

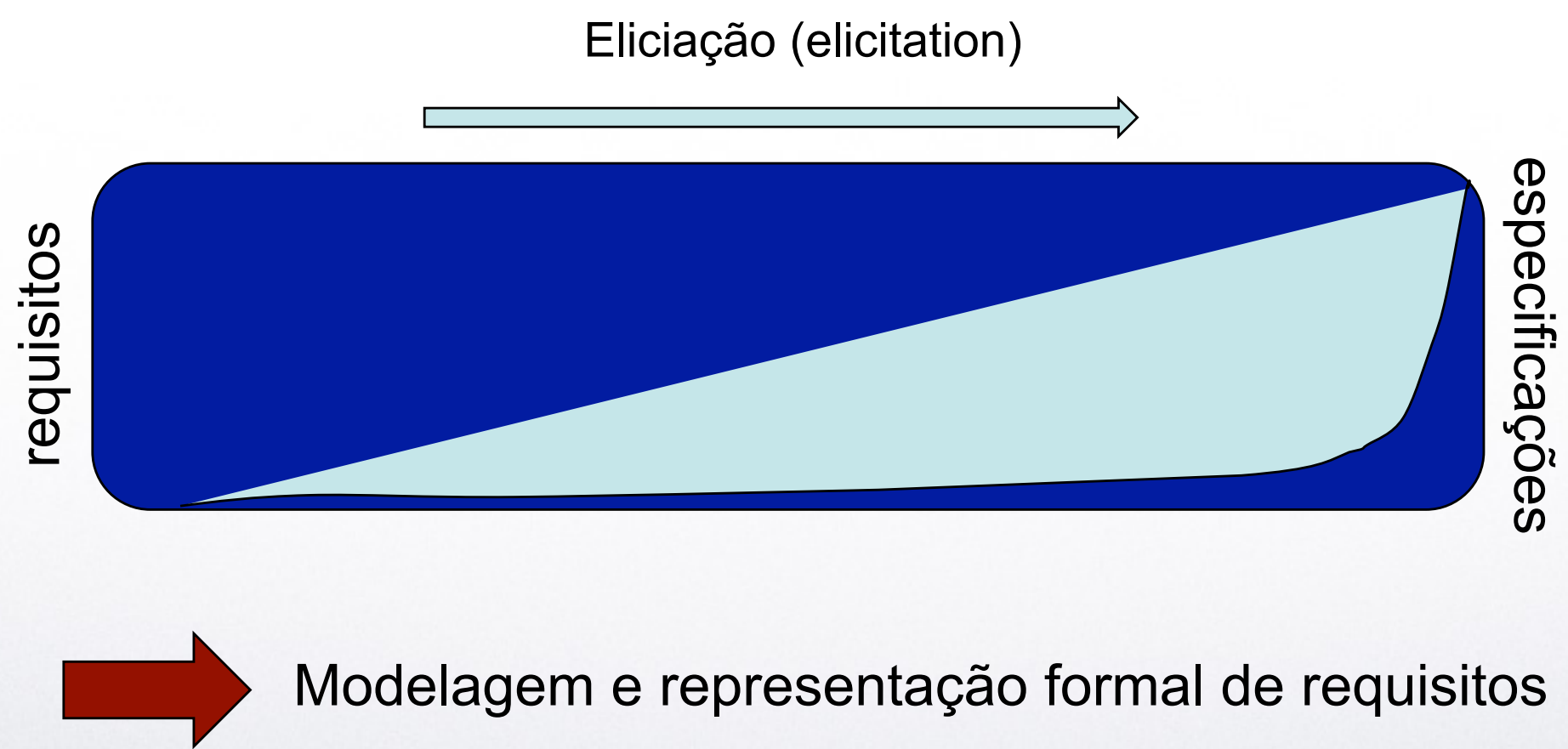
# ***PMR 5020***

## Modelagem do Projeto de Sistemas

### Aula 4: Modelagem e análise de requisitos

Prof. José Reinaldo Silva  
[reinaldo@poli.usp.br](mailto:reinaldo@poli.usp.br)

Uma visão intuitiva...



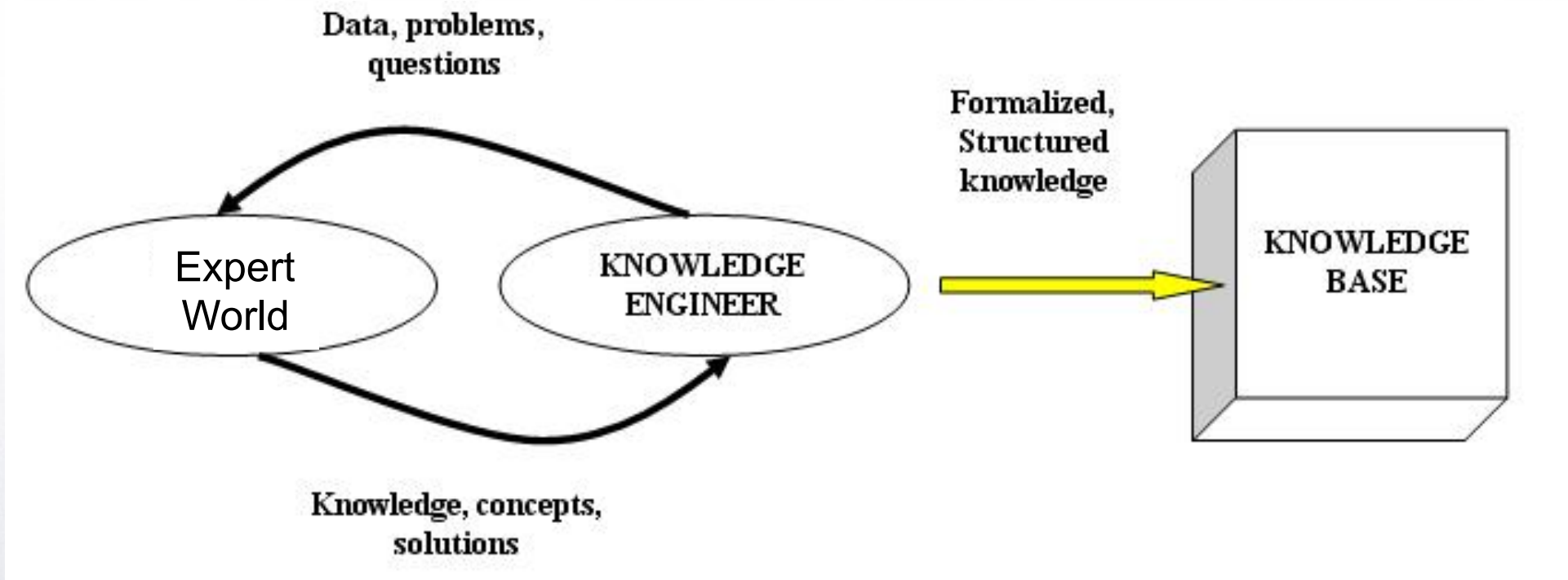
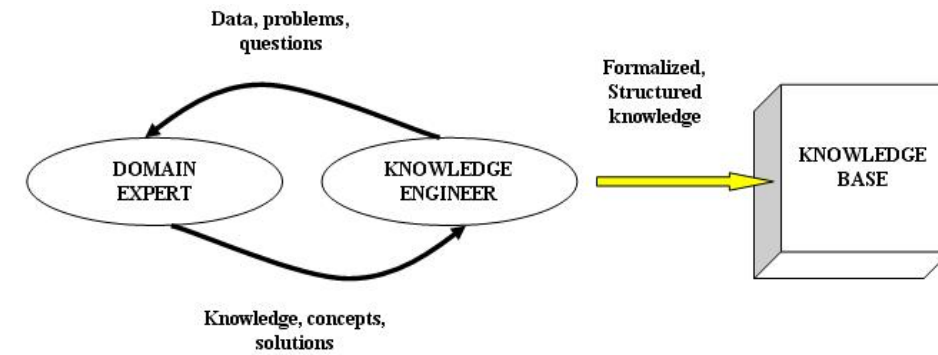


## Modelando Requisitos

Processo de projeto da ER consiste em modelar sistemas em várias vistas, tais como:

- Modelagem organizacional
- Modelagem Estática (ou modelagem de dados)
- Modelagem Comportamental (ou dinâmica)
- Modelagem Contextual (ou de domínio)
- Modelagem Não-funcional

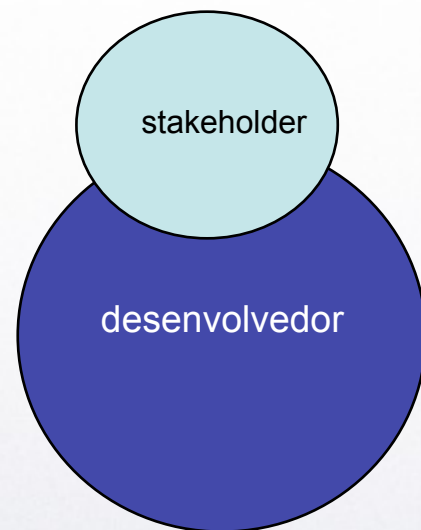
# O processo de eliciação





# O acoplamento de domínios

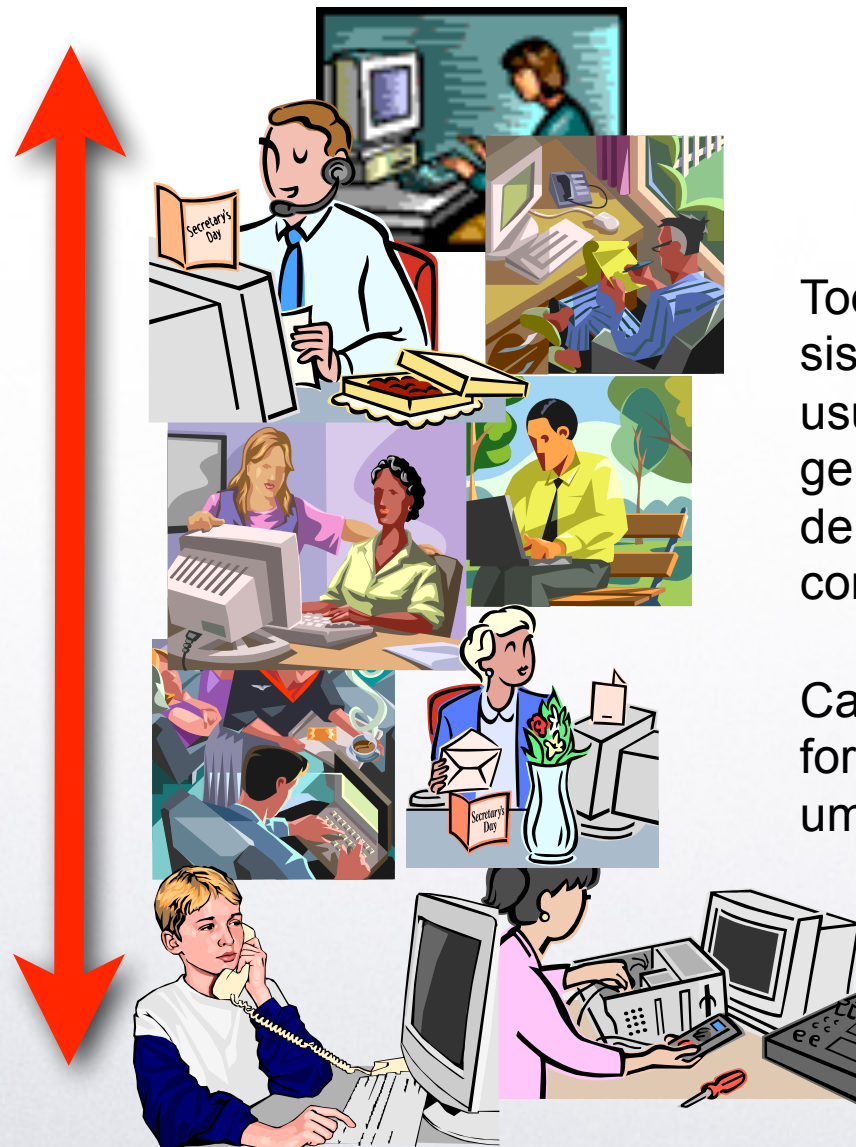
Domínios acoplados



Domínios disjuntos



# Viewpoints



Todo sistema baseado em recursos computacionais – sistemas computáveis – tem uma gama variada de usuários e interessados nos seus recursos (chamados genericamente de agentes), que podem ser pessoas de variados perfis (profissionais e de relacionamento com o sistema, outros sistemas, máquinas, etc.)

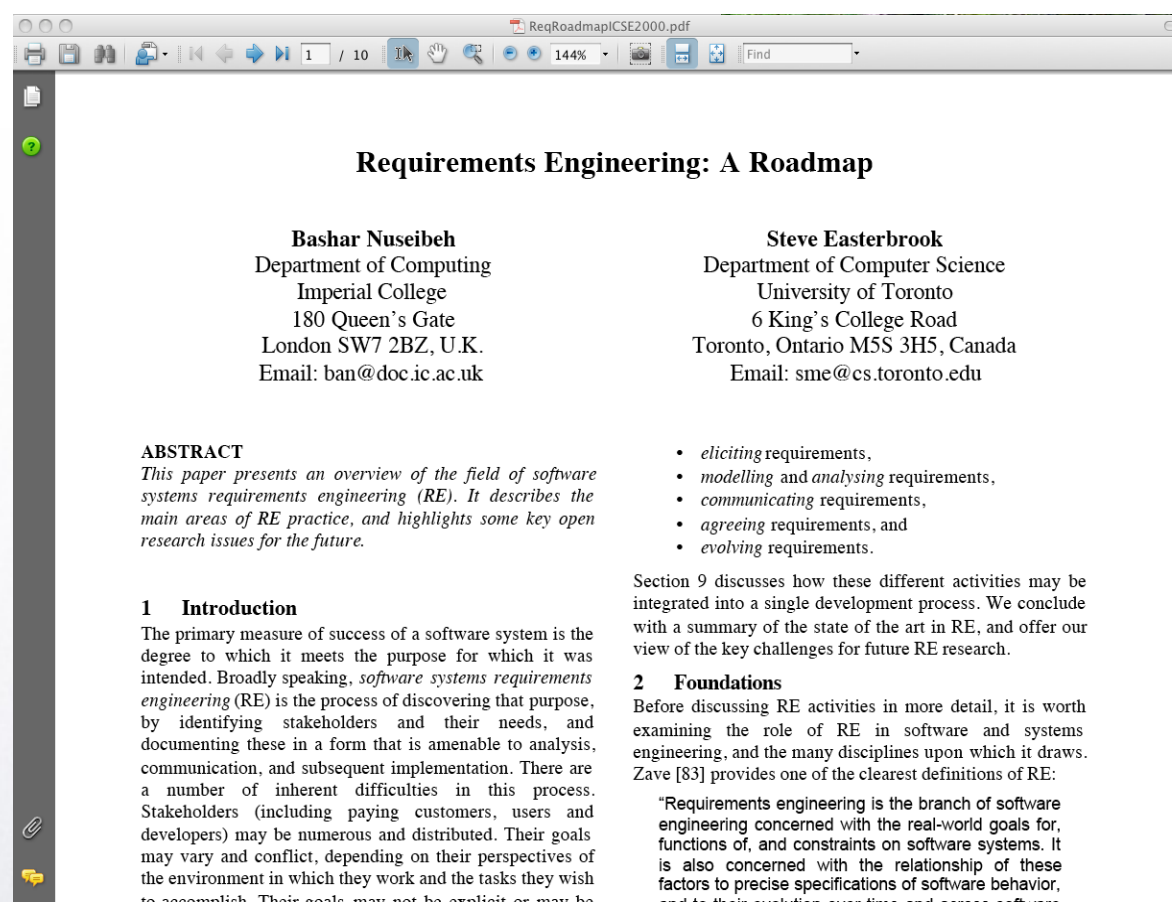
Cada um destes agentes interage com o sistema de forma diferente e requer deste coisas diferentes. Cada um deles mantém o seu **viewpoint** sobre o sistema.

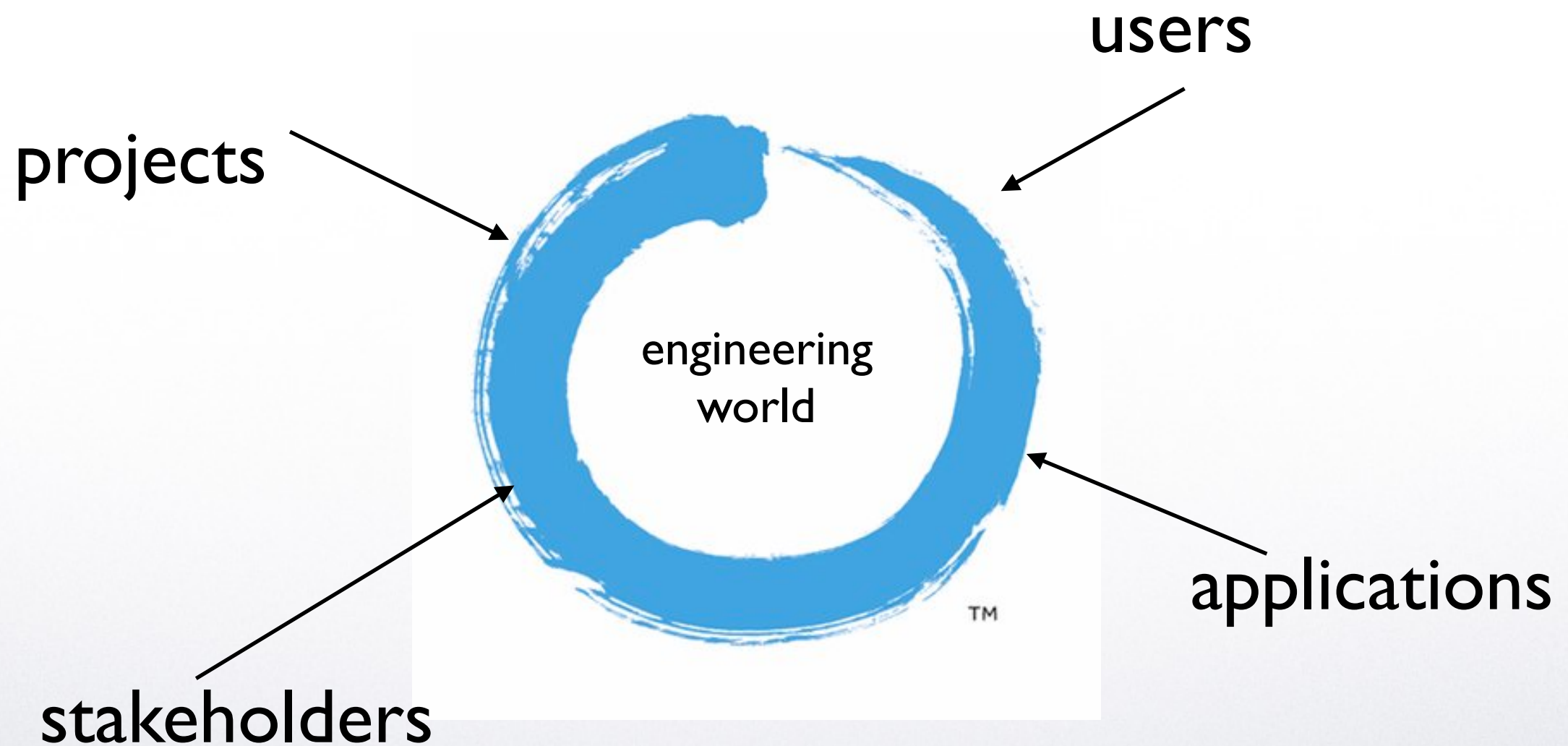


# Leitura da semana



Nuseibeh, B. and Easterbrook, S., on Proc. of the Conf. on the Future of Software Engineering, ACM, New York, USA, 2000.





eliciação



# Técnicas de Eliciação

- Métodos tradicionais ( questionários, enquetes, entrevistas, análise de documentação já existente);
- Técnicas de grupo em geral envolvendo o(s) stakeholder (s) e até usuários usando RAD (Rapid Application Design) ou JAD (joint application design)
- Protipagem (usada quando o grau de incerteza sobre os requisitos é muito grande)
- Técnicas voltadas a modelo (model driven). Inclui requisitos voltados a objetivo (goal driven), e é praticada em sistemas como KAOS (Keep all Objects Satisfied) e CREWS (Cooperative Requirements Engineering with Scenarios).
- Técnicas cognitivas (em geral derivadas ou originadas na Inteligência Artificial)
- Técnicas Etnográficas (baseadas na inserção do eliciador no ambiente do projeto)

**Table 1. Six categories of elicitation methods, extended from (Nuseibeh and Easterbrook 2000)**

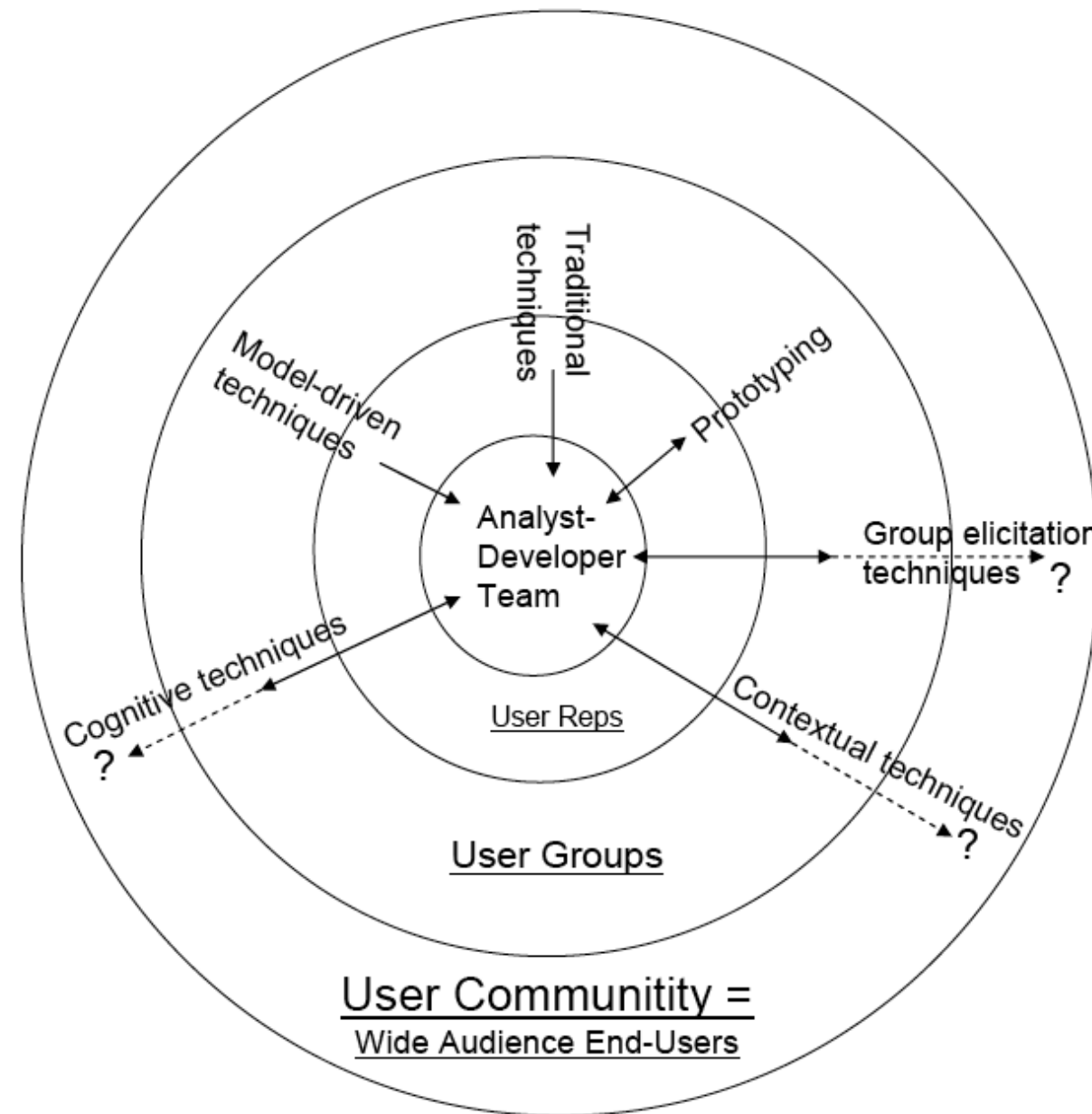
<b>Category</b>	<i>1.Traditional techniques</i>	<i>2.Prototyping</i>	<i>3.Group elicitation techniques</i>	<i>4.Contextual techniques</i>	<i>5.Cognitive techniques</i>	<i>6.Model-driven techniques</i>
<b>Technique examples</b>	Questionnaires and surveys, interviews, and analysis of existing documentation	Prototyping the early versions of user interface.	Group techniques: brainstorming, focus groups, and RAD/JAD workshops.	Ethnographic techniques such as participant observation.	Protocol analysis, laddering, card sorting, and repertory grids.	Goal-based methods and scenario-based methods.
<b>Reach</b>	Mainly user reps	User reps	User groups, <b>User community?</b>	User reps, <b>User community?</b>	User reps, <b>User community?</b>	User reps
<b>Communication</b>	Single-directional with the exception of interviews	Two-directional	Two-directional	Single- and Two-directional	Single- and Two-directional	Two-directional



# Modelagem e Análise de Requisitos

- Modelagem Contextual (do ambiente em torno do sistema ou do BP);
- Modelagem dos Dados;
- Modelagem Funcional ou Comportamental;
- Modelagem do Domínio;
- Modelagem não-funcional;
- Validação ou análise dos requisitos

- Modelagem organizacional
- • Modelagem Estática (ou modelagem de dados)
- Modelagem Comportamental (ou dinâmica)
- Modelagem Contextual (ou de domínio)
- Modelagem Não-funcional



Tuunanen, T., A New Perspective on Requirements Elicitacion Methods, Journal of Information Technology Theory and Application, pp 45-72, vol. 5, no. 3, 2003.



O Ponto de partida para a fase inicial do design é a documentação dos requisitos eliciados. Isto implica em ter uma representação que não pode ainda ser formal, que é flexível e tem características de **modelagem visual**. Admtiremos sem maiores discussões que a UML é (ainda) a melhor candidata para esta tarefa, apesar das críticas recentes.



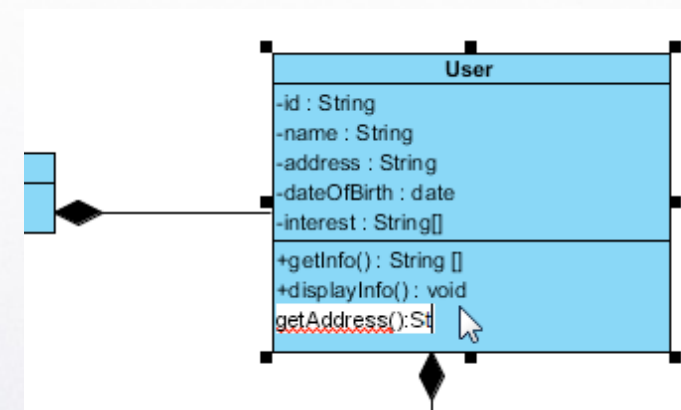
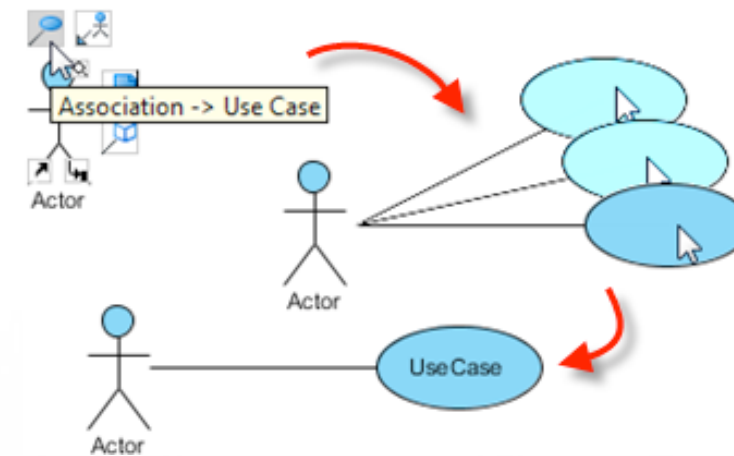
O Estudo da UML é um requisito desta disciplina (co-requisito)



# Visual modeling

Uso de linguagem gráfica e esquemas (formais ou não) para representação de algum conteúdo.

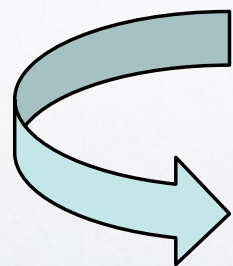
Ainda que não sejam formais estas representações possuem alguma disciplina, associada à sua semântica.





(Nuseibeh and Easterbrook, 2000)

- Modelagem do contexto (enterprise modeling)
- Modelagem estática (de dados)
- Modelagem comportamental
- Modelagem de domínio
- Modelagem não-funcional



Análise

Uma vez modelados e documentados os requisitos, o desafio passa a transformá-los na “descrição” do artefato ou sistema. Para isso precisamos descobrir inconsistências, discrepâncias, redundâncias, contradições, etc. e removê-las, seja esclarecendo melhor os *features* do artefato, ou “negociando” os objetivos.

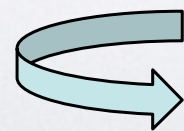
**Existem métodos para se fazer a análise de requisitos?**



# Classificação dos métodos de análise

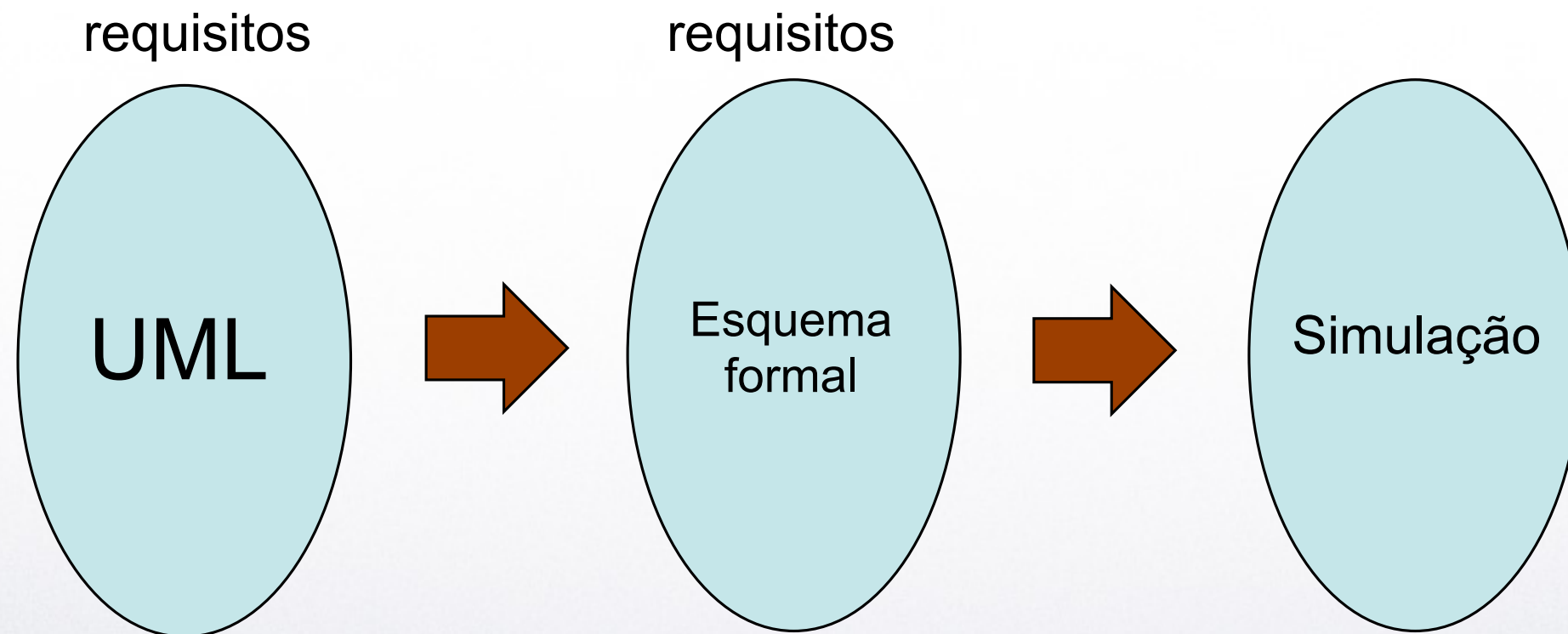
Os métodos de análise podem ser classificados como:

1. Análise dinâmica (animação);
2. Métodos baseados em conhecimento Case based reasoning (CBR)  
Constraint Satisfaction  
KBS analysis and critics
3. Análise de consistência



**Validação**

# Análise Dinâmica





# Métodos Práticos

www.volere.org

**Volere** Requirements Resources

HOME TEMPLATES RESOURCES TOOLS COURSES SERVICES CONTACT SITEMAP

**Volere** (Voh-lair-ray) the Italian verb to want, or to wish.

This is the home of the **Volere Requirements Specification Template** and other requirements and business analysis resources. Volere is the umbrella that covers the collection of requirements templates, processes, books, consulting and training. Since its inception, Volere has been used by thousands of organizations around the world. [Read what some of them have to say.](#)

We offer courses including the flagship **Mastering the Requirements Process**. This course is based on the acclaimed book *Mastering the Requirements Process—3rd edition, Getting Requirements Right*. We also provide **Mastering Business Analysis** and **MRP part 2**.

Available downloads are the **Volere Requirements Specification Template**, **Stakeholder Analysis**, **Prioritisation Analysis** and the **Atomic Requirement Template**, or as it is more popularly known, the **Snow Card**. Some content is free with registration.

Other services include **specification and requirements reviews**, **requirements process design**, and **consulting** to make you better at requirements and business analysis.

**Volere Events**

- Brussels, October 11-13. James Robertson teaches **Mastering the Requirements Process**. Please contact **IT Works** for details.
- Brussels, October 12,13. Suzanne Robertson teaches the advanced **Mastering the Requirements Process part 2**. Please contact **IT Works** for details.
- Rome, October 17-19. Suzanne Robertson teaches **Mastering the Requirements Process**. Contact **Technology Transfer**.



# Volere

Requirements Resources



- HOME
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← → ↻ ⓘ www.volere.org/tools.htm ☆ 🌐 🟢 ⋮

📱 Apps ★ Bookmarks 📄 What is cycle time?... 📄 Import to Mendeley 📄 SWGE | EDITOR\_TR...

# Volere

Requirements Resources



Navigation ☰

## Requirements Tools

We acknowledge the contributions of Dora Lam and Rabi Achrafi to this list. Please note that the list does not imply a recommendation, nor does omission imply that we disapprove of the tool. We urge you to carefully consider your requirements for a tool before looking at any of them. Some of these companies have demonstration versions available.

Pete Jones of Phonak AG suggests that when reviewing tools, you give vendors five minutes to sell their tool. That is, the vendor's site should be able to tell you in that amount of time what the tool can do for you. If the vendor has done his requirements, then he should know that your main interest, and possibly your only interest at this time, is whether the tool will work for you. You are not interested in a laborious explanation of every button and menu choice possessed by the tool, not are you interested in glorious promises, and most likely not having a salesman call. The way the vendor addresses your review is a guide to how well the tool will work for you.

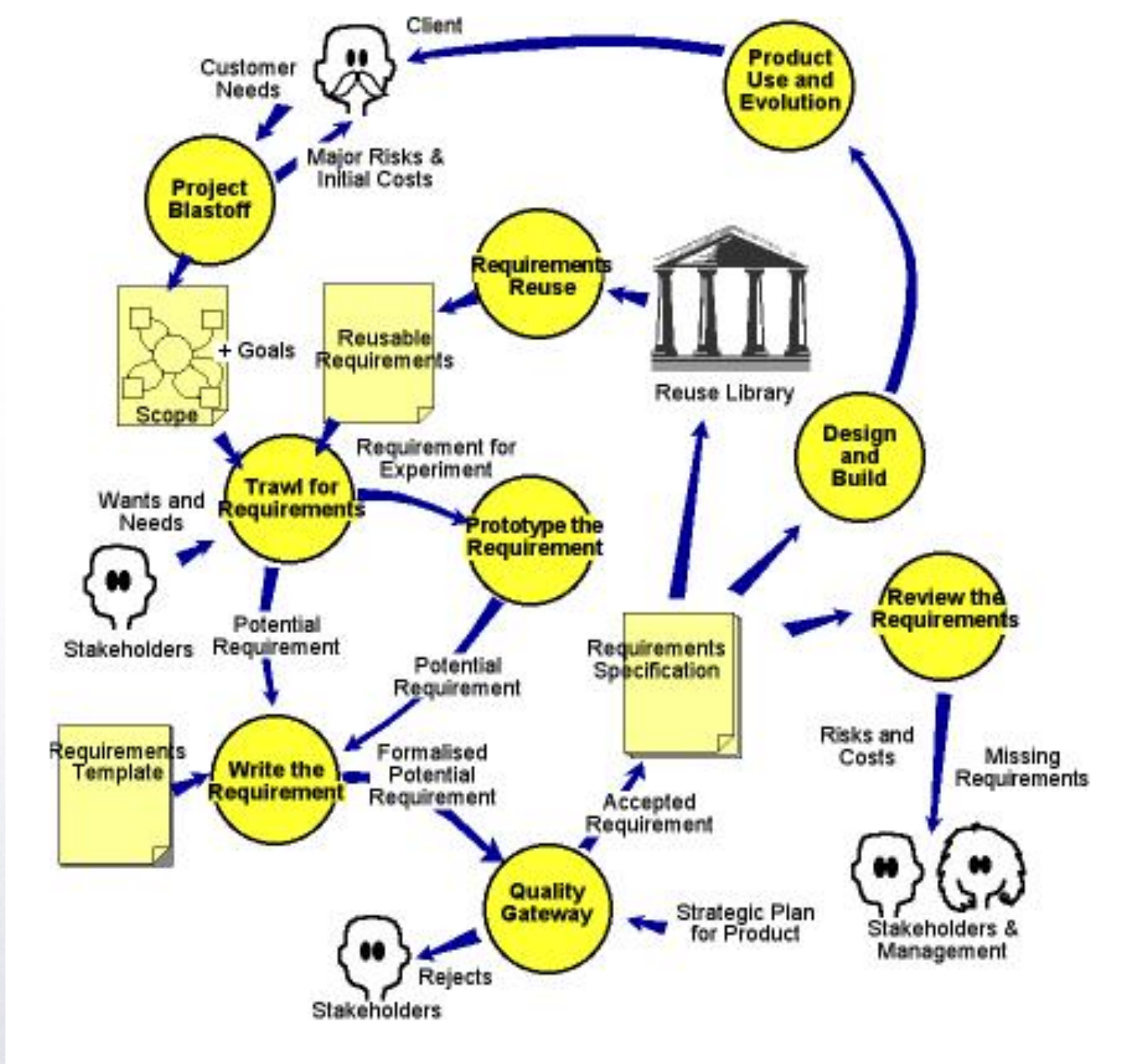
**Tool Name : Accept 360°, version 4.0**  
**Company Name: Accept Software, Inc.**  
**Web Address : <http://www.acceptsoftware.com>**

Version 4.0 of Accept's industry-leading solution for enterprise product planning extends Accept 360°'s functionality into Design, as well as adding exciting new features in Strategic Planning, reports and analysis, and core platform capabilities. Major highlights include:

All 0-9 A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

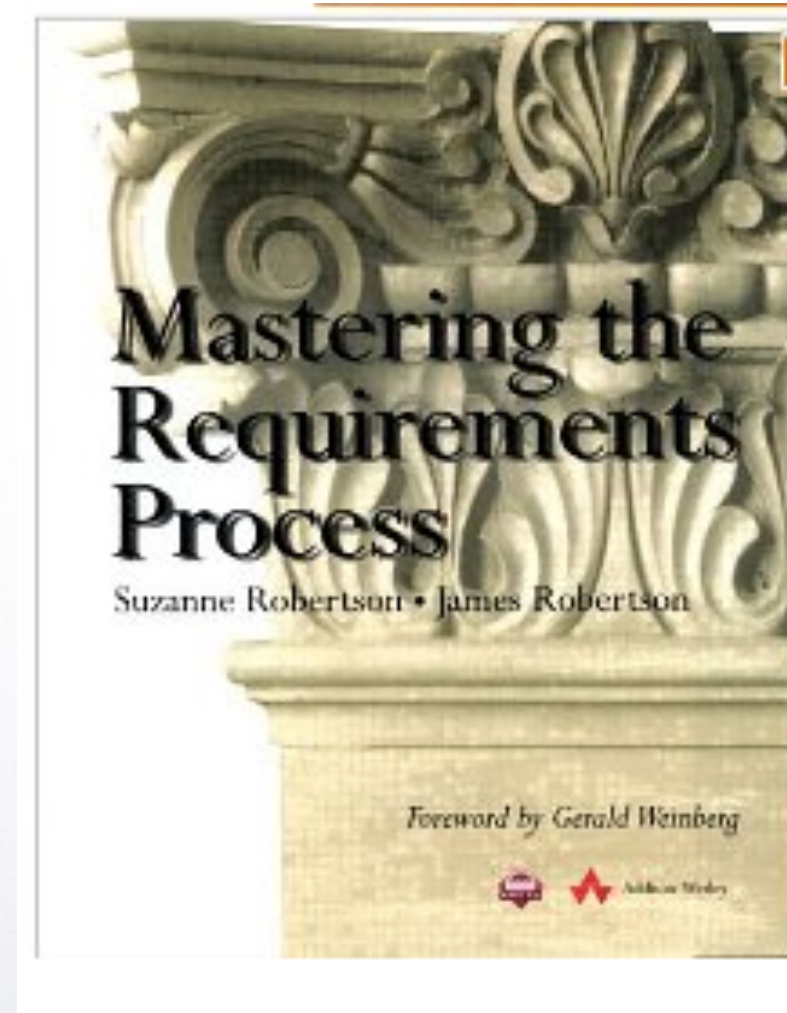


# Volere

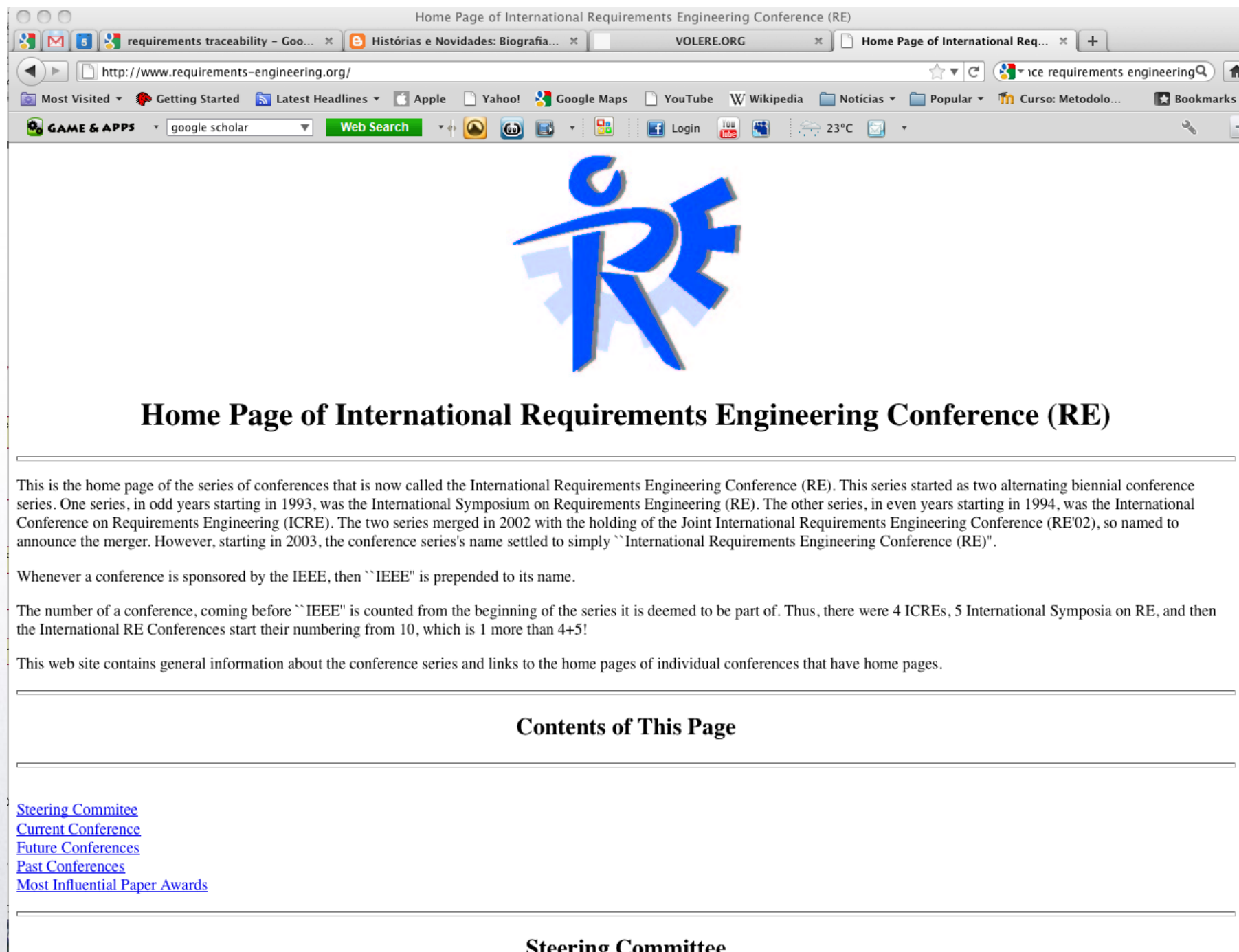




Mastering the Requirements  
Engineering Process  
Suzanne and James Robertson  
Addison Wesley, 1999



# Pesquisa em Requirements Engineering



The screenshot shows a web browser window with the URL <http://www.requirements-engineering.org/>. The page features a large blue logo of a stylized figure holding a gear, with the letters 'RE' integrated into the design. Below the logo, the title "Home Page of International Requirements Engineering Conference (RE)" is displayed. The main text provides a history of the conference series, mentioning the International Symposium on Requirements Engineering (RE) and the International Conference on Requirements Engineering (ICRE), which merged in 2002 to form the International Requirements Engineering Conference (RE). It also notes that conferences sponsored by IEEE are prefixed with "IEEE". The page includes a "Contents of This Page" section with links to the Steering Committee, Current Conference, Future Conferences, Past Conferences, and Most Influential Paper Awards. At the bottom, the text "Steering Committee" is visible.

Home Page of International Requirements Engineering Conference (RE)

This is the home page of the series of conferences that is now called the International Requirements Engineering Conference (RE). This series started as two alternating biennial conference series. One series, in odd years starting in 1993, was the International Symposium on Requirements Engineering (RE). The other series, in even years starting in 1994, was the International Conference on Requirements Engineering (ICRE). The two series merged in 2002 with the holding of the Joint International Requirements Engineering Conference (RE'02), so named to announce the merger. However, starting in 2003, the conference series's name settled to simply "International Requirements Engineering Conference (RE)".

Whenever a conference is sponsored by the IEEE, then "IEEE" is prepended to its name.

The number of a conference, coming before "IEEE" is counted from the beginning of the series it is deemed to be part of. Thus, there were 4 ICREs, 5 International Symposia on RE, and then the International RE Conferences start their numbering from 10, which is 1 more than 4+5!

This web site contains general information about the conference series and links to the home pages of individual conferences that have home pages.

**Contents of This Page**

[Steering Committee](#)  
[Current Conference](#)  
[Future Conferences](#)  
[Past Conferences](#)  
[Most Influential Paper Awards](#)

**Steering Committee**





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**Requirements Engineering and Agile Development**  
**- collaborative, just enough, just in time, sustainable -**

---

By Rainer Grau and Kim Lauenroth,  
with support from  
Bogdan Bereza, Erik van Veenendaal and Sven van der Zee.  
English Review by Gareth Rogers.



A Engenharia de requisitos pode ser resumida em três campos básicos:

- a eliciação de requisitos
- a análise de requisitos
- a validação dos requisitos
- o gerenciamento dos requisitos



# Validation

- **Validity**. Does the system provide the functions which best support the customer's needs?
- **Consistency**. Are there any requirements conflicts?
- **Completeness**. Are all functions required by the customer included?
- **Realism**. Can the requirements be implemented given available budget and technology
- **Verifiability**. Can the requirements be checked?



# Validation Techniques

- Requirements reviews
  - Systematic manual analysis of the requirements.
- Prototyping
  - Using an executable model of the system to check requirements.
- Test-case generation
  - Developing tests for requirements to check testability.



## The key questions

- **Verifiability**. Is the requirement realistically testable?
- **Comprehensibility**. Is the requirement properly understood?
- **Traceability**. Is the origin of the requirement clearly stated?
- **Adaptability**. Can the requirement be changed without a large impact on other requirements?

## The key problems

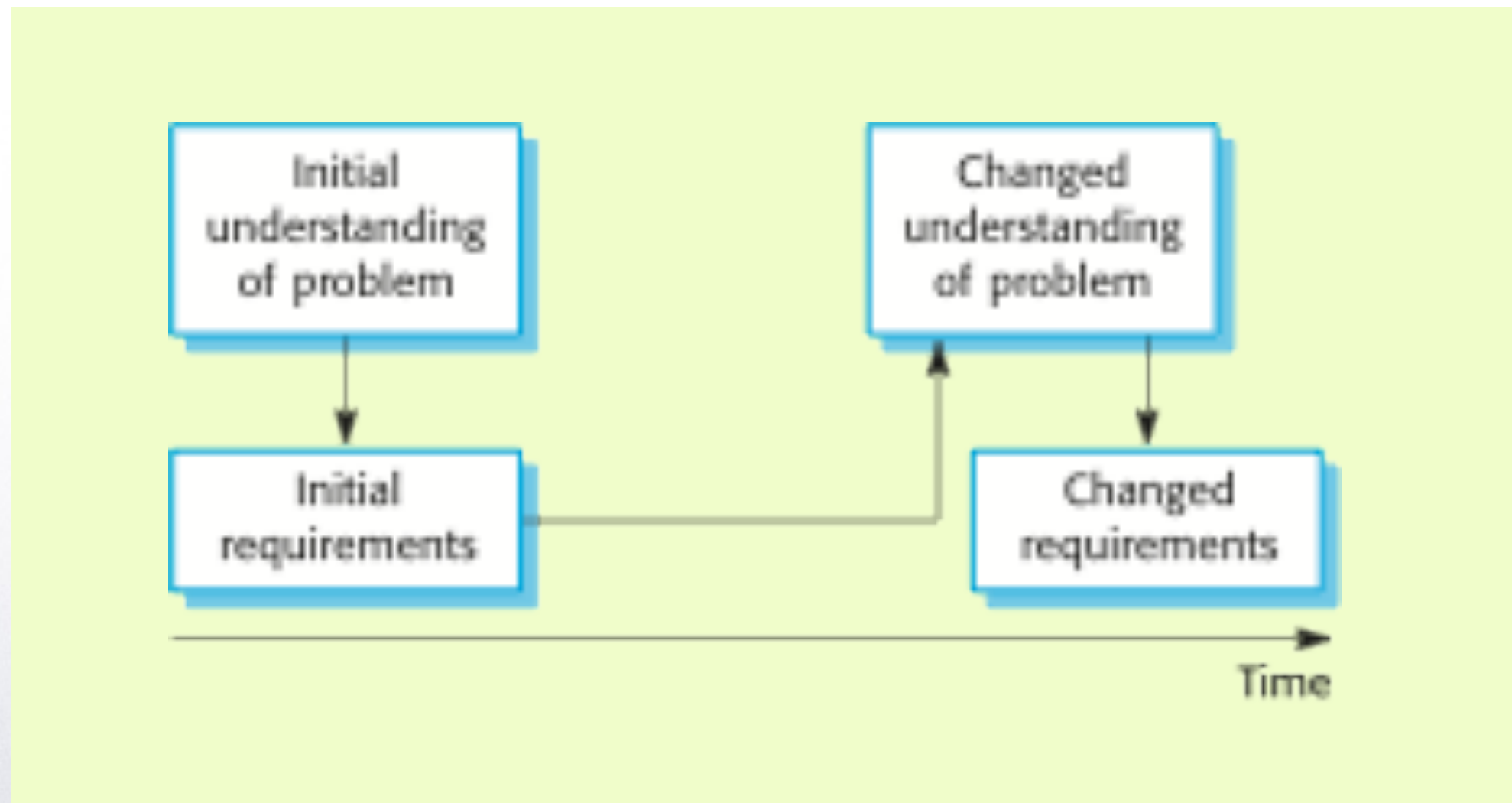
- The priority of requirements from different viewpoints changes during the development process.
- System customers may specify requirements from a business perspective that conflict with end-user requirements.
- The business and technical environment of the system changes during its development.



*volatile requirements*



# The evolutive trap



## Good req's X Bad req's

- **Enduring requirements.** Stable requirements derived from the core activity of the customer organisation. E.g. a hospital will always have doctors, nurses, etc. May be derived from domain models
- **Volatile requirements.** Requirements which change during development or when the system is in use. In a hospital, requirements derived from health-care policy



Requirement Type	Description
Mutable requirements	Requirements that change because of changes to the environment in which the organisation is operating. For example, in hospital systems, the funding of patient care may change and thus require different treatment information to be collected.
Emergent requirements	Requirements that emerge as the customer's understanding of the system develops during the system development. The design process may reveal new emergent requirements.
Consequential requirements	Requirements that result from the introduction of the computer system. Introducing the computer system may change the organisations processes and open up new ways of working which generate new system requirements
Compatibility requirements	Requirements that depend on the particular systems or business processes within an organisation. As these change, the compatibility requirements on the commissioned or delivered system may also have to evolve.

# The traceability concept

- Traceability is concerned with the relationships between requirements, their sources and the system design
- Source traceability
  - Links from requirements to stakeholders who proposed these requirements;
- Requirements traceability
  - Links between dependent requirements;
- Design traceability
  - Links from the requirements to the design;



# Traceability

*“The requirements traceability is the ability to describe and follow the life of a requirement, in both a forward and backward direction, i.e. from its origins, through its development and specification, to its subsequent deployment and use, and through periods of ongoing refinement and iteration in any of these phases.”*

Gotel, O., Filkenstein, A.; An Analysis of the Requirements Traceability Problem, in Proc. of the First Int. Conf. on Requirements Engineering, pp 94-101, Colorado Springs, USA, 1994.

# Traceability Example

- *SRD – System Requirements Document*
  - *High level requirements*
  - *Done by stakeholders*
- *SS – System Specification*
  - *More detailed requirements*
  - *Developer interpretation*
- *Segments*
  - *More detailed portions of the SS*
  - *Includes design information*



## Traceability Matrix

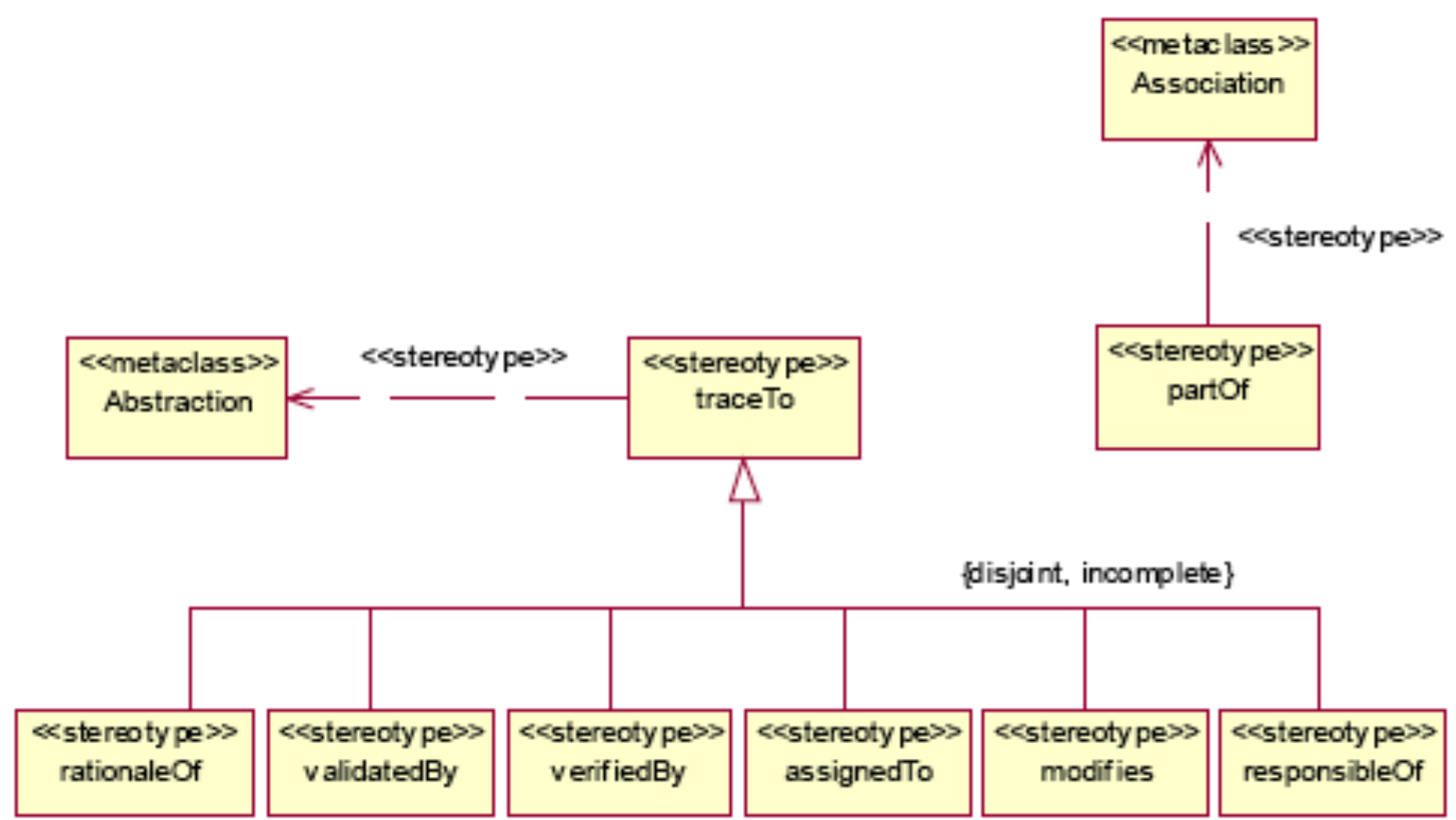
<i>SRD</i>	<i>SS</i>	<i>Seg 1</i>	<i>Seg 2</i>	<i>Seg 3</i>	<i>ICD</i>
3.1.2.1	3.3.4.5	3.2.2.5.6	3.5.3.2		3.1.4.6.7
	3.3.4.6	3.2.2.5.7			3.1.4.6.8
		3.4.5.6.2			3.1.4.6.9
3.4.3.1	3.6.7.2	3.5.2.5.1	3.7.4.3.1	3.6.4.5.2	3.3.2.4.5
	3.8.4.2		3.7.4.3.2		3.3.2.4.7

# Traceability Management

- *Requirements are added/deleted/modified*
- *Impact analysis*
- *Trace changed*
- *Continues through maintenance*



# Traceability links



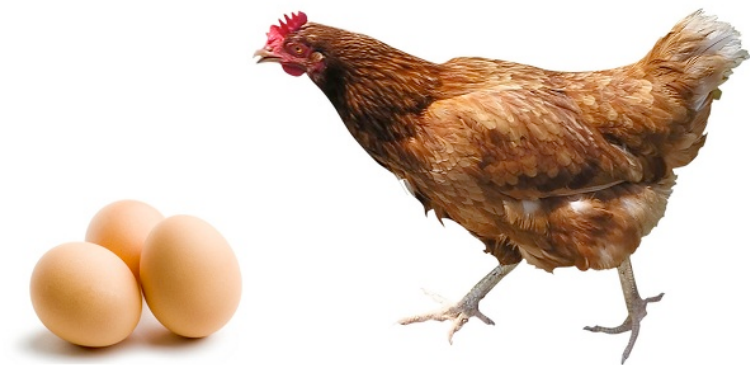
# Para reflexão!

A representação escolhida para a análise de requisitos e a representação escolhida para a especificação que encerra o processo da Engenharia de requisitos teria alguma influência no restante do processo de design?



## Onde está o problema: na eliciação ou na análise?

E sempre tentador imaginar se o problema de fato está em produzir uma boa eliciação, ou investir na análise para aperfeiçoar uma eliciação factível mas não perfeita. O mundo do design é cheio de dilemas que leva ao célebre problema do “ovo e da galinha”, qual dos dois vem primeiro.



o que vem primeiro?

## *Design features*

A base para a formulação de requisitos deve ser um conjunto genérico de features (objetivos) abstratos que definem o projeto. Esta definição genérica pode ser refinada em requisitos funcionais e não-funcionais até chegar em funções específicas de mais baixo nível.

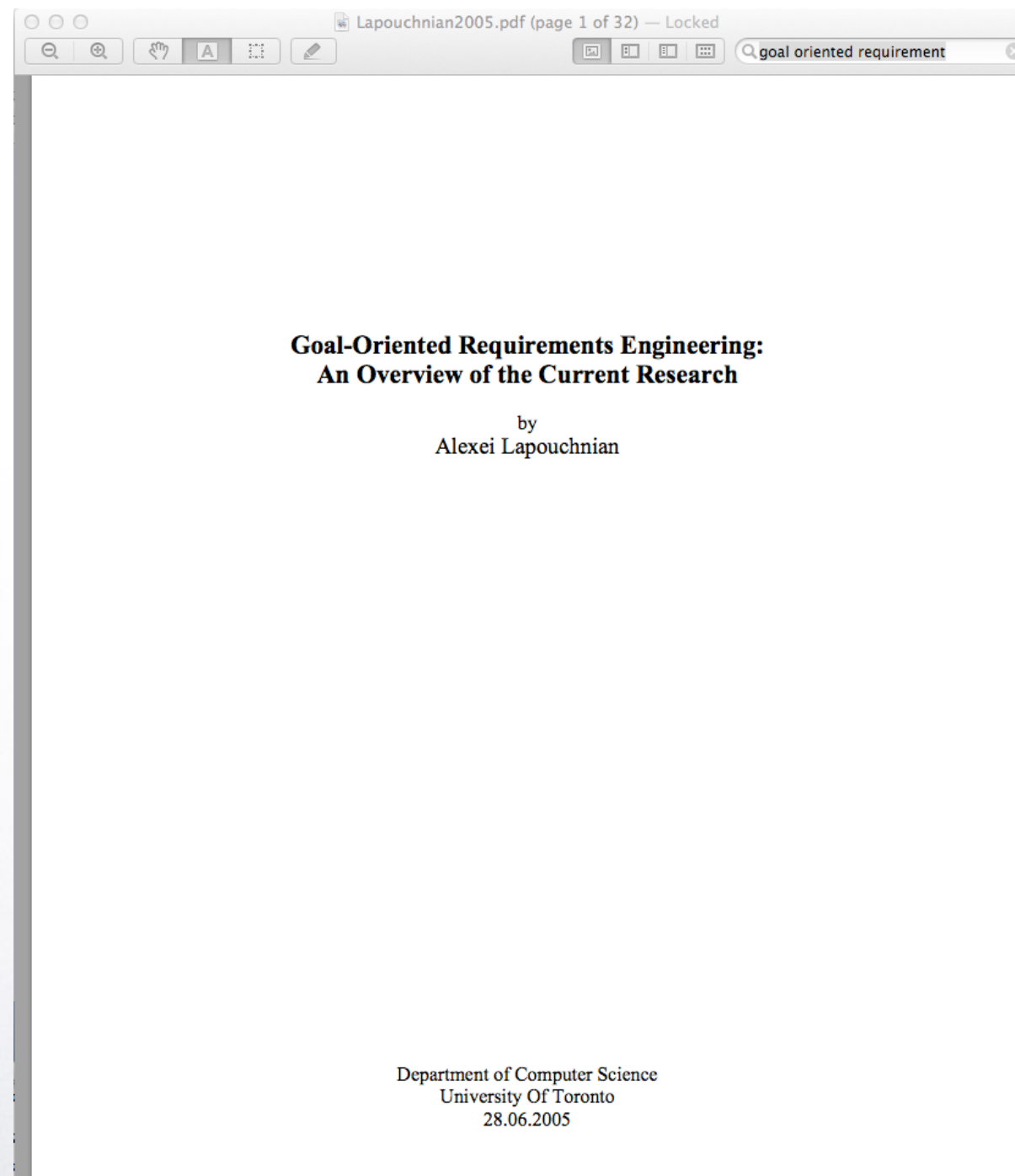
Silva, J.R.; Uma formalização do processo de design baseado em metáforas: sua aplicação na automatização de Sistemas de Eventos Discretos, tese de doutorado, Escola Politécnica da USP, 1992.



## Leitura da semana



To be functional or  
not to be functional,  
that is the question



## Os perigos da eliciação de requisitos

funcional



não-funcional

Um dos perigos da eliciação (e portanto da análise) de requisitos é privilegiar a análise funcional e a funcionalidade como alvo central.

Normalmente se diz que os requisitos devem refletir o que o sistema é e o que faz mas NUNCA "o como" este deve fazer as coisas (que seria alvo de etapas posteriores).

O perigo do "funcional" como antecipação do design está no stakeholder (especialmente em domínios disjuntos) ou no próprio designer (no caso de domínios próximos), ou em ambos quando não se trata de casos extremos.



# Requisitos orientados a objetivos (goals)

## What are goals?

A *goal* is an objective the system under consideration should achieve. Goal formulations thus refer to intended properties to be ensured; they are optative statements as opposed to indicative ones, and bounded by the subject matter

Axel van Lamsweerde, Goal Oriented Requirement Engineering: a Guided Tour, RE 2001, Toronto

## Exemplos



Atender mais passageiros



Agilizar e personalizar o atendimento



garantir a circulação com segurança e rapidez



## Goals (objetivos) integram o funcional e o não funcional

funcional



não-funcional

Goals also cover different types of concerns: functional concerns associated with the services to be provided, and non-functional concerns associated with quality of service such as safety, security, accuracy, performance, and so forth.

**Uma estratégia mais inteligente seria basear a busca pelos requisitos em conceitos que integrem o funcional e o não-funcional evitando o dilema da escolha ou da prioridade.**



## Porque goals (objetivos)?

### Why are goals needed?

There are many reasons why goals are so important in the RE process.

- Achieving requirements completeness is a major RE concern.. Goals provide a precise criterion for *sufficient completeness* of a requirements specification; the specification is complete with respect to a set of goals if all the goals can be proved to be achieved from the specification and the properties known about the domain considered.

É difícil distinguir quando um requisito que se refere a algum aspecto do sistema foi plenamente eliciado. Assim a preocupação inicial que tínhamos com o sistema, e sua representação por um plano, pode se propagar para todo o processo de eliciação.

- Avoiding irrelevant requirements is another major RE concern. Goals provide a precise criterion for requirements *pertinence*; a requirement is pertinent with respect to a set of goals in the domain considered if its specification is used in the proof of one goal at least.

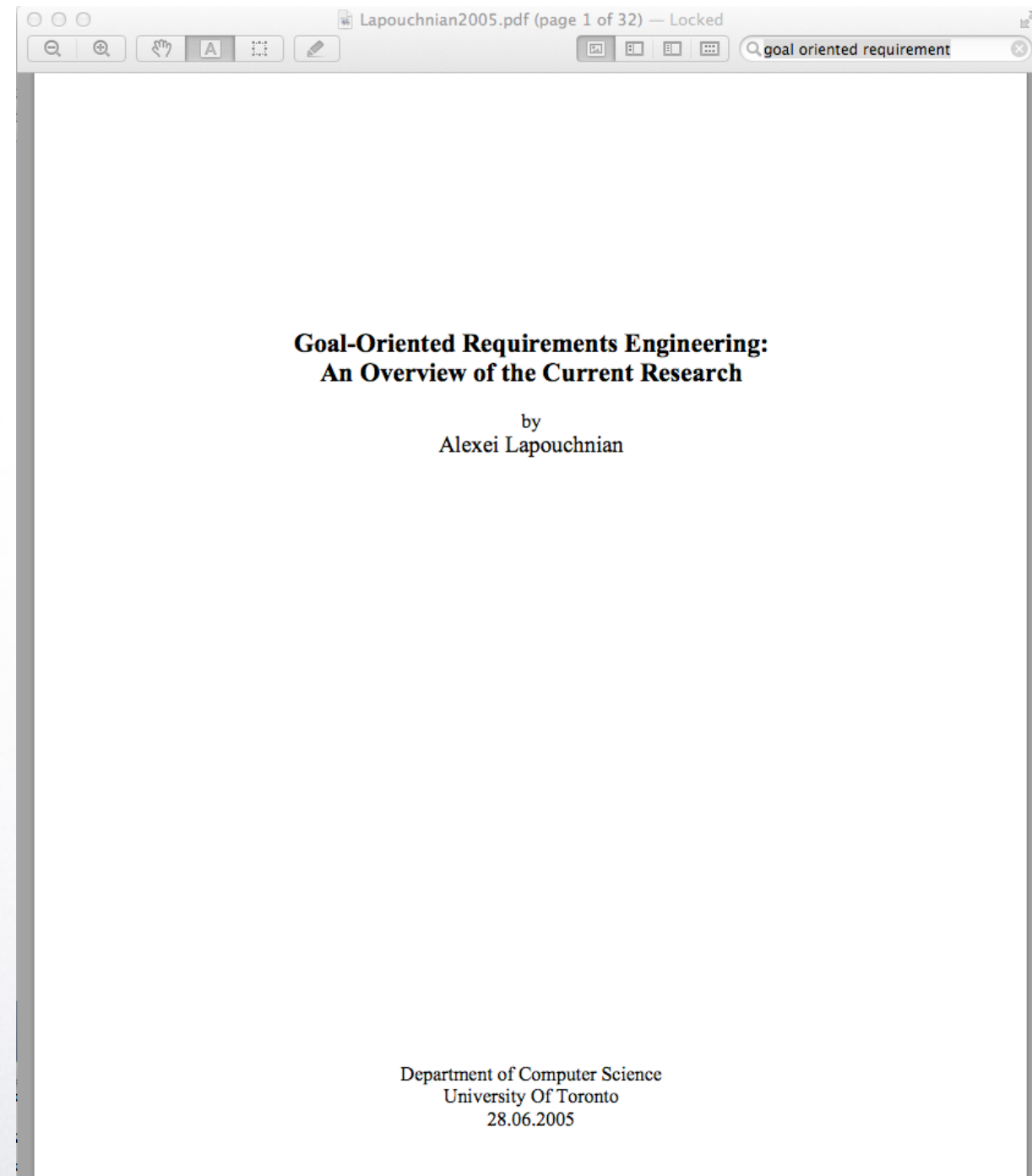
- Explaining requirements to stakeholders is another important issue. Goals provide the rationale for requirements, in a way similar to design goals in design processes [Mos85, Lee91]. A requirement appears because of some underlying goal which provides a base for it [Ros77, Dar91, Som97]. More explicitly, a goal refinement tree provides traceability links from high-level strategic objectives to low-level technical requirements. In particular, for business application systems, goals may be used to relate the software-to-be to organizational and business contexts

Objetividade é outro aspecto importante. É preciso ter um conjunto minimal de requisitos válidos.

Validação e traceability (discutido na aula passada) são outros aspectos importantes para uma boa fase de eliciação e análise de requisitos.



# Leitura da semana



## Segundo milestone

Para consolidar a proposta cada um deve incrementar o documento que já tem (composta do título, autor e abstract) para o artigo final e acrescentar :

- I. uma seção (a introdução) que explique claramente qual é a proposta e o que dos conceitos deste curso será utilizado no artigo;

**Pesquisa sobre métodos de eliminação de requisitos**





Obrigado

*Reinaldo*