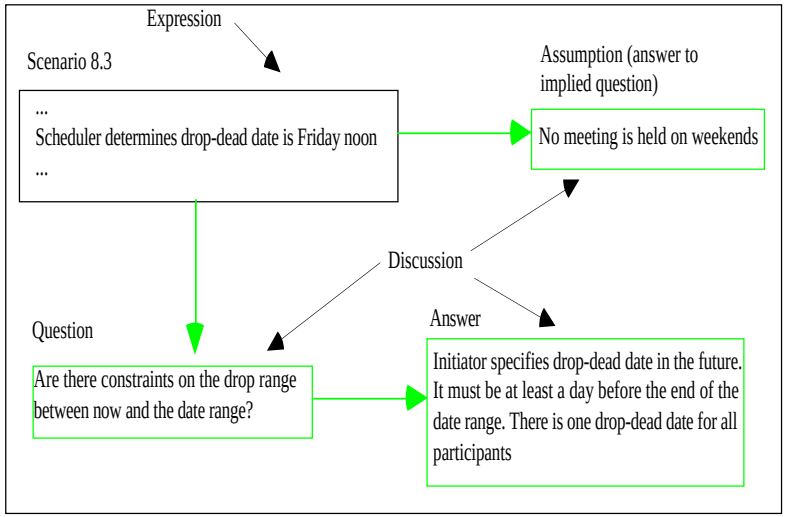


Figure 2: Relations among the types of goal specifications.

Inquiry-Based Requirements Analysis



Example Dicussion



Scenarios in Requirements Elaboration

Definition:

A sequence of concrete behaviors performed in a concrete situation.

Examples:

Tell me what you do when you use the ATM.
Tell me about the last time you used the ATM.

Helping to identify actions

What do the users do now?

Helping to identify obstacles and avoidance/mitigation behaviors

What can go wrong?

What do users to to detect problems and recover from them?

elping to walk through and validate required behaviors

Is this really what the users want??

Scenarios as Stories

Scenarios can have three types of structure:

Agency: Which agents interact during the course of the scenario

Temporal: The event trace of the scenario (time-ordered sequence of actions)

Plot: What is the "point" of the scenario? How does it demonstrate the actors' goals?

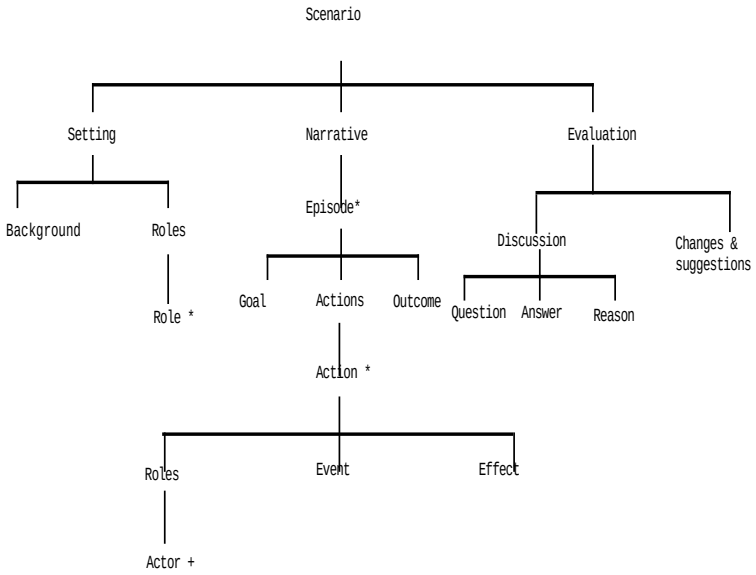
Plots are "grammatical"

Folk tales have (culture-specific) canonical structures.

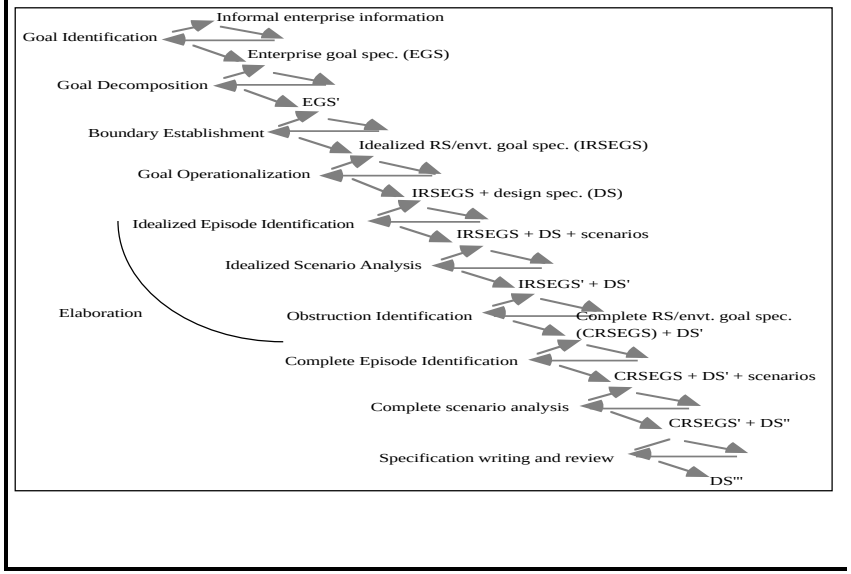
The nodes in these structures are goal-related

The "point" of a story is not a trace of events, but the accomplishment/prevention of protagonists' goals

Scenario Grammar



Goal Refinement Strategy



Goal Identification, Decomposition and Dependency Analysis

Goal identification

Define high-level goals that the RS is to help achieve.

This research assumes that the goals are given ("Systems Rationalism" - Kling)

Goals are named by phrases that describe the desirable state of affairs achieved when the goal succeeds.

E.g. "Customer request serviced," but not "Service customer requests."

Goal decomposition

Replace goals with subgoals

Assume no specific method for decomposition.

Dependency Analysis

***Precedence* :**

Achieve goals in order

Obligation

Achieving a goal requires achievement of another

Thwarting

Achievement of one goal prevents/undoes accomplishment of another

Goal Operationalization and Boundary Establishment

Piecemeal approach

Ask how each goal could be operationalized

Framework approach

Develop single system concept or metaphor and coordinate operationalization and allocation decisions

Obstacle Identification & Mitigation

For all possible goals:

(a) *Failure occurrence.*

Can this goal be obstructed, and if so, when?

(b) *Failure consequence.*

If this goal can be obstructed, what are the consequences?

In the following obstacle situations:

(a) *Prerequisite failure.*

Can another goal be obstructed that is a prerequisite to this goal?

(b) *Replicate collision.*

If the goal deals with one object among a population of similar objects, can these replicate objects contend for limited enterprise resources, which, if exhausted, would obstruct the goal?

(c) *Replicate confusion.*

If the goal deals with one object among a population of similar objects, can these replicate objects be confused, thereby obstructing the goal?

(d) *Actor failure.*

Can the actor responsible for achievement of this goal fail or become otherwise unavailable, thereby obstructing the goal?

(e) *Goal thwarting.*

If $G_2 \downarrow G_1$, then under what circumstances could G_2 be achieved, thereby obstructing G_1?

Scenario Identification Heuristics

(A) Identify scenarios for idealized cases first.

(1) Each goal in the goal hierarchy should be achieved by an episode in at least one scenario. This heuristic guarantees total goal coverage.

(2) Respect dependencies in the goal hierarchy so that the episodes of every scenario observe the dependency rules for their goals.

(B) Cover all obstacles and goal thwarting relationships at least once in the set of scenarios.

(1) In at least one scenario, explore the consequences of thwarting every goal that can be thwarted.

(2) Include at least one scenario for every identified obstacle.

(3) For obstacles involving replicates, construct scenarios that minimally exhibit the resource contention or object confusion.

(C) Construct scenarios to investigate "interesting" combinations of goals.

Usually domain-specific.

Elaboration

Adding Defensive Goals

How can the obstacle be prevented or defended against?

Adding Mitigation Goals

How can the consequences of the obstacle be mitigated or the obstacle recovered from?

Example: Collaborative Meeting Scheduler

Goal Specification

Meeting Scheduled
- *Meeting Request Accepted*
  - *Meeting requested*
  - *Attendees notified of requested meeting*
- *Attendees Know Current Meeting Status*
  - *Attendees notified of current meeting status*
  - *Attendees attended to current meeting status notification*
- *Meeting Request Processed*
  - *Meeting Request Scheduled*
  - *Attendees Know Of Meeting*
    - *Attendees notified of meeting*
    - *Attendees attended to meeting requests*
  - *Preferences Known*
    - *Attendees Preferences Known*
      - *Attendees' preferences solicited*
      - *Attendees preferences announced*
    - *VIPs Location Preferences Known*
      - *VIP's location preferences solicited*
      - *VIP's location preferences announced*
    - *Speakers Requirements Known*
      - *Speaker's requirements solicited*
      - *Speaker's requirements announced*
  - *Preferences Changed*
    - *Attendee's preferences changed*
    - *VIP's location preference changed*
    - *Speaker's requirements changed*
    - *Change notification attended to*
  - *Meeting Date And Location Known*
    - *Meeting date and location scheduled*
    - *Attendees notified of meeting date and location*
- *Facilities Changed*
  - *Initiator notified of facilities changes*
  - *Facilities change notification attended to*

Boundary Establishment and Operationalization

Competing metaphors:

Messaging

Calendaring

IEGH Goals	Messaging option IOGH actions	Calendaring option IOGH actions
Attendees Know Of Meeting	*Initiator announces desired attendees* *RS notifies attendees of meeting* *Attendees attend to meeting request*	*(NULL)*
Attendees Preferences Known	*RS solicits attendees preferences* *Attendees announce preference*	*Attendees record appointments* *RS retrieves attendees' appointments*
Attendees Changes Accounted For	*Attendee changes preferences* *VIP changes location preferences* *Speaker changes requirements* *RS records change notification*	*Attendee changes appointments* *VIP changes location preference-determining information* *Speaker changes requirements-determining information* *RS attends to change notification*
Meeting Date And Location Known	*RS schedules meeting date and location* *RS notifies Initiator of meeting date and location* *RS notifies attendees of meeting date and location*	*RS schedules meeting date and location* *RS notifies attendees of meeting date and location*

Scenario Identification

(a) Normal cases and goal thwarting.

Successful Schedule:

Meeting Request Accepted - Preferences Known - Meeting Date and Location Known

Early Change of Preference:

Meeting Request Accepted - Preferences Known - Preferences Changed - Meeting Date and Location Known

Facilities Change under Scheduled Meeting:

Meeting Request Accepted - Preferences Known - Meeting Date and Location Known - Facilities Changed

Benign Change of Facilities:

Facilities Changed - Meeting Request Accepted - Preferences Known - Meeting Date and Location Known

(b) Single Obstacles.

Unfeasible schedules.

Room unavailability.

Non-respondant (Messaging metaphor)

Out-of-date calendar (Calendaring metaphor)

(c) Combinations of obstacles.

Example Scenario

Scenario	*Successful meeting scheduled*	
Back-ground		
Roles		
Scheduler	*The automated meeting scheduler RS (Messaging option)*	
Gwen	*Initiator of meeting; not a participant*	
Colin	*Important participant*	
Annie	*Active participant*	
Allison	*Normal participant*	
Episode	*Request meeting*	
Goal	*Meeting request accepted*	
Actions/ Role	**Operation**	**Consequences**
Gwen	*Call meeting to discuss research plans*	*Scheduler recorded meeting request, preferred time span and desired participants.*
Scheduler	*Send important participant e-mail msg to Colin*	*Colin received e-mail msg.*
Scheduler	*Send important participant e-mail msg to Annie*	*Annie received e-mail msg.*
Scheduler	*Send important participant e-mail msg to Allison*	*Allison received e-mail msg.*
Colin	*Attend to received e-mail msg.*	*Colin knows about the meeting.*
Annie	*Attend to received e-mail msg.*	*Annie knows about the meeting*

Outcome	*The participants and Gwen have been told about the meeting and the scheduler is waiting for their preferences.*
Episode	*Schedule meeting request*
Goal	*Meeting request scheduled*
Outcome	*Scheduler determines date by which it must schedule the meeting*
Episode	*Get preferences*
Goal	*Preferences known*
Outcome	*Scheduler recorded Colin's location preference, Annie's equipment needs, and all three participants' preferred and excluded times.*
Episode	*Schedule meeting*
Goal	*Meeting date and location known*
Outcome	*Scheduler recorded the optimal time for the meeting and room location. All three participants and Gwen have been informed of schedule.*

Evaluation

Question	**Answer**	**Reason**
What if one of the participants doesn't respond?	*Go ahead and schedule anyway, provided participant isn't active.*	*Have to schedule meeting eventually. Can't have the meeting without the active participant.*
	Send reminder messages at predetermined intervals before drop-dead date	*Users often forget to reply.*

Changes/ suggestions

Add requirement to deal with non-responding participants and explore scenarios in which active, important and normal participants do not respond.

Conclusions

Goal refinement can be made a systematic basis for requirements elaboration

Concrete scenarios are vital to understanding of goals

Method as described is rationalistic and pays insufficient attention to non-logical factors

Case study shows need to integrate goal refinement with ad hoc and method-specific processes

Ecological data gathering is needed to accommodate human and social factors

Goal Elaboration

Obstacle / combination	**Defensive actions**	**Mitigation actions**
Unfeasible schedule	*Organizational (build more rooms; abandon meetings, etc.)*	*(1) Prioritize normal participants and schedule high-priority participants first.* *(2) Schedule as many normal participants as possible,* *(3) Initiator asks for additional preferred times from participants*
Participant does not respond (Messaging)	*(1) Organizational (Culture of replying to requests).* *(2) Remind periodically before scheduling date passes.*	*(1) Make decision anyway ignoring non-respondent.* *(2) Give non-respondents a choice of valid time slots.*
Participant does not keep calendar up to date (Calendaring)	*Organizational*	*Confirm meetings immediately schedule is calculated.*
Facilities change + confusion over identity of the room that was chosen.	*n.a. (combination)*	*Confirm every room booking with Facilities organization whenever a room is closed.*