# *Awareness* do Espaço de Trabalho em Ambientes Colaborativos Inclusivos na *Web*

Este exemplar corresponde à redação final da Tese devidamente corrigida e defendida por Leonelo Dell Anhol Almeida e aprovada pela Banca Examinadora.

Campinas, 28 de fevereiro de 2011.

Prof.ª Dr.ª Maria Cecília Calani Baranauskas
(Orientadora)

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Prof. Dr. José Mario De Martino (FEEC – UNICAMP)
Prof. Dr. Sérgio Roberto Pereira da Silva (Depto. Informática - UEM)
Profª. Drª. Laura Sánchez García (Depto. Informática – UFPR)
Profª. Drª. Amanda Meincke Melo (UNIPAMPA)

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**Profª. Drª. Amanda Meincke Melo**
**UNIPAMPA**

**Profª. Drª. Laura Sánchez García**
**Departamento de Informática / UFPR**

**Prof. Dr. Sérgio Roberto Pereira da Silva**
**Departamento de Informática / UEM**

**Prof. Dr. José Mario De Martino**
**FEEC / UNICAMP**

**Profª. Drª. Maria Cecília Calani Baranauskas**
**IC / UNICAMP.**

**Instituto de Computação**
**Universidade Estadual de Campinas**

# *Awareness* do Espaço de Trabalho em Ambientes Colaborativos Inclusivos na *Web*

Leonelo Dell Anhol Almeida[1]

Fevereiro de 2011

**Banca Examinadora:**

Prof.ª Dr.ª Maria Cecília Calani Baranauskas (Orientadora)
Instituto de Computação, Universidade Estadual de Campinas – UNICAMP

Prof.ª Dr.ª Laura Sánchez García
Departamento de Informática, Universidade Federal do Paraná – UFPR

Prof.ª Dr.ª Amanda Meincke Melo
Universidade Federal do Pampa – UNIPAMPA

Prof. Dr. Sérgio Roberto Pereira da Silva
Departamento de Informática, Universidade Estadual de Maringá – UEM

Prof. Dr. José Mario De Martino
Faculdade de Engenharia Elétrica e de Computação, Universidade Estadual de Campinas – UNICAMP

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# Resumo

O potencial crescimento do acesso à *Web* nos mais diversos segmentos da população – sejam elas determinadas por aspectos sócio-econômicos, culturais, de letramento, deficiências físicas ou de habilidades com Tecnologias de Informação e Comunicação – tem modificado significativamente a maneira como a *Web* é utilizada. Uma das principais mudanças é o propósito de uso, antes centrado no trabalho, que agora divide o foco com compartilhamento de informações, socialização e entretenimento. Além disso, a diversidade de público traz consigo diferentes necessidades que são influenciadas pelos aspectos supracitados, entre outros. Nesse contexto, um dos grandes desafios para a Ciência da Computação é o suporte à consciência dos interlocutores em situações colaborativas, que envolve o conhecimento das ações, objetos, presença, identidade e contexto, entre outros fatores. Na área de sistemas colaborativos essa consciência é chamada *awareness*. *Awareness* em sistemas colaborativos tem sido investigado desde o início da década de 90, por meio da proposição de *frameworks* e mecanismos de *software*. As abordagens existentes na literatura para o *design* de sistemas colaborativos não oferecem suporte ao conhecimento do público-alvo, e são geralmente voltadas somente à sintaxe e à semântica dos sistemas colaborativos.

Esta tese propõe uma perspectiva sócio-técnica para abordar o tema de *awareness* em Sistemas Colaborativos Inclusivos (SCI) na *Web*. Por SCI entende-se o sistema computacional capaz de oferecer o acesso e a manutenção da interação e da comunicação pela maior diversidade de pessoas sem segregação e, na medida do possível, sem *design* especializado. Para tanto foi desenvolvido o *framework* FAware, para apoio ao *design* de mecanismos para suporte a *awareness* em SCI na *Web*. FAware promove o conhecimento do público-alvo, a reflexão sobre os aspectos a serem tratados sobre diversos tipos de mecanismos para suporte a *awareness* e provê ferramental para o *design* e a avaliação de SCI na *Web*. O referencial teórico-metodológico do trabalho envolveu as disciplinas de Interação Humano-Computador, Semiótica Organizacional e Sistemas Colaborativos.

Para avaliar o FAware foram realizados dois estudos de caso que envolveram alunos de graduação e pós-graduação em Ciência da Computação, especialistas em acessibilidade e *designers* da interação. O primeiro estudo de caso tratou da avaliação de um *website* de governo eletrônico, enquanto que o segundo foi relacionado ao *redesign* de uma ferramenta de comunicação síncrona integrada a uma rede social inclusiva. Os resultados foram expressivos em relação ao módulo para avaliação de SCI na *Web*, no qual mesmo especialistas em acessibilidade foram capazes de identificar mais de 40% de problemas de acessibilidade, em adição aos encontrados utilizando ferramentas de avaliação semiautomática. Além disso, resultados indicam que participantes do segundo estudo de caso utilizariam o FAware também em outros contextos de uso e que eles consideram que o *framework*, além de orientar o *redesign*, promoveu o conhecimento deles sobre o tema.

# Abstract

The potential increase in the Web access by various sectors of the population – determined by socio-economic, cultural, literacy, physical or low skills in Information and Communication Technologies – has significantly changed the way in which the Web is used. One of the main changes is in the purpose of use, previously centered on work, now divides its focus with information sharing, socialization, and entertainment. Also, the audience diversity brings different needs influenced by the aforementioned aspects. In this context, one of the main challenges for the Computer Science is to provide support to awareness about the interlocutors in collaborative situations, which involves the knowledge of actions, objects, presence, identity, context, and other aspects. Awareness in collaborative systems is being investigated since the early 90s, with the proposition of frameworks and software mechanisms. Current approaches in literature to collaborative systems design do not offer support for characterizing the target audience, and usually are focused on syntax and semantics of collaborative systems.

This thesis proposes a socio-technical perspective to approach awareness in web-based Inclusive Collaborative Systems (ICS). By ICS we mean computer systems that offer access and maintenance of interaction and communication to the greatest diversity of people without segregating them or making specialized design. For that we proposed the FAware framework to support the design of awareness mechanisms in web-based ICS. The FAware promotes the knowledge of target users, the thinking process about aspects to be taking into account in different types of mechanisms to support awareness, and provides tools for the design and evaluation of web-based ICS. The theoretical and methodological references of this work involved the disciplines of Human-Computer Interaction, Organizational Semiotics, and Collaborative Systems.

To evaluate FAware we conducted two case studies with undergraduate and postgraduate students in Computer Science, accessibility experts, and interaction designers. The first study consisted of evaluating a website for electronic government, while the second aimed at redesigning a synchronous communication tool integrated to an inclusive social network. The results were expressive in relation to the module for evaluation of web-based ICS (first case study), in which even the accessibility experts were able to identify 40% more problems beyond those found using semi-automatic evaluation tools. In addition, the participants of the second case study would adopt FAware also in other contexts of use, and the framework guided the redesign and also promoted their knowledge about the theme.

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# Sumário

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# Lista de Abreviaturas e Siglas

| | |
|---|---|
| AEE | Atendimento Educacional Especializado. |
| ATAG | *Authoring Tools Accessibility Guidelines*. |
| CMC | *Computer-Mediated Communication*, Comunicação Mediada por Computador. |
| CSCL | *Computer-Supported Cooperative Learning*. |
| CSCW | *Computer-Supported Cooperative Work*. |
| CSS | *Cascading Style Sheets*. |
| CSSN | *Computer-Supported Social Network*. |
| DP | *Design* Participativo. |
| DU | *Design* Universal. |
| FAware | *Framework* de apoio ao *design* de mecanismos para suporte a *awareness* em sistemas colaborativos inclusivos. |
| GEM | *Group Elicitation Method*. |
| GUI | *Graphical User Interface*. |
| HCI | *Human-Computer Interaction*. |
| HTML | *Hyper Text Markup Language*. |
| IBGE | Instituto Brasileiro de Geografia e Estatística. |
| ICS | *Inclusive Collaborative System*. |
| ICT | *Information and Communication Technology*. |
| IM | *Instant Messaging*. |
| INAF | Indicador Nacional de Alfabetismo Funcional. |
| IPM | Instituto Paulo Montenegro. |
| ISN | *Inclusive Social Network*. |
| ISO | *International Organization for Standardization*. |
| IU | Interface de Usuário. |
| MEASUR | *Methods for Eliciting, Analyzing and Specifying User Requirements*. |
| NAM | *Norm Articulation Method*. |
| NGO | *Non-Governmental Organization*. |

| | |
|---|---|
| ONG | Organização Não Governamental. |
| OS | *Organizational Semiotics*. |
| OSN | *Online Social Network*. |
| PAM | *Problem Articulation Method*. |
| PD | *Participatory Design*. |
| PHP | *Hypertext Preprocessor*. |
| PL/SQL | *Procedural Language/Structured Query Language.* |
| RSI | Rede Social Inclusiva. |
| RSO | Rede Social *Online*. |
| SAM | *Semantic Articulation Method* ou *Self Assessment Manikin*. |
| SBC | Sociedade Brasileira de Computação. |
| SCI | Sistema Colaborativo Inclusivo. |
| SO | Semiótica Organizacional. |
| SQL | *Structured Query Language.* |
| TIC | Tecnologia de Informação e Comunicação. |
| UAAG | *User Agent Accessibility Guidelines*. |
| UD | *Universal Design*. |
| UI | *User Interface*. |
| UNESCO | *United Nations Educational, Scientific and Cultural Organization*. |
| W3C | *World Wide Web Consortium*. |
| WAI | *Web Accessibility Initiative*. |
| WCAG | *Web Content Accessibility Guidelines*. |
| XHTML | *Extensible Hyper Text Markup Language*. |

# Capítulo 1:

# Introdução

O crescimento da *Web*, estimulado pelo aumento da disponibilidade de acesso à Internet e a redução do custo de Tecnologias de Informação e Comunicação (TICs), vem provocando mudanças significativas na maneira como as pessoas se comunicam, se atualizam, aprendem e se divertem. Um exemplo relevante atualmente é a explosão de sistemas de socialização, como redes sociais, *blogs*, micro-*blogs* e mensageiros instantâneos. Muitas pessoas ainda estão dando os primeiros passos em relação ao uso de TICs, outras já experientes com tecnologias sentem a velocidade da inovação tanto em relação ao conteúdo quanto à maneira como as pessoas se apropriam da *Web*. Assim é necessário que provedores de conteúdo e sistemas para a *Web* criem ou adaptem aplicações que possam ser utilizadas e compreendidas também por toda a diversidade de pessoas que atualmente começa a utilizar a *Web*.

Um aspecto central em ferramentas colaborativas e, em especial as voltadas à socialização e ao entretenimento, é a *awareness*[2] que as pessoas mantêm sobre outras (*e.g.*, identidade, presença e reputação), os objetos, as ações, o contexto e as conversas; quando interagindo em um espaço de trabalho compartilhado entre os usuários, limitado pelo tempo e espaço. A *awareness* propicia o estabelecimento de relações que vão desde trocas diretas de mensagens ao estabelecimento de valores como confiança, privacidade, ética e reputação, seja entre duas pessoas, um grupo ou mesmo em relação ao sistema computacional. Desta maneira, esta pesquisa investigou aspectos de *awareness* em sistemas colaborativos na *Web* que tenham o objetivo de serem utilizados em contextos de grande diversidade entre pessoas e sem segregá-las.

As próximas seções apresentam o tema, objetivo e organização da tese. A seção 1.1 apresenta a motivação e a problemática nas quais este trabalho está inserido. A seção 1.2, o objetivo e a abordagem da pesquisa. A seção 1.3 apresenta a organização do restante da

[2] Este tese utiliza o termo inglês *awareness*, pois suas traduções para o português (*e.g.,* percepção e consciência) remetem a conceitos já empregados em Interação Humano-Computador, mas com outros significados, tais como percepção, relacionada ao Sistema Perceptual Humano (Card *et al.*, 1983).

tese, que é composta de 7 capítulos. Destes, 5 são artigos publicados ou submetidos a congressos e periódicos e que representam a pesquisa realizada.

## *1.1 Motivação e Problemática*

O Brasil é caracterizado por grandes diferenças em sua população, que envolvem aspectos sócio-econômicos, geográficos, de letramento, deficiências físicas, habilidades no uso de TICs, entre outros. Com o forte crescimento do uso da Internet no Brasil – em torno de 110% nos últimos quatro anos (IBGE, 2009) – pessoas com as mais variadas características, interesses e necessidades passaram a acessar a *Web*. Além disso, um estudo realizado pela IBM (2009) projetou que, em 2012, as redes sociais alcançarão 800 milhões de pessoas e que a interação com tais sistemas consumirá cerca de 90% da largura de banda da Internet. No Brasil, o acesso a redes sociais já é responsável por cerca de 15% de todas as visitas à *Web* (Serasa Experian, 2010). No entanto, muitas pessoas ainda enfrentam barreiras que dificultam e que, por vezes, impedem o acesso à informação disponível na *Web*. A parcela da população afetada por essas barreiras é geralmente negligenciada por provedores de conteúdo. A seguir, apresentamos alguns dados que evidenciam a dimensão desse cenário.

**Acesso à Internet**. O Instituto Brasileiro de Geografia e Estatísticas (IBGE) (2009) apontou que, apesar do crescimento do acesso à Internet, em 2009, somente 41,7% da população brasileira tinha acesso à Internet. Em outros países em desenvolvimento como a China e Índia esse cenário é ainda mais crítico. Na China, em 2009, somente 31% da população tinha acesso à Internet e, na Índia, somente 7% (Internet World Stats, 2010).

**Letramento**. O Indicador de Alfabetismo Funcional (INAF), fornecido pelo Instituto Paulo Montenegro (IPM) (2009), apontou que em 2009, 25% da população brasileira entre 15 e 64 anos eram funcionalmente iletrados. Isto significa que essas pessoas não eram capazes de executar tarefas simples que envolvam leitura de palavras e frases. Além disso, o INAF revelou que o analfabetismo aumenta drasticamente com a faixa etária, chegando a 52% quando considerando pessoas entre 50 e 64 anos.

**População idosa**. O aumento da população idosa em decorrência da melhoria da qualidade de vida e da evolução da medicina é um fenômeno mundial. Dados do IBGE de 2009 apontam que o número de pessoas com 60 ou mais anos de idade cresceu 26% na última década.

**Condições econômicas**. O Banco Mundial (2010) apontou que, em 2007, 12,7% da população brasileira vivia abaixo da linha da pobreza (considerando U$ 2/dia)[3]. Em 2005, na Índia este índice era de 75,6% e, na China, 36,3% da população.

**Deficiências físicas**. O último censo demográfico disponibilizado pelo IBGE, em 2000, revelou que 24,6 milhões de brasileiros possuíam algum tipo de deficiência física. No Brasil, o Governo Federal fornece diretrizes e ferramentas para apoiar o desenvolvimento de código *web* acessível. O Decreto nº 5.296 (Brasil, 2004) estabelece que os *websites* governamentais sejam acessíveis. Atualmente, esse objetivo ainda está longe de ser alcançado, mesmo em *websites* com grande número de visitações *e.g.* o da Receita Federal (2010), conforme avaliação de Santana *et al.* (2010); além de não existirem órgãos fiscalizadores.

Consciente deste cenário desafiador, a Sociedade Brasileira de Computação (SBC) realizou em 2006 um seminário que resultou em um conjunto de 5 grandes desafios para a computação no Brasil para os próximos 10 anos[4]. O quarto desses desafios é intitulado "Acesso Participativo e Universal do Cidadão Brasileiro ao Conhecimento". Para abordar este desafio, Baranauskas & de Souza (2006) afirmam que é necessário o conhecimento e o envolvimento do público-alvo, não somente sob a ótica de sistemas computacionais, mas também por abordagens multidisciplinares e amplas que visem o respeito às diferenças das pessoas e incentivem o desenvolvimento de soluções acessíveis a todos.

Tendo em vista a iniciativa da SBC e os dados que indicam o crescente uso de sistemas computacionais para fins não restritos ao ambiente de trabalho – geralmente envolvendo cooperação ou colaboração[5], e não raramente de maneira síncrona –, faz-se necessário o desenvolvimento de sistemas que atendam a toda a diversidade populacional encontrada no contexto brasileiro sem segregação. As abordagens clássicas na área de sistemas colaborativos – inicialmente focadas no trabalho e cunhadas como *Computer-Supported Cooperative Work* (CSCW) –, consideram como usuários os profissionais letrados e com habilidades para interação com TICs. Almeida & Baranauskas (2008b) evidenciaram as lacunas em *frameworks* para CSCW, especialmente as relacionadas a aspectos físicos, empíricos e sociais.

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[3] Para fins de comparação, em 2005 no Brasil, este índice era de 18,3%.

[4] Grandes Desafios da Computação no Brasil 2006-2016. São Paulo, 8 e 9 de maio, 2006.

[5] Nesta tese entende-se por cooperação as situações interativas onde participantes tem um objetivo comum que é alcançado por ações, em objetos menores, conduzidas por cada participante ou subgrupo. Já colaboração também envolve um objetivo comum, mas este é alcançado com atuação em conjunto sobre o mesmo objeto (Dourish & Bellotti, 1992; Salvador *et al.*, 1996; Gutwin & Greenberg, 2002).

A *Awareness* quando tratada em contextos de diversidade torna-se um desafio, pois, além dos aspectos sintáticos e semânticos tratados usualmente nas pesquisas, ainda devem-se considerar características físicas (*e.g.*, periféricos disponíveis), empíricas (*e.g.*, largura de banda, velocidade de atualização das informações), pragmáticas (*e.g.*, as intenções, protocolos sociais compartilhados) e sociais (*e.g.*, o contexto social em que as pessoas estão inseridas). Dessa maneira, é necessário investigar profundamente implicações da diversidade das pessoas na sua interação com sistemas computacionais e maneiras de contribuir para a *awareness* considerando essas características.

## *1.2 Objetivo e Abordagem metodológica*

Entendendo os desafios colocados quando considerados contextos de diversidade de pessoas e o rápido crescimento do acesso à Internet; o foco crescente em sistemas colaborativos com propósitos que vão além do ambiente de trabalho e afetam a maneira como as pessoas reúnem informações, se relacionam e se divertem; e o papel relevante da *awareness* para que as pessoas possam compreender a dinâmica do espaço compartilhado, do contexto e da comunicação em tais sistemas, esta tese tem como objetivo geral:

> "Investigar a *awareness* em sistemas colaborativos na *Web*, e propor soluções para que estes possam prover condições adequadas para o acesso e o uso em contextos de diversidade de pessoas como o Brasileiro."

Nesta tese, sistemas colaborativos na *Web* que provêem pessoas com mecanismos que contribuem para que elas possam ter acesso, utilizar e se comunicar, sem segregação e considerando suas diferenças, são denominados Sistemas Colaborativos Inclusivos (SCI) na *Web*. A integração de tais sistemas viabiliza o estabelecimento de ambientes colaborativos inclusivos, não restritos somente a aspectos técnicos, mas que envolvem, também, o ambiente físico e o social em que as pessoas estão imersas.

Para alcançar o objetivo geral desta pesquisa fez-se necessário buscá-lo em outras atividades da pesquisa:

- Uma revisão de literatura de sistemas colaborativos, *awareness* e de mecanismos para suporte à *awareness* que visou encontrar soluções que possam ser reutilizadas ou adaptadas para o contexto desta pesquisa. Também foi realizado um estudo sobre as contribuições e lacunas dos *frameworks* para *awareness* existentes (apresentado nos Capítulos 2 e 6);

- Identificação de requisitos oriundos da investigação sobre o contexto em que esta pesquisa está inserida (apresentada nos Capítulos 3 e 4) e sobre acessibilidade na *Web*. A participação nos projetos e-Cidadania (2010) e Todos Nós (2010) foi essencial para este propósito. O projeto e-Cidadania teve como objetivo a constituição de cultura mediada por sistema de rede social inclusiva. Nesse projeto, foram realizadas 11 oficinas participativas com representantes da comunidade da Vila União, em Campinas-SP, durante um período de 30 meses. Como resultado principal foi criada a Rede Social Inclusiva (RSI), Vila na Rede (2010). Da participação no projeto Todos Nós foi realizado um estudo sobre diretrizes para conteúdo *web*, sob a ótica do *Design* Universal (Connell *et al.*, 1997), resultados desta participação podem ser encontrados em Santana *et al.* (2008) e no *website* WARAU (2010);
- O desenvolvimento de um *framework* de apoio ao *design* de mecanismos para suporte a *awareness* em SCI na *Web*. Este *framework*, chamado FAware, está disponível na *Web*[6]. O FAware provê funcionalidades que contribuem para a elicitação de requisitos; modelagem e escolha de mecanismos para suporte a *awareness*; além da avaliação de acessibilidade universal para aplicações *web* (apresentada nos Capítulos 5 e 6);
- A proposição de ferramentas colaborativas e mecanismos para suporte a *awareness* utilizando o conhecimento reunido sobre e com o público-alvo e com a interação com o FAware (apresentada nos Capítulos 4 e 6);
- A validação do FAware como ferramenta de apoio ao *design*, por meio de dois estudos de caso (apresentados nos Capítulos 5 e 6). O primeiro estudo de caso consistiu da avaliação do módulo Acessibilidade Universal. Neste estudo, participaram 17 alunos de graduação e pós-graduação em Ciência da Computação e 3 especialistas em acessibilidade na *Web*. O segundo estudo de caso envolveu a avaliação dos módulos para elicitação de requisitos e do módulo para modelagem e seleção de mecanismos para suporte a *awareness*. Participaram do segundo estudo 3 pesquisadores de um projeto que tem por finalidade a constituição de uma RSI para profissionais de Atendimento Educacional Especializado (AEE).

Para a realização desta pesquisa foi adotado como referencial teórico-metodológico a disciplina da Semiótica Organizacional (SO) (Stamper, 1973; 1988), os princípios e

[6] Disponível em: http://eurydice.nied.unicamp.br/FAware. Atualmente o acesso é permitido somente para requisições feitas de dentro do domínio da Unicamp.

diretrizes do *Design* Universal (DU) (Connel *et al.*, 1997; Story *et al.*, 1998) e as técnicas do *Design* Participativo (DP) (Mumford, 1964; Muller, 1997), que permitiram, respectivamente, a compreensão de todo o sistema de informação, incluindo desde aspectos físicos até os sociais estabelecidos e compartilhados pelas pessoas; a proposição de soluções que possam ser utilizadas por toda a diversidade de pessoas, respeitando suas diferenças e sem segregá-las; e o envolvimento das pessoas durante todo o processo de desenvolvimento da pesquisa. Este envolvimento promoveu a participação e a democracia nas decisões tomadas, considerando o público-alvo não somente como meros consumidores de soluções, mas também como co-autores delas.

## *1.3 Organização da Tese*

Esta tese está organizada em sete capítulos. Destes, os Capítulos 2, 3, 4, 5 e 6 são artigos que expressam a pesquisa realizada. As autorizações necessárias para a utilização dos artigos nesta tese podem ser encontradas no Anexo A. Os Capítulos 2, 3 e 4 são artigos completos publicados em congressos nacionais e internacionais, já os Capítulos 5 e 6 são artigos submetidos a periódicos internacionais. O Capítulo 7 apresenta as conclusões e trabalhos futuros oriundos desta pesquisa. Ainda, ao final do texto existem três apêndices, o primeiro é um complemento do Capítulo 5, que apresenta a tabela de unidades de mapeamento entre o *Design* Universal e diretrizes técnicas para acessibilidade na *Web*. O segundo apresenta a relação das demais atividades e publicações realizadas durante o período desta pesquisa. Já o terceiro apresenta aspectos funcionais e de implementação do *framework* FAware.

A Figura 1.1 apresenta a organização e a articulação das contribuições da tese, de maneira a constituir o *framework* FAware. O Capítulo 2 apresenta a Análise Semiótica da Literatura relacionada à *awareness* em sistemas colaborativos, que proporcionou a identificação de lacunas nas abordagens atuais para investigação em *awareness*, um conjunto de requisitos relacionados a *awareness* e um levantamento e classificação de mecanismos para suporte a *awareness*. O estudo relacionado à compreensão dos requisitos para SCI na *Web*, quando considerando contextos de diversidade é apresentado nos Capítulos 3 e 4. Tal estudo envolveu o arcabouço da SO, do DU e do DP, articulados em oficinas participativas, e foi desenvolvido dentro do contexto do projeto e-Cidadania. Para a investigação sobre acessibilidade na *Web*, foi produzido um mapeamento entre diretrizes do DU, diretrizes técnicas de acessibilidade na *Web* (W3C-WCAG) e ergonomia física (ISO 9241). Esse estudo é apresentado no Capítulo 5. O *framework* FAware foi então construído utilizando (indicado por setas pretas e linhas pontilhadas): 1) artefatos da SO, para apoiar a especificação de sistemas de informação, 2) requisitos oriundos das oficinas participativas, convertidos em metadados para indexar a base de

conhecimento do FAware, 3) a classificação dos mecanismos para suporte a *awareness,* que compuseram a base de conhecimnto do FAware e 4) o mapeamento descrito no Capítulo 5, que foi materializado no módulo de avaliação de acessibilidade universal.

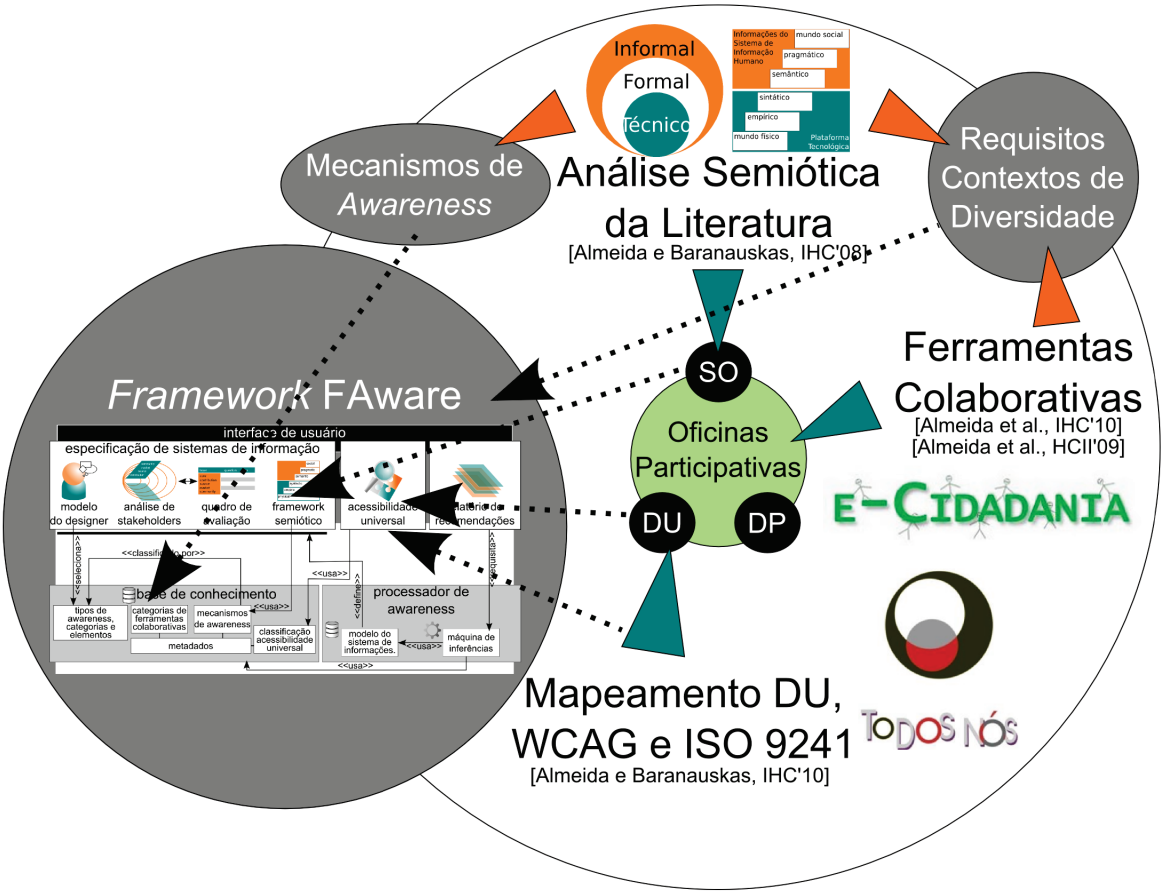


**Figura 1.1. Diagrama da organização da tese**

A seguir é apresentada a descrição de cada artigo utilizado nos capítulos:

> **Capítulo 2**. Um Prospecto de Sistemas Colaborativos: Modelos e *Frameworks* (2008). Leonelo D. A. Almeida e M. Cecília C. Baranauskas. In: Anais Estendidos do VIII Simpósio sobre Fatores Humanos em Sistemas Computacionais, 2008. Porto Alegre: SBC. pp. 204-213.

**Visão Geral e Contribuições**. Este capítulo apresenta uma revisão de literatura de sistemas colaborativos e realiza uma análise baseada em artefatos da SO. O primeiro

artefato utilizado é a Cebola Semiótica, na qual alguns dos principais conceitos envolvidos em sistemas colaborativos foram organizados de maneira a propiciar a compreensão de como eles se relacionam e se influenciam. Por meio desta análise também é possível identificar a complexidade do conceito de *awareness* e a maneira em que ele pode ser tratado em cada camada do artefato (*i.e.* técnico, formal e informal). Com a utilização do segundo artefato, a Escada Semiótica (também chamado de *Framework* Semiótico), foi possível compreender os tipos de signos mais comumente endereçados pelas abordagens correntes. Em conseqüência desta análise identificamos lacunas em relação aos signos relacionados ao mundo físico, empírico e ao mundo social. Assim utilizamos estes resultados para situar o objeto de pesquisa desta tese e o referencial teórico-metodológico mais adequado para abordar *awareness* em SCI na *Web*.

> **Capítulo 3.** *Designing Inclusive Social Networks; A Participatory Approach* (2009). Leonelo D. A. Almeida, Vânia P. A. Neris, Leonardo C. de Miranda, Elaine C. S. Hayashi e M. Cecília C. Baranauskas. In: HCI International, 2009. Lecture Notes in Computer Science - Online Communities and Social Computing. Heidelberg: Springer, v. 5621, pp. 653-662.

**Visão Geral e Contribuições**. Um dos maiores desafios desta pesquisa é o de conhecer o público-alvo, considerando o contexto de diversidade Brasileiro. Para tanto, neste artigo investigamos o uso de técnicas participativas para apoiar a modelagem de um SCI focado em redes sociais, em conjunto com pessoas potencialmente interessadas em tal ferramenta. Este estudo foi realizado dentro do escopo do projeto e-Cidadania e teve a participação de representantes da comunidade-alvo e de pesquisadores. Foram utilizados duas técnicas participativas, o GEM (*Group Eliciting Method*) e o *BrainDraw*. O GEM teve o objetivo de elicitar idéias de funcionalidades para a rede social, enquanto que o *BrainDraw* proporcionou uma maneira colaborativa e democrática para a proposição de soluções de *design* para as idéias elicitadas anteriormente. Idéias relacionadas a *awareness* estiveram presentes em ambas as atividades. Como resultados têm-se a construção de um *wireframe*[7] que representa os elementos que emergiram das atividades participativas, a identificação de aspectos de *awareness* em tais sistemas e a confirmação do *Design* Participativo como referencial relevante para a promoção do envolvimento do

[7] Um guia visual básico utilizado para sugerir *layouts* de elementos fundamentais em uma interface de usuário.

público-alvo de maneira democrática e propiciando o conhecimento de suas reais preferências e necessidades.

> **Capítulo 4.** Conversas *Online: A Synchronous Communication Tool Integrated to Inclusive Social Networks* (2010). Leonelo D. A. Almeida, Elaine C. S. Hayashi, Júlio C. dos Reis, M. Cecília Martins e M. Cecília C. Baranauskas. In: Anais do IX Simpósio de Fatores Humanos em Sistemas Computacionais, 2010. Porto Alegre: SBC, pp.51-60.

**Visão Geral e Contribuições**. Baseado nos resultados obtidos no Capítulo 3 e na retroalimentação advinda de outras práticas participativas do projeto e-Cidadania, realizadas após o lançamento da rede social Vila na Rede, apresentam-se, neste capítulo, a investigação, o desenvolvimento e a avaliação de uma ferramenta de comunicação síncrona integrada à rede social, criada de maneira participativa e apoiada pelo arcabouço da SO. Dessa maneira, foi possível analisar a criação de um SCI utilizando o referencial teórico-metodológico desta pesquisa, além do surgimento de mecanismos de *awareness* para prover suporte à comunicação. Como resultados foi possível analisar a adequação e a demanda por mecanismos de *awareness* em ferramentas de comunicação síncrona, que podem ser considerados críticos devido a fatores como: a) sincronismo, b) contato direto entre pessoas com diferentes contextos, habilidades e intenções, c) quantidade de pessoas presentes na rede social e d) diversidade de periféricos utilizados (*e.g.*, *webcam* e microfone).

> **Capítulo 5.** *Mapping Technical Guidelines for Accessible Web Content into Universal Design Principles: Theory and Practice* (2010). Leonelo D. A. Almeida e M. Cecília C. Baranauskas. Submetido a periódico internacional.

**Visão Geral e Contribuições**. Neste capítulo é apresentado um estudo de caso realizado para avaliar o módulo Acessibilidade Universal do *framework* FAware. O módulo Acessibilidade Universal integra princípios e diretrizes do *Design* Universal com diretrizes para acessibilidade em conteúdo *web*. Dessa maneira, é possível aliar as orientações alinhadas ao mundo real, expressas pelo *Design* Universal, às recomendações técnicas provenientes de organizações como W3C e ISO. Como resultados verificaram-se contribuições significativas aos avaliadores na compreensão, não somente das diretrizes, mas também das razões oriundas do mundo real que as norteiam. Além disso, dados das avaliações registradas no FAware indicam que, mesmo especialistas em acessibilidade,

foram capazes de identificar em algumas páginas 40% mais problemas de acessibilidade em relação à avaliações utilizando somente ferramentas semiautomáticas.

> **Capítulo 6.** *Designing for Awareness of Others in Web-Based Inclusive Collaborative Systems* (2010). Leonelo D. A. Almeida e M. Cecília C. Baranauskas. Submetido a periódico internacional.

**Visão Geral e Contribuições**. Este capítulo apresenta o *framework* FAware, que tem o objetivo de apoiar o *design* de mecanismos para suporte a *awareness* em SCI na *Web*. Inicialmente são apresentados os componentes do *framework* (*i.e.*, Interface de Usuário, Base de Conhecimento e Processador de *Awareness*). O componente Interface de Usuário é organizado em três módulos: Especificação do Sistema de Informação, Acessibilidade Universal (apresentado em detalhes no Capítulo 5) e Relatório de Recomendações. A base de conhecimento é organizada por uma taxonomia baseada em Gutwin & Greenberg (2002). Esta taxonomia classifica mecanismos e conceitos relacionados a *awareness* de acordo com tipos de *awareness* (*i.e.*, de espaço de trabalho, conversacional, contextual), tempo, categoria de ferramentas colaborativas, uma série de elementos (*e.g.* identidade, presença e localização) e perguntas específicas sobre tais elementos e que, potencialmente, são respondidas por mecanismos para suporte a *awareness*. Além disso, FAware possui um conjunto de metadados que auxiliam na compreensão e no *design* de mecanismos. Esses metadados são utilizados tanto no componente "Especificação do Sistema de Informação" como para indexar as referências (*i.e.*, publicações científicas, ferramentas comerciais e *software* livre) da base de conhecimento. Por fim, o "Relatório de Recomendações" do FAware é capaz de fazer recomendações de mecanismos utilizando o componente "Processador de *Awareness*" e considerando o sistema de informação especificado pelo *designer*. Para avaliar os componentes do FAware foi realizado um estudo de caso envolvendo *designers* de um projeto que tem como objetivo a criação de uma rede social para compartilhamento de conhecimento entre professores de Atendimento Educacional Especializado (AEE). O objeto de estudo foi a ferramenta Conversas *Online*, apresentada no Capítulo 4. Dessa maneira foi possível verificar em que medida o FAware pode contribuir para o *design* de mecanismos para suporte a *awareness* mesmo em ferramentas já desenvolvidas com o propósito de serem inclusivas. Resultados indicam que *designers* avaliaram positivamente o FAware e afirmaram que o utilizariam em outros contextos de *design*. Além disso, participantes consideraram o FAware não somente como uma ferramenta de elicitação de requisitos e proponente de recomendações, mas destacaram também seu caráter epistêmico, oriundo do relatório de recomendações (eles desejavam visualizar elementos e questões da taxonomia mesmo

quando o FAware não possui nenhuma recomendação disponível) e dos metadados sugeridos como requisitos.

# Capítulo 2:

# Um Prospecto de Sistemas Colaborativos: Modelos e *Frameworks*

## *2.1 Introdução*

O interesse por sistemas colaborativos iniciou-se há pouco mais de 20 anos quando se passou a entender que o ambiente de trabalho envolve a execução articulada de tarefas por pessoas em grupos (Grudin, 1994). Com sistemas colaborativos, a visão anterior de sistemas computacionais em ambientes de trabalho voltados à chamada "automação de escritório" mudou radicalmente. O novo modelo sugere a possibilidade de equipes distribuídas geograficamente e temporalmente poderem colaborar, mediadas por sistemas colaborativos. Com a popularização da Internet e de dispositivos móveis, novas demandas surgiram em relação ao desenvolvimento de sistemas mais robustos para atender à quantidade de usuários e pesquisas multidisciplinares para compreender toda a diversidade de competências de uso desses sistemas.

Devido ao grande número de propósitos de utilização de sistemas colaborativos, alguns grupos com interesses mais específicos ganharam força nesta área, entre eles: o *Computer-Supported Cooperative Work* (CSCW) que envolve pesquisa para o desenvolvimento de sistemas com foco no trabalho em diversas áreas do conhecimento (Grudin, 1991; Grudin, 1994); o *Computer-Supported Cooperative Learning* (CSCL) voltado principalmente para o desenvolvimento de sistemas com foco no aprendizado (Chan, 2005); o *Computer-Supported Social Networks* (CSSN), que pesquisa sistemas e componentes para redes sociais (Wellman, 1996), entre outros.

Em sistemas colaborativos, vários conceitos existentes em sistemas computacionais tradicionais foram especializados e estendidos para atender às novas demandas, principalmente no que diz respeito à manutenção da comunicação entre usuários. Exemplo de extensões e novos conceitos são: *feedback* compartilhado (Dourish &

Bellotti, 1992) e *awareness* (Gutwin & Greenberg, 2002), respectivamente. Para organizar esse novo conjunto de conceitos e tentar prover suporte ao *design* de sistemas colaborativos, alguns modelos e *frameworks* foram propostos. Neste trabalho apresentamos e situamos contribuições de alguns dos principais modelos conceituais e *frameworks*, entre eles: o modelo de *groupware* de Ellis e Wainer (1994), o modelo Denver, de Salvador *et al.* (1996), o modelo de *awareness* de espaço de trabalho, de Gutwin e Greenberg (2002), os *frameworks* MArq-G* (Barbosa *et al.*, 2005) e Manas (Barbosa, 2006), da Engenharia Semiótica, o *framework* F@ de Tran *et al.* (2006) e o *framework* de suporte a *awareness* BW-M, de Kirsch-Pinheiro *et al.* (2005).

Vários são os fatores que podem comprometer a qualidade de um sistema colaborativo. Grudin (1988) foi um dos primeiros autores a indicar como um dos fatores que influenciam no insucesso de sistemas colaborativos, a disparidade entre quem se beneficia do sistema e quem precisa realizar trabalho extra para manter o sistema. Gutwin & Greenberg (1996, 208) afirmam que "*... as interações em espaços de trabalho virtuais são pobres quando comparadas com seus equivalentes fisicos*"[8] (fazendo alusão aos sinais corporais que observamos durante uma comunicação face-a-face). Tran *et al.* (2006, 462) apontam que "*... um dos fatores para a falta de sucesso é a lacuna entre os frameworks atuais e o processo de design de mecanismos*"[8]. Portanto, investigar os principais conceitos da área e identificar as principais lacunas em modelos e *frameworks* é uma atividade indispensável para guiar a proposição de novos trabalhos, visando melhorar o nível de aceitação de sistemas colaborativos.

Neste trabalho utilizamos artefatos da SO (Stamper, 1973; Liu, 2000) por oferecerem instrumentos para a compreensão de sistemas colaborativos como sistemas de informação não restritos aos níveis formais e técnicos. Na SO, sistemas de informação são considerados produtos das relações entre os níveis técnicos (*e.g.*, aplicações, equipamentos), formais (*e.g.*, métodos, padrões, procedimentos) e informais (*e.g.*, protocolos sociais, comportamentos). A SO considera desde aspectos que envolvem a infra-estrutura física necessária ao funcionamento dos sistemas até questões que tratam dos impactos sociais oriundos da utilização de tais sistemas em um determinado contexto social. Dessa forma, esperamos contribuir com a identificação de lacunas e desafios da área de sistemas colaborativos.

O trabalho está organizado da seguinte forma: apresentação de conceitos fundamentais para sistemas colaborativos; apresentação de modelos e *frameworks* da área; realização de

[8] Tradução livre.

uma análise de conceitos, modelos e *frameworks* por meio dos artefatos da SO e, por fim, apresentação das conclusões do trabalho.

## 2.2 Principais Conceitos em Sistemas Colaborativos

Nesta seção, apresentamos os conceitos estendidos de sistemas computacionais tradicionais propostos para atender às demandas da área de sistemas colaborativos e discutimos alguns fatores externos que influenciam o comportamento de sistemas desta área. Entre os conceitos estendidos abordamos: contexto, *feedback* compartilhado, coordenação, segurança e avaliação; em relação a novos conceitos consideramos: grupo, espaço de trabalho compartilhado, protocolo social interativo, níveis de interação, *awareness* e situação interativa; também analisamos as influências dos fatores externos tempo e espaço na constituição desses sistemas.

Em sistemas colaborativos, "grupo" é definido como "*... uma coleção de pessoas que interagem e colaboram juntas em um espaço de trabalho compartilhado para alcançar objetivos do grupo*"[8] (Tran *et al.*, 2006, 464). Como elementos dessa definição têm-se, portanto, conjunto de pessoas, espaço de trabalho, propósitos e relações. Elmarzouqi *et al.* (2007, 89) acrescentam ainda a "consciência" dos membros do grupo para a "existência" dos outros participantes: "*... um sistema multi-usuário que suporta as ações de grupos de usuários e, em particular a consciência dos outros participantes*"[8].

Dois fatores externos que afetam significativamente sistemas colaborativos são tempo e espaço. Por "tempo" entende-se o momento de utilização de um sistema colaborativo entre seus participantes. O "espaço" refere-se à distribuição geográfica dos usuários de sistemas colaborativos. Embora a medida dos limiares que determinam o que é "próximo" e o que é "distante" geograficamente é dependente de cada instância de sistema colaborativo, a tarefa de auxiliar grupos distribuídos geograficamente é ainda um desafio. Hinds & Martin (2006, 343) comentam que equipes distribuídas geograficamente "*... podem encontrar desafios significativos no estabelecimento e manutenção de redes sociais densas ...*"[8]. Monclar *et al.* (2007) propuseram o Mobile Exchange of Knowledge (MEK), um conceito que refere-se ao compartilhamento de informação feito de forma transparente por meio de dispositivos móveis que se comunicam e trocam informações conforme o nível de afinidade entre os perfis dos usuários próximos geograficamente.

"Espaço de trabalho compartilhado" consiste em um espaço restrito onde pessoas podem ver e manipular objetos relacionados com suas atividades (Gutwin & Greenberg, 2002; Tran *et al.*, 2006). Informações sobre ações e objetos manipulados em um espaço de trabalho compartilhado podem ser propagadas aos demais usuários do grupo de forma explícita (Antunes *et al.*, 2005) ou implícita, esta última chamada de "*feedback* compartilhado" (Dourish & Bellotti, 1992).

Contexto é um dos principais conceitos em sistemas colaborativos, pois permite que usuários tenham informações sobre o grupo de trabalho em que estão inseridos, assim como os objetivos de tal grupo. Dourish & Bellotti (1992, 107) mostram a importância do contexto para grupos afirmando que "*... contexto não é somente o conteúdo de contribuições individuais, mas também sua natureza; sua significância em relação a todo grupo e seus indivíduos*". Ainda em relação a contexto, Borges *et al.* (2005) consideram contexto uma descrição complexa do conhecimento físico, histórico ou outras circunstâncias dentro das quais uma ação ou evento ocorrem. Tanto Rosa *et al.* (2006) como Borges *et al.* (2005) utilizam as cinco categorias de informação propostas inicialmente no modelo Denver (Salvador *et al.*, 1996) para compor as informações contextuais: 1) pessoas e grupos, 2) tarefas agendadas, 3) relacionamento entre pessoas e tarefas, 4) local onde as tarefas ocorrem e 5) tarefas e atividades já concluídas.

Além de serem informados sobre as atividades dos demais membros do grupo, usuários de sistemas colaborativos necessitam estabelecer comunicação, seja por meio de mensagens instantâneas ou videoconferência, em determinados momentos e lugares. Tais cenários são chamados de situações interativas. Para favorecer a comunicação em situações interativas, usuários estabelecem diferentes protocolos de comunicação, dependendo da ferramenta utilizada, sincronia, quantidade de participantes da situação interativa, entre outros; esse protocolo é chamado de "protocolo social interativo" (Salvador *et al.*, 1996, 55-56).

Os níveis de interação em sistemas colaborativos comumente utilizados na literatura são: colaborativo (*i.e.*, todos os membros de um grupo possuem um objetivo comum e trabalham diretamente no mesmo artefato), cooperativo (*i.e.*, os membros de um grupo possuem um objetivo comum que é alcançado por meio de objetivos menores que são executados por subgrupos ou individualmente), misto (*i.e.*, pessoas alternam freqüentemente entre tarefas individuais e colaborativas) (Dourish & Bellotti, 1992; Salvador *et al.*, 1996; Gutwin & Greenberg, 2002) e individual (*i.e.*, quando, apesar de estar utilizando um sistema colaborativo, a pessoa está realizando uma tarefa individual).

Em redes sociais, aqui exemplificadas por *websites* de relacionamento (*e.g.*, Orkut[9], Facebook[10], MySpace[11]), a articulação da atribuição de papéis e a coordenação e execução de atividades é, geralmente, simples ou definida por protocolo social; já as políticas de privacidade e segurança são bastante complexas pois há um grande volume de

[9] Orkut. http://www.orkut.com.

[10] Facebook. http://www.facebook.com.

[11] MySpace. http://www.myspace.com.

pessoas com propósitos distintos. Uma forma bastante aceita de realizar o controle de privacidade e acesso a informações é por meio de atribuições de papéis (*e.g.*, Guzdial *et al.*, 2000) a cada usuário. Alternativamente temos outras metodologias como em Goecks & Mynatt (2004), que propuseram políticas de compartilhamento de informação utilizando o Level of Details (LoD); este consiste na definição de níveis de detalhes, conforme uma medida de proximidade em relação a outros indivíduos.

"*Awareness*" é um dos conceitos mais discutidos atualmente em sistemas colaborativos. Reservar espaço para o estudo de *awareness* durante o desenvolvimento de um sistema colaborativo é um requisito indispensável e um fator determinante para o sucesso do sistema, pois é reconhecido que a *awareness* facilita a colaboração simplificando processos de comunicação e a coordenação (Vivacqua *et al.*, 2006). O conceito é complexo e tem sido definido diferentemente de acordo com mecanismos de comunicação, tempo, espaço, níveis de interação, entre outros. Uma definição bem aceita é a que vem sendo utilizada amplamente pela literatura de CSCW (*e.g.*, Cadiz *et al.*, 2002; Gutwin *et al.*, 2004): "*... a compreensão das atividades dos demais, que provê um contexto para sua própria atividade*" (Dourish & Bellotti, 1992, 107). Jones *et al.* (2004), propõem uma classificação de mecanismos de *awareness* por meio de uma matriz, que compreende interface de usuário (focada em pessoas ou lugares) e sincronismo. Nessa classificação, Jones *et al.*, informam para cada célula a finalidade de mecanismos de *awareness* de localização, quais perguntas tais mecanismos devem responder e quais mecanismos já foram propostos anteriormente para essa finalidade.

A literatura apresenta vários modelos de avaliação de sistemas colaborativos. No entanto, como já apontado por Grudin (1988), avaliar um sistema colaborativo é uma tarefa que demanda considerações diferentes da avaliação de sistemas mono-usuários. A avaliação de sistemas colaborativos requer um processo de acompanhamento da utilização dos sistemas por um período de tempo que varia conforme a complexidade do sistema e das diferentes formas de interação entre as pessoas por ele possibilitadas.

## 2.3 Modelos e Frameworks em Sistemas Colaborativos

A complexidade de fatores presentes em sistemas colaborativos promoveu o interesse pelo estudo de modelos e *frameworks* que pudessem apoiar o desenvolvimento de sistemas colaborativos. No contexto deste trabalho diferenciamos modelos e *frameworks* da seguinte forma:

- Modelos definem de forma organizada os conceitos que estão envolvidos na modelagem de sistemas colaborativos e descrevem como estes conceitos se relacionam;

- *Frameworks* constituem uma representação estruturada dos conceitos propostos em modelos, oferecendo suporte para que *designers* possam instanciá-los conforme as características específicas de um sistema colaborativo, ou seja, são um passo intermediário entre um modelo conceitual e as funções, relacionamentos e objetos que serão construídos.

Para a seleção de modelos e *frameworks* a serem analisados neste trabalho foram considerados como critérios: 1) textos clássicos da área, 2) modelos e *frameworks* que tenham sido publicados na década atual em eventos bem conceituados e 3) a diversidade de foco das propostas (*e.g.*, trabalhos que envolvem *hardware*, *software*, aspectos sociais). A análise conduzida considerou os seguintes modelos: o modelo conceitual de *groupware* de Ellis & Wainer (1994), o modelo Denver, de Salvador *et al.* (1996), o modelo de *awareness* de espaço de trabalho, de Gutwin & Greenberg (2002) e o modelo ACCM de Elmarzouqi *et al.* (2007). Entre os *frameworks* foram considerados: o MArq-G* de Barbosa *et al.* (2005), o F@ de Tran *et al.* (2006), o *framework* de suporte a *awareness* BW-M de Kirsch-Pinheiro *et al.* (2005), o Manas de Barbosa (2006) e o *framework* para grupos auto-geridos de desenvolvimento de aplicações de Vivacqua *et al.* (2006).

O modelo proposto por Ellis & Wainer (1994) possui três componentes: a) o ontológico, que reflete objetos e respectivas operações que podem ser realizadas, b) o de coordenação, que descreve as atividades da aplicação e c) o de interface-usuário, que descreve as diversas visões dos componentes presentes em sistemas colaborativos. Um dos principais objetivos desse modelo é o de caracterizar um sistema colaborativo e, consequentemente, oferecer condições para a comparação entre tais sistemas. Os autores reforçam a ideia de que os componentes descrevem aspectos das aplicações sob o ponto de vista dos usuários, ou seja, aquilo com que usuários podem interagir ou o que os afeta. Aspectos relacionados exclusivamente ao interesse de desenvolvedores não são representados (*e.g.*, linguagem de programação, forma de persistência, entre outros). Ellis & Wainer (1994) definem semântica pretendida, semântica operacional e cenários. A semântica pretendida de um objeto é a descrição do uso que o *designer* pretende que o usuário faça das instâncias desse objeto. Segundo os autores, a semântica pretendida apresenta-se ao usuário por meio de manuais. Semântica operacional é definida como as restrições nas relações possíveis entre objetos no sistema e o conjunto de operações que podem ser aplicadas a esses objetos. As situações de interação são delimitadas por cenários, que retratam os estados dos objetos ativos e atividades a cada instante. Dessa forma, a modelagem de sistemas colaborativos pode ser realizada por meio de fluxos de atividades e cenários. O componente interface-usuário é dividido em três visões: 1) visões

dos objetos de informação, que têm a finalidade de atender às diversas habilidades e necessidades dos usuários, 2) visões dos participantes (*e.g.*, *status*, *background*, preferências, distribuição geográfica) e 3) visões do contexto (*i.e.*, estrutural, social e organizacional).

O modelo Denver (Salvador *et al.*, 2006) também é estruturado em três componentes: a) objetivos e requisitos, b) *design* funcional e c) tecnologia para a implementação do *design*. No componente *design* funcional, sistemas colaborativos são definidos por meio de cinco categorias: 1) pessoas (*e.g.*, nome, aparência, voz, endereços, números de telefone, línguas, assinatura, cultura, negócios, interesses), 2) artefatos (*i.e.*, texto, som, imagem temporal, imagem estática e elementos computacionais), 3) tarefas e atividades (*i.e.*, objetivos, tarefas, atividades e operações sobre artefatos), 4) situações interativas, definidas em cinco eixos (*i.e.*,dependência, localização, tamanho, tempo e sincronismo) e 5) protocolos sociais, também definidos em cinco eixos (*i.e.*, tamanho, formalidade da identificação de participantes, estilo do encontro, controle da interação, nível de contenção, detecção e resolução). Salvador *et al.* (1996) também propuseram um esboço de um método de avaliação de sistemas colaborativos. Para cada requisito (*i.e.*, foco da tarefa, predições precisas da utilização do sistema, baixa demanda cognitiva, *awareness* e aceitabilidade) define-se o espaço de avaliação que é composto por espaço de *design*, procedimento de avaliação e uma sugestão de evidência.

Um dos principais modelos para tratamento do conceito de *awareness* em sistemas colaborativos é o de Gutwin & Greenberg (2002), que propõem uma teoria descritiva para tratar *awareness* de espaço de trabalho. Para tal, eles realizaram uma organização da teoria e conceitos da área com o apoio de uma investigação profunda de referenciais de outras áreas (*e.g.*, psicologia, lingüística, etnografia e pesquisa sobre fatores humanos) que fossem relevantes para *awareness*. Os autores reforçam a importância do conceito enfatizando a relação entre *awareness* e a fluidez e naturalidade da colaboração e consideram que o aprimoramento dos mecanismos de *awareness* favorece a usabilidade de tais sistemas. Gutwin & Greenberg apontam alguns fatores que tornam difícil a tarefa de manter *awareness* de espaço de trabalho:

- Os dispositivos de entrada e saída nos sistemas de colaborativos geram somente uma fração da informação perceptual disponível em uma comunicação face-a-face;
- As ações dos usuários em um espaço de trabalho computacional geram muito menos informações do que as ações em um espaço de trabalho físico;
- Os sistemas colaborativos não apresentam nem mesmo as informações que neles estão disponíveis.

Gutwin & Greenberg utilizam o conceito de *awareness* situacional, que pode ser alcançada por meio de três estágios: 1) percepção dos elementos relevantes do ambiente, 2) compreensão desses elementos e 3) predição dos estados desses elementos em um futuro próximo. A partir dessas definições os autores consideram *awareness* de espaço de trabalho uma especialização de *awareness* situacional, pois *awareness* de espaço de trabalho não atende a *awareness* informal que ocorre ao redor da colaboração. O foco do *awareness* de espaço de trabalho está nos estágios 1 e 2 do *awareness* situacional. A manutenção de *awareness* de espaço de trabalho é representada por meio do modelo cíclico de percepção-ação de Niesser (1976). O modelo é dividido em três partes: na primeira parte são discutidos os tipos de informação que as pessoas mantêm de um espaço de trabalho compartilhado. Os tipos de informação podem ser resumidos em: com QUEM está trabalhando, O QUE eles estão fazendo, ONDE eles estão trabalhando, QUANDO os eventos ocorrem e COMO estes eventos ocorrem. Na segunda parte são apresentadas as formas de obtenção de informação de *awareness* de espaço de trabalho, onde Gutwin & Greenberg identificaram três fontes básicas: 1) corpos das pessoas (comunicação indireta), 2) artefatos do espaço de trabalho e *feedthrough* (*i.e.*, informação das atividades de um membro enviada aos demais) e 3) conversação, gestos e comunicação intencional. A terceira parte representa como as pessoas usam esta informação durante a colaboração; as formas de uso são divididas em cinco atividades:

- Gerenciamento de União - o grau de união dá-se pela quantidade de coisas que uma pessoa pode executar sem a necessidade de colaborar com outras pessoas;
- Simplificação da Comunicação Verbal - referências dêiticas, demonstrações, manifestação, evidência visual;
- Coordenação de Ações – garantia de que ações ocorram em certa ordem, no momento certo e atendendo a restrições;
- Antecipação - ações baseadas em expectativas do que outros usuários irão fazer. Um exemplo é o de uma pessoa com uma tesoura que, provavelmente, vai cortar o papel que vir a segurar e;
- Assistência - de um usuário para o outro, podendo esta ser auxiliada pelo *awareness* de espaço de trabalho, fornecendo informação como: qual o objetivo, qual o estágio da tarefa, qual o estado da área de trabalho.

*Augmented Continuum of Collaboration Model* (ACCM) (Elmarzouqi *et al.*, 2007) é um modelo que estende o modelo de Ellis & Wainer (1994) para cinco componentes: comunicação (*e.g.*, e-mail, transferência de arquivos), co-produção (*e.g.*, editores),

conversação (*e.g.*, mensagens instantâneas, videoconferência, audioconferência), regulamentação (*e.g.*, gerenciamento de perfis) e *awareness* (*e.g.*, ações dos demais usuários, situação de documentos). A partir da extensão dos componentes do modelo de Ellis & Wainer (1994), Elmarzouqi *et al.* propõem a utilização da extensão em um espaço contínuo composto de três camadas, onde a mais interna é a de coordenação, passando pela cooperação até alcançar a camada de colaboração. Com o uso do espaço contínuo é possível representar as diferentes formas de interação em relação ao tempo e ao nível de acoplamento necessário para a execução das tarefas.

O MArq-G* (Barbosa *et al.*, 2005) é um *framework*, construído sob a ótica da Engenharia Semiótica, para suporte ao *design* de sistemas colaborativos. O foco do *framework* está em processos de comunicação e não em tarefas. Uma característica importante do *framework* é o oferecimento de *feedback* não prescritivo (pois *designers* podem justificar suas decisões mesmo quando estas não estejam de acordo com as regras verificadas pelo *framework*) dos impactos das decisões tomadas pelo *designer* em uma atividade de instanciação de sistema colaborativo. Durante levantamento de trabalhos relacionados, Barbosa *et al.* realizaram um estudo comparativo com o modelo conceitual de Ellis & Wainer (1994) e o modelo Denver de Salvador *et al.* (1996). Nesse estudo foi destacada a vantagem do *framework* MArq-G* pela disponibilidade de *feedback* ao *designer*. O *framework* baseia-se no MetaCom-G*, que é um modelo abstrato de metacomunicação. O MetaCom-G* define dimensões comunicativas: hierarquias de grupo, papéis, objetos, perfis comunicativos e modelos de colaboração (*i.e.*, o nível de interação entre os membros de um grupo). O MArq-G* é implementado na linguagem Prolog e é composto por: linguagem de *design* (utilizada para descrever a visão do *designer* em relação ao processo de comunicação do grupo), interpretador de descrição de *design* (que utiliza as regras criadas a partir de psicologia social, teoria da coordenação e trabalhos relacionados sobre sistemas colaborativos) e *design rationale*. Em sua tese de doutorado, Barbosa (2006) propõe o Manas, que é um aprimoramento do MArq-G*, cujo diferencial está no modelo de comunicação. Esse modelo permite uma modelagem detalhada da comunicação e a representação de grupos que não são regidos por relações hierárquicas, tal como se observa em sistemas de redes sociais (*e.g.*, Orkut, Yahoo!Groups[12]).

Tran *et al.* (2006) argumentam que os conceitos apresentados em modelos descritivos como o de Gutwin & Greenberg (2002) sofrem com a falta de precisão e concisão, o que resulta em dificuldade na utilização de tais conceitos no desenvolvimento de mecanismos

[12] Yahoo!Groups. http://groups.yahoo.com/

de *awareness*. Esses autores propõem o F@, composto por dois níveis de formalismo: o abstrato, que trata das classificações de *awareness* (*i.e.*, contextual, conversacional, espaço de trabalho e *auto-awareness*) e o concreto, que descreve o sistema colaborativo em termos de lógica temporal. O F@ representa três componentes para o processo de colaboração em grupo: pessoas, que são membros de um grupo; propósito, que é a finalidade que gera a necessidade da criação de um grupo e espaço de trabalho compartilhado, que é o ambiente virtual compartilhado no qual um grupo colabora. Com relação a *awareness* de espaço de trabalho o F@ considera necessário haver *awareness* em relação à presença de pessoas (*i.e.*, membros passados de um grupo, membros atuais e membros futuros), objetos e atividades das pessoas. Tran *et al.* (2006) apresentam um estudo de caso com uma ferramenta de comunicação instantânea e mostram como a utilização do *framework* auxiliou na identificação da necessidade e no *design* de novos mecanismos de *awareness* para a ferramenta de estudo.

Kirsch-Pinheiro *et al.* (2005) apresentam um *framework* para suporte a *awareness* em sistemas colaborativos para a *Web*, chamado BW-M. Em uma primeira etapa, o *framework* permite o registro dos eventos que serão gerenciados pelo *framework*. Em seguida, cada evento ocorrido no sistema colaborativo é reportado ao *framework* que, no caso do evento estar registrado, armazena-o. Por último, um usuário pode solicitar a qualquer momento ou o sistema colaborativo pode decidir (*e.g.*, por *timeout*) por solicitar informação de *awareness*, então, a informação armazenada é enviada ao usuário. O BW-M também permite o filtro da informação de *awareness* a ser apresentada aos usuários, baseado no contexto em que um usuário se encontra no momento da interação (*e.g.*, no trabalho, no aeroporto, usando um *desktop* ou um *handheld*). É necessário que usuários do sistema colaborativo sejam capazes de definir um conjunto de perfis e situações de interação.

Vivacqua *et al.* (2006) propõem um *framework* para oferecer suporte a grupos auto-geridos, que são aqueles capazes de se coordenar e colaborar, sem a necessidade de coordenação externa ou centralizada, para o desenvolvimento de aplicações. O *framework* inicial é composto por oito categorias de mecanismos de colaboração: comunicação (*e.g.*, e-mail, mensagens instantâneas, fóruns), repositório compartilhado de objetos e trabalho do grupo, mecanismos de negociação, mecanismos para tomada de decisões, ferramentas de planejamento, ferramentas de agendamento, ferramentas para verificação do grupo (*e.g.*, revisão de tarefas, *deadlines*) e mecanismos de *awareness*.

Dada a grande variedade de áreas onde sistemas colaborativos podem ser utilizados e a consequente quantidade de conceitos e disciplinas envolvidos no seu desenvolvimento, faz-se necessário organizar esse arcabouço estabelecendo de forma clara tanto aspectos

técnicos como o impacto social da utilização potencial dos sistemas. Essa organização será apresentada na próxima seção.

## 2.4 Análise Baseada na Semiótica Organizacional

Nesta seção, propomos uma organização dos conceitos modelos e *frameworks* apresentados, investigando o potencial impacto de sistemas colaborativos inspirados neles. Para tanto utilizamos como ferramental os artefatos da SO.

A SO é uma disciplina que explora o uso de signos e seus efeitos em práticas sociais (Liu, 2000). Para este trabalho será adotada a escola Stamperiana para a SO (Stamper, 1973). Esta disciplina conta com diversos artefatos que constituem um ferramental importante na clarificação de sistemas de informação, sendo capazes de representar tanto aspectos físicos como sociais do grupo (ou organização). "*A SO compreende as tarefas internas de uma organização, incluindo seus sistemas de informação e suas interações com o ambiente, objetivando encontrar novos caminhos de análise, descrevendo e explicando a estrutura e o comportamento da organização.*" (Schimiguel *et al.*, 2006, 169).

O primeiro artefato utilizado é a Cebola Semiótica (*Semiotic Onion*, de Stamper, 1993), que permite a representação de sistemas de informação por meio de três camadas onde cada uma ao mesmo tempo em que influenciam também são influenciadas pelas demais:

- Informal (camada externa) - Considera os sistemas de informação como um todo e descreve as interações dos agentes com a comunidade e com o mundo social;
- Formal (camada intermediária) - Corresponde às atividades estruturadas em procedimentos bem definidos;
- Técnico (camada interna) - É a representação de parte dos sistemas formais, geralmente apoiada por máquinas e tecnologias da informação. Seus produtos são oriundos da distribuição de responsabilidades entre os agentes.

A Figura 2.1 representa a instanciação da Cebola Semiótica para o escopo de sistemas colaborativos. Nela, dois recursos gráficos foram utilizados para dar maior poder de expressão ao artefato. O primeiro é a área pontilhada em torno de conceitos presentes em mais de uma das camadas da Cebola Semiótica. O segundo recurso são setas utilizadas para indicar uma relação direta e obrigatória entre conceitos indicados.

A Escada Semiótica (Stamper, 1973, 1993; Liu, 2000) é outro artefato da SO que representa os signos envolvidos em processos comunicativos segundo seis níveis. "*Um signo é alguma coisa que representa algo para alguém em algum contexto ou*

*capacidade, em alguma comunidade ou contexto social.*" (Stamper, 1993, 4). Além das três camadas tradicionais (*i.e.*, sintática, semântica e pragmática) da Semiótica Peirceana, foram adicionadas outras três camadas (*i.e.*, mundo físico, empírico e social) (Stamper, 1993), assim brevemente descritas:

- Mundo físico - meio nos quais os signos são materializados e os dispositivos para transmiti-los;
- Empírico - propriedades estatísticas dos conjuntos de signos;
- Sintático - foco em estruturas complexas, independentemente do que é representado em instâncias de signos;
- Semântico - relação entre signos e o que eles representam;
- Pragmático - propósito no uso dos signos;
- Social - impacto que o uso dos signos tem no mundo social.

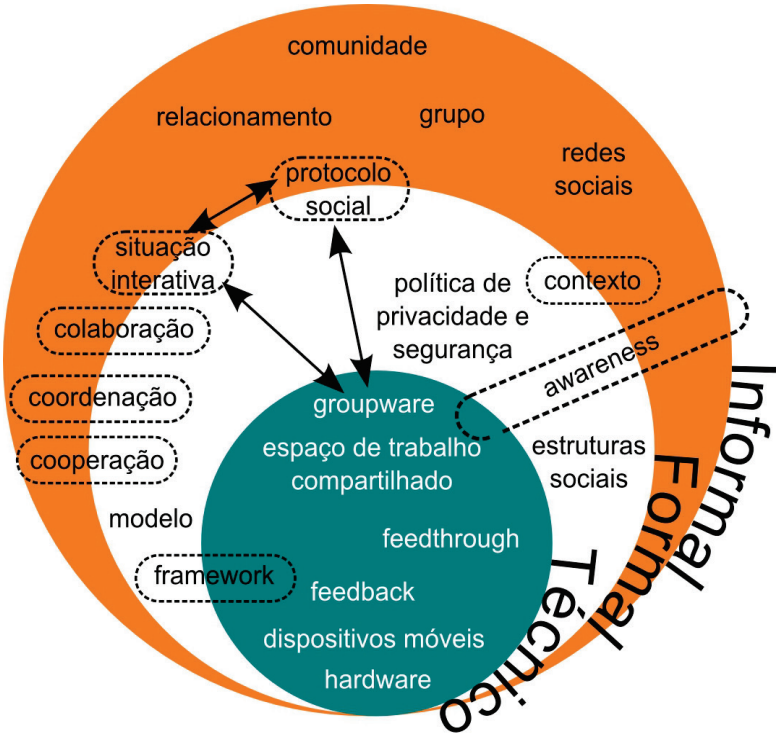


**Figura 2.1. Instanciação da Cebola Semiótica para sistemas colaborativos.**

A Figura 2.2 representa a instanciação da Escada Semiótica segundo os conceitos e requisitos analisados sobre sistemas colaborativos. Para o contexto de sistemas

colaborativos, a camada do mundo físico engloba os signos que representam artefatos físicos que integram sistemas colaborativos, tais como computadores, dispositivos móveis, conexões com internet ou intranet, sejam elas por cabeamento ou sem fio e quaisquer outros periféricos que possam ser utilizados para dar suporte à colaboração.

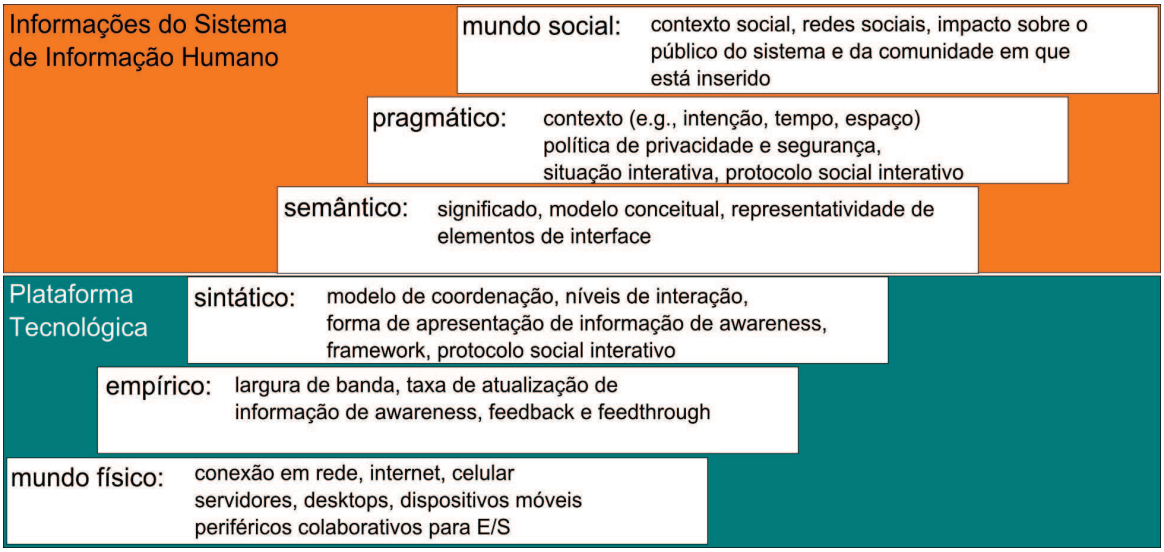


**Figura 2.2. Instanciação da Escada Semiótica para sistemas colaborativos.**

Na camada empírica não há uma preocupação com as características físicas dos signos, mas sim com cadeias de signos. Um exemplo disso é o signo "conexão de internet" presente na camada física e que, na camada empírica leva o foco de atenção para a taxa de transmissão de dados por essa conexão, ou seja, a largura de banda. Além disso, mais especificamente para sistemas colaborativos há a preocupação com taxas de atualização de informações de *feedthrough* e de *awareness*, taxas estas que podem variar conforme o usuário e contexto de uso.

Sistemas colaborativos são mediadores de relacionamentos entre usuários que possivelmente podem estar distribuídos geograficamente e que podem nem mesmo se conhecer pessoalmente. Portanto, é importante a existência de um modelo sintático bem definido, de forma a reduzir as barreiras que usuários encontram na comunicação mediada por computador. Exemplos de signos pertencentes a camada sintática são protocolos sociais interativos, modelos de coordenação e suporte a diferentes níveis de interação.

Além de oferecer uma sintaxe apropriada para a interação, sistemas colaborativos devem oferecer signos que reduzam a distância semântica dos conceitos ou objetos representados, facilitando a exploração dos recursos do sistema. Trata-se do degrau da semântica na Escada Semiótica.

Considerando a significativa diversidade de áreas nas quais sistemas colaborativos podem ser utilizados não é trivial a compreensão do uso pretendido de sistemas colaborativos e seus componentes. A camada pragmática oferece signos que contribuem para a clarificação das intenções de uso de sistemas colaborativos. Em sistemas colaborativos, contexto e política de privacidade são alguns dos signos mais relevantes neste nível da Escada Semiótica.

A camada superior da Escada Semiótica, o mundo social, deve refletir os impactos dos sistemas colaborativos na comunidade de usuários que os utilizam. Para tanto, é necessário conhecer o contexto social dos grupos, as redes sociais que envolvem tais grupos, seus compromissos e responsabilidades, suas crenças, elementos da cultura.

A partir da instanciação da Escada Semiótica propomos uma organização dos trabalhos analisados sobre *frameworks* e modelos, que é apresentada na Figura 2.3. Nessa Figura estão representadas no eixo vertical as camadas da Escada Semiótica e, no eixo horizontal as contribuições dos *frameworks* e modelos, organizados segundo o tempo de sua criação.

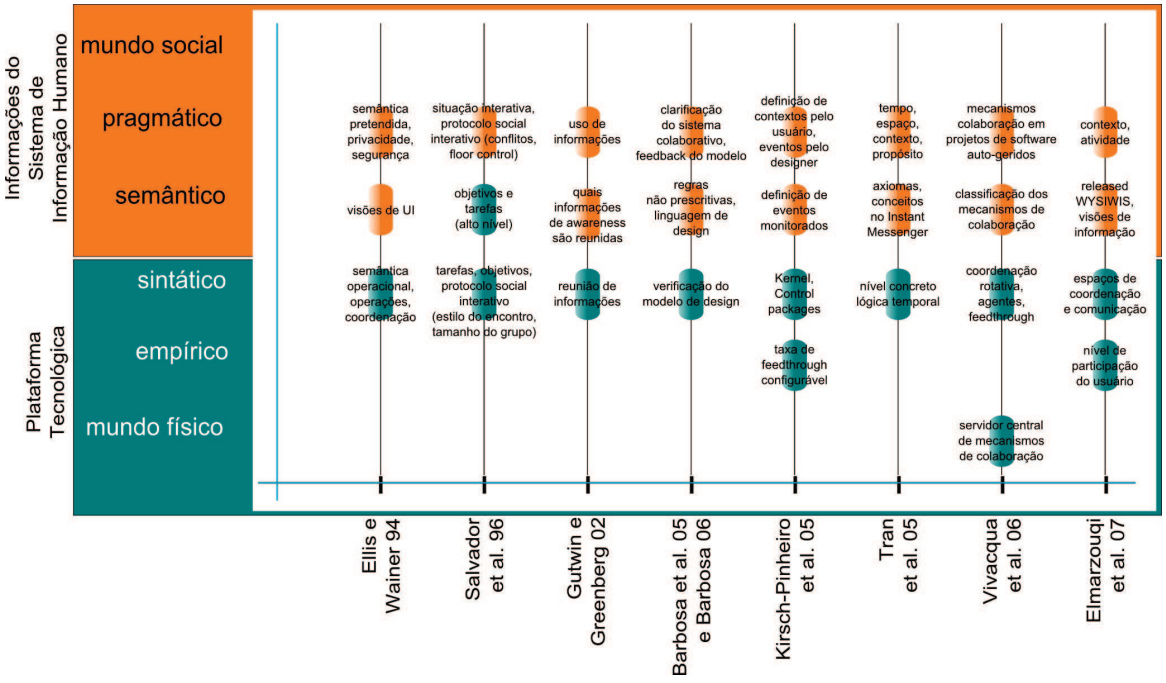


**Figura 2.3.Organização dos modelos e *frameworks* de acordo com a instanciação da Escada Semiótica.**

## *2.5 Discussão*

Nesta seção propusemos a organização dos conceitos da área de sistemas colaborativos com o objetivo de clarificar quais são os temas centrais para a área e quais as lacunas de

pesquisa que podem ser exploradas. Para tanto, utilizamos dois artefatos da SO, a Cebola Semiótica e a Escada Semiótica. Com a utilização da Cebola Semiótica foi possível situar os conceitos relacionados a sistemas colaborativos de acordo com seu nível de formalismo. O recurso de áreas pontilhadas envolvendo elementos que pertencem a mais de um dos níveis do artefato foi utilizado para destacar estes elementos que, de acordo com o observado nas últimas conferências da área de CSCW, são alguns dos temas mais pesquisados. Vale observar que cinco dos seis elementos destacados estão situados entre a camada formal e informal. Isto, de certo modo, reflete a questão da multidisciplinaridade da área de CSCW, explorada desde sua proposta inicial. Um dos elementos destacados representa o conceito de *awareness,* presente em todos os níveis da Cebola Semiótica, o que é coerente com as diversas definições do conceito sob diversos pontos de vistas e contextos de uso.

A partir da instanciação da Escada Semiótica realizamos a organização dos *frameworks* e modelos conceituais, sendo alguns deles específicos para *awareness* em sistemas colaborativos (Gutwin & Greenberg, 2002; Elmarzouqi *et al.*, 2007; Kirsch-Pinheiro *et al.*, 2005) e outros que abordam sistemas colaborativos como um todo (*i.e.*, Ellis & Wainer, 1994; Salvador *et al.*, 1996; Barbosa *et al.*, 2005; Barbosa, 2006; Tran *et al.*, 2006; Vivacqua *et al.*, 2006). A atividade de instanciação da Escada Semiótica para o contexto de sistemas colaborativos mostrou que os trabalhos analisados em seu conjunto cobrem, de forma geral, as camadas da Escada Semiótica correspondentes às propostas pela Semiótica Peirceana (*i.e.*, sintática, semântica e pragmática) em contraste com as camadas propostas por Stamper (*i.e.*, mundo físico, empírico e mundo social). Esse resultado sugere a necessidade de extensão de *frameworks* e modelos de forma a alcançar os demais níveis da Escada Semiótica. Por exemplo, o mundo físico e o empírico, são cada vez mais relevantes em cenários de dispositivos móveis e interoperabilidade entre sistemas utilizados em plataformas diferentes e considerações da camada do mundo social (*e.g.*, códigos de conduta, compromissos e responsabilidades) são necessários em contextos de sistemas colaborativos cada vez mais utilizados para representar os sistemas de informação de uma sociedade.

Resultados desta análise sugerem a necessidade de uma abordagem mais ampla a sistemas colaborativos, compreendendo não somente um subconjunto das camadas componentes de sistemas de informação, mas a compreensão dos requisitos e impactos de tais sistemas oriundos desde aspectos técnicos até de regras que regem a sociedades afetadas e que, também, afetam tais sistemas.

Um exemplo contemporâneo da necessidade de uma abordagem a sistemas colaborativos como sistemas de informação é a análise dos sistemas produzidos usando o MediaWiki[13]. A Wikipedia[14], uma enciclopédia na *Web* que permite a construção colaborativa de seu conteúdo e que, só na língua inglesa, conta com mais de 2,5 milhões de artigos, foi produzida a partir da tecnologia MediaWiki. A partir do sucesso da Wikipedia centenas de outros sistemas desse gênero foram propostos usando o MediaWiki, alguns muito parecidos e outros trazendo inovações tecnológicas em relação à Wikipedia. Entretanto a incidência de insucesso de tais sistemas é muito grande. A pergunta que se faz em relação a esse cenário é: Como sistemas produzidos com a mesma infra-estrutura tecnológica podem ter uma diferença tão grande em relação à aceitação do público? Acreditamos que a resposta esteja na compreensão do sistema de informação que proporcionou a Wikipedia ao invés de uma análise puramente técnica ou apenas social.

## *2.6 Considerações Finais*

Neste trabalho realizamos uma revisão da literatura da área de sistemas colaborativos envolvendo publicações da última década das principais conferências da área, alguns textos clássicos e a diversidade de foco das contribuições. Inicialmente apresentamos os principais conceitos, nos quais foi possível apontar algumas das inovações trazidas pela área em relação aos demais tipos de sistemas computacionais. Em seguida foram apresentados alguns modelos e *frameworks* que visam oferecer apoio ao desenvolvimento e manutenção de sistemas colaborativos, sendo alguns deles com foco mais específico e outros que visam oferecer apoio à concepção de toda a arquitetura de um sistema colaborativo. A partir da revisão propusemos, por meio dos artefatos da Semiótica Organizacional: uma organização de conceitos com a Cebola Semiótica, uma classificação dos conceitos, sob a ótica de signos, utilizando a Escada Semiótica e uma classificação dos modelos e *frameworks* analisados, segundo a instanciação da Escada Semiótica.

Com a instanciação da Cebola Semiótica pudemos identificar os conceitos potencialmente mais impactantes da área (*e.g.*, *awareness*). Apesar da grande quantidade de pesquisas que utilizam estudos de casos para realizar a validação das propostas de sistemas colaborativos e de mecanismos de *awareness* ainda pouco se discute em relação a sistemas colaborativos como meio de transformação social. Também não foram identificados trabalhos que se dirijam à proporcionar condições de interação levando em

[13] MediaWiki. http://www.mediawiki.org/.

[14] Wikipedia. http://www.mediawiki.org/.

consideração a diversidade populacional como a encontrada em países como Brasil, China e Índia. Nos trabalhos analisados, testes geralmente são realizados com usuários já familiarizados com o mundo digital.

A partir deste trabalho pudemos observar lacunas que podem orientar novas pesquisas na área de sistemas colaborativos. Ainda existe uma demanda significativa para *frameworks* e modelos que tratem questões como a arquitetura física dos sistemas colaborativos, as taxas necessárias de troca de informações para usuários interagirem de forma adequada e os impactos que determinadas configurações de sistemas colaborativos podem causar na sociedade. Essa demanda é significativa, especialmente considerando o potencial de crescimento da utilização de sistemas colaborativos, não se limitando ao acesso exclusivo por computadores e periféricos tradicionais, mas também considerando o rápido crescimento da utilização de dispositivos móveis (*e.g.*, celulares, *handhelds*), ferramentas assistivas para pessoas com algum tipo de deficiências e periféricos especializados em colaboração (*e.g.*, iPencil (Guo *et al.*, 2007)).

Também há a necessidade de modelos e *frameworks* que contemplem as diferentes necessidades e competências dos usuários. Apesar de usuários com deficiências físicas contarem com ferramentas assistivas, tais como, leitores e ampliadores de telas, ainda existem diversas outras deficiências (*e.g.*, baixo letramento, deficiência cognitiva) que poderiam ser tratadas com a personalização dos sistemas colaborativos. Conseqüentemente, teríamos maiores condições de desenvolver sistemas colaborativos com propósitos sociais. Estas questões estão sendo consideradas em continuidade a este trabalho.

# Capítulo 3:

# Designing Inclusive Social Networks: A Participatory Approach

## *3.1 Introduction*

Brazil, as other developing countries, is characterized by vast differences with regard to socio-economics, culture, geographical region as well as access to technology and knowledge. Social indicators presented by the Committee of Entities Combating Hunger and for Life (COEP[15] in its Portuguese acronym) show that in 2003, 34% of the population lived below the poverty line. Furthermore, approximately 26% of the population is functionally illiterate[16], whereas functional illiteracy is defined by an age of 15 or higher and less than 4 years of formal education. Moreover, the last census of 2000 found that 14.5% of the population has impairments[17]. In this scenario, Information and Communication Technology, especially hypermedia systems, has the potential of benefiting citizens, allowing access to knowledge, communication and collaboration, and thus promoting the process of the constitution of a fairer society.

For this purpose, it is necessary to investigate how to design systems that consider the diversity of users taking the digitally excluded into account. Although there are many online social networks developed to aid people in activities of communication and cooperation, they were not built for diversity. They do not address access to people with different interaction abilities, including inexpert users, elderly, illiterates, people with disabilities and others. A review about fourteen current systems to support social

[15] COEP. http://www.coepbrasil.org.br. Last census available.

[16] MEC. http://portal.mec.gov.br.

[17] MJ. http://mj.gov.br.

networks shows that the resources that social networks put available today are not enough to allow access to the variety of users cited above (Almeida *et al.*, 2008a).

Social networks provide resources for maintaining social relationships, for finding users concomitant interests, and for sharing content and knowledge that has been contributed or endorsed by other users (Mislove *et al.*, 2007). When a social network enables every person to integrate a group which is able to interact under a social protocol and a set of rules to promote the sharing of goods and subjects obtained through production and mobilization within these groups, it is called an Inclusive Social Network (ISN) (Hayashi *et al.*, 2008). ISN can be especially useful in contexts of expressive disparity among people due its capacity to provide conditions of use despite of physical, social, economics or cognitive conditions.

Facing the challenge of developing an ISN that could be used by Brazilian citizens, taking into account their different needs and interaction abilities, this work presents a discussion about some relevant design issues and the participatory process used to elicit them. The approach is based on concepts of Universal Design (Trace, 2008) or Design for All and uses techniques from Participatory Design (Schuler & Namioka, 1993) to support an exploratory design process. The process starts with the elicitation of the different "views" (from the community, designers and developers) about systems to support ISNs, passes through design concepts and gets to an interface proposal that materializes the design solutions.

This paper is organized as follows: Section 3.2 presents the theoretical and methodological references and describes the applied techniques; Section 3.3 presents our approach to the design of ISNs; Section 3.4 points out some design issues that demand extra studies; Section 3.5 presents our final considerations.

## *3.2 Theoretical and Methodological References*

The design of "Interfaces for All" aims at addressing efficiently and effectively the various interaction problems arising from different user abilities (Stephanidis, 2001). According to Stephanidis, the underlying principle is to ensure, during the design process, that the needs of elderly and people with disabilities are considered. To that end, it is important that these needs are known since the early stages of product and service design. This approach reduces the need for "a posteriori" adjustments and makes it possible to offer products that meet the demands of end users in the population.

Design for All means designing interfaces enabling access to users with diverse competencies in the population in a non-discriminatory way; this means to offer the possibility of interaction and access to the content in ways that make sense for people considering their different interaction abilities.

The development of Interfaces for All is still a challenge as design problems persist even if we consider some particular users groups (cf. Neris *et al.*, 2008). In some cases, only the use of assistive technologies (such as screen readers or automatic translators) and adherence to the recommendations of accessibility found in the literature are not sufficient for the effective interaction of these users (Melo & Baranauskas, 2006a). Melo & Baranauskas show the need to bring these people into the design process to understand their needs and to design with and for them.

The PD approach has its origin in the promotion of the participation of workers and syndicates in the decision making processes related to development of new technologies for workplaces in the Scandinavia of the early 1970s (Schuler & Namioka, 2003). PD proposes effective users involvement throughout the software lifecycle promoting benefits such as mutual learning between designer and user; leverage of comprehension of users characteristics, preferences and needs; and the democratic design of technologies (Muller *et al.*, 1997).

In order to guide designers in choosing participatory practices to be employed along the software lifecycle development, Muller *et al.* (1997) proposed a taxonomy of 61 participatory techniques. Two of these techniques are Group Elicitation Method (GEM) and BrainDraw. Within the GEM, participants write a design idea on paper and circulate to the next participant of the group. Upon receiving the ideas of another participant, each one has a short time (for about two minutes) to agree, disagree or put a new point of view. This phase continues until all participants have seen the ideas of the other participants at least once. In the BrainDraw, each participant starts a drawing in one sheet of paper (considering a defined interaction situation) and after a short time (for about a minute) every participant circulates the paper among the other participants. The short time to draw guarantees that no one will be able to finish a complete idea in their sketches, so that the final artifacts will be a mixture of ideas of everyone. Each design is unique because it has a different beginning.

## *3.3 Applying PD in the Context of ISNs*

The development of a system to support ISNs demands a participatory and inclusive approach, as described in the following sections.

### 3.3.1 Eliciting Design Concepts

A group of eight people - considering target community representatives and researchers with different focus such as design, development and media - was invited for the GEM activity. They were asked to write one design idea related to ISNs (*e.g.* allow collaborative edition, show interconnections in the network of adds and people,

construction of a reputation system) and then pass the sheet to the next participant. After the round, the participants were asked to highlight the main concepts they found in their sheets. These concepts were then announced to the others and written down on a whiteboard. Connections between the concepts were draw and as a result, we obtained a conceptual map. We decided to use the conceptual map because it allowed us to correlate the contributions of each participant's main words (concepts) while discussing their meanings and relative importance. The importance of the concepts was determined considering the number of times the concepts appeared in the sheets of paper to the design situation.

Considering the relative importance of the concepts, we categorized them into five groups, being group A the one with the most important concepts. The groups and their concepts are shown in Table 3.1.

**Table 3.1. Main concepts divided into five groups.**

| Group | Concepts |
|---|---|
| A | Identity and identification, tailoring, privacy, reputation, coordination model |
| B | Different media, various needs of use, diverse interest groups |
| C | Awareness, means of representation and expression (*e.g.*, pictures, avatar, videos) |
| D | Features (calendar, instant messenger, sharable areas, collaborative edition, forums, idea links, groups, visibility, people) |
| E | Physical (real) center (TeleCenter) |

From the groups inTable 3.1, it is possible to realize that concepts such as identity, tailoring, privacy, awareness are more important for the participants than the tools/features themselves. This point out the need to make the system accessible independently of the communication tools it will present. Also, it is important to reinforce that the physical center was mentioned showing the importance of the public spaces in the context of ISNs. As many users do not have computers with Internet access at home, they need to use the services of a Telecenter. This also brings important issues for the design regarding environmental and personal constraints.

The concepts obtained with the GEM composed the basis for the scenario created for the next activity, the BrainDraw, which is described next.

### 3.3.2 Gathering Design Elements

Once we had the concepts (Table 3.1) elicited during the GEM, we proceeded to the application of the BrainDraw technique. This time, a group of 22 people took part of the activity, among them researchers, community leaders and end users. Among the users were people who have little or no contact with computers and the Internet.

Due to the size of the group, it was divided into five smaller groups and, inside each group, the BrainDraw technique was applied. For the generation of design proposals' phase it was described a scenario of use. This scenario, translated below, was read to the whole group and a projection stayed on the wall during the activity.

"*You are in front of the computer. In the screen, you see the website from the Inclusive Social Network that you are a member of. You see an advertisement (a product, service, social event or an idea) that you are interested in. You notice that the person who put the advertisement is present in that moment in that website. You get in touch with that person and immediately you ask that person something about the advertisement. The person answers your question. That makes you feel satisfied with that website and you keep browsing there...*"

As we would like to gather design elements that could represent the concepts obtained with the GEM, the scenario proposed included elements associated with awareness (*you notice the person is present, you get in touch*). Also the proposal of the advertisement can consider questions related to reputation and privacy. Further, the coordination model (*you are a member*), different media and communication (*you ask something*) among others were considered.

In addition to the BrainDraw technique proposed in Muller *et al.* (1997) we performed another two phases after the generation of design proposals: discussion within the group to generate a consolidated design proposal with best accepted ideas from the design proposals; and the exposition and discussion of the consolidated design proposals among all the participants. Figure 3.1 presents two of the five groups' consolidations. From this example it is possible to verify the diversity of ideas as the menu style, categorization of advertisements, presence indicator, and others.

With the drawings obtained from the consolidation phase and the subsequent presentation and discussion of those consolidations we conducted an analysis of the design elements. In the first stage of the analysis we identified the variation in presentation style, number of occurrences and localization in the screen. A brief summary is presented in Table 3.2.

From the analysis considering the presence or position of design elements, we can highlight some important findings to understand the community's context:

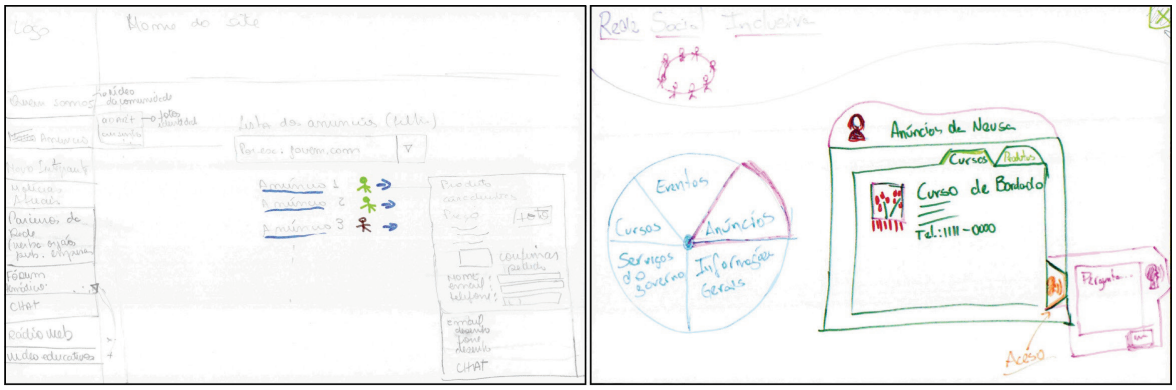


**Figure 3.1. Examples of the consolidations of the groups' design proposals.**

**Advertisements**. Four of the five consolidations proposed categories for the advertisements and different manners to represent them (menu, selection box). Again, 4 consolidations considered to present the advertisements of a specific category in some kind of list (tabs, sequential list, previous/next buttons). Finally, all the consolidations proposed the full visualization of just one advertisement at a time;

**Website sponsors**. Despite having appeared only once, the sponsors' area was well accepted by all during the presentation and discussion phase. This emphasizes the care about the sustainability of the website;

**Communication mechanisms**. Due to the scenario of use every consolidation presented communication mechanisms. The best ranked where telephone and chat. We believe this represents the lack of participants' experience with computers. People not experienced with computers suggested mechanisms of their daily life;

**Multimedia in advertisements**. We identified the frequent use of images while no other media was used to illustrate advertisements.

More than the syntactic aspects, referencing the presence and position of design elements, the drawings allow an analysis considering also semantics, pragmatics and social aspects of the design.

Semantics aspects are related to the meaning of the interface elements for the community. All the groups used different colors to signalize the presence or absence of a contact. However, G1 showed the status of the advertiser even before the announcement details. This signalizes the importance that this group places on awareness. Also, G2 used a large picture of a community personage in the main page. During the discussion, they emphasized that it represents an interactive character that would present the community.

G3 drew a logo in which a group of people are in circle with their hands attached, what shows the meaning of an ISN for them.

**Table 3.2. Detailed individual analysis of the design elements from the groups' consolidation.**

| Element | | Nr of Times | Place | Media |
|---|---|---|---|---|
| Navigation menu | | 5/5 | Left side (3/5) | Sequential vertical text (3/5) |
| Site's name | | 5/5 | Top (4/5) | Text (4/5) |
| Logo | | 3/5 | Left top (3/3) | Picture (3/3) |
| Communication mechanisms | Chat | 3/5 | Right side (2/3) | Text (3/3) |
| | Phone | 4/5 | Near the description of the advertisement (3/4) | Text (4/4) |
| | E-mail | 1/5 | Near the description of the advertisement (1/1) | Text (1/1) |
| | SMS | 1/5 | | |
| | Message via site | 1/5 | | |
| | Forum | 1/5 | Navigation menu (1/1) | Text (1/1) |
| Presence indication of online users | | 1/5 | Left bottom (1/1) | Picture (1/1) |
| Advertisement | Various types of media | 5/5 | All five were different | Text and picture (5/5) |
| | Navigation | 3/5 | All three were different | Arrows pointing right (next) and left (previous) advertisement (2/3) |
| | Presence indication of the advertiser | 5/5 | Near the advertisement (4/5) | Picture (3/4) |

Pragmatics aspects are related to the intentions behind the design, considering which type of communication and negotiation the interface provides. From the menu items that appeared in the drawings (*e.g.* net partners, school's projects, animals donation, among others) it is possible to realize which information the community intends to share using the system. Furthermore, G1's advertisement considers interface elements that allow the

confirmation of an order, representing the seriousness in the relationship between the advertiser and the interested person. Another important aspect regarding the participants' intentions with the system is the disclosure of the community, *i.e.* the group of people that shares the social network. It appeared in different ways, *e.g.* G1 proposes videos about the community, G2 proposed the personage to present the community, G4 showed pictures of the neighborhood.

Social aspects are related to the effects of the system use and their impact in society. They include those related to commitments, beliefs, and culture. In this sense, education was the main aspect pointed out in most of the drawings. The educational impacts of an ISN where emphasized by participants during the discussion phase and appeared in the drawing in different ways. G1 presented a link in the menu for educational videos. Also, they added a link for a web radio with educational purposes. G2 presented announcements for supporting classes. G3 presented announcements for courses. G5 presented links in the menu for education and social events (concepts). Also, they linked educational videos in some announcements, *e.g.* "learn how to recycle your trash" linked with an announcement of a returnable bag. The analysis of the consolidated drawings shows that the use of a participatory technique supports the design team with important information considering diverse aspects of the interaction with ISN systems. The results of the analysis were then considered in the proposal of a first approach for the design, as shown in next section.

### 3.3.3 Materializing Design Ideas

In this section we present how concepts, design elements, semantics, pragmatics and social aspects of the design, elicited from the participatory activities, were addressed in an ISN system prototype (Vila na Rede. available at http://www.vilanarede.org.br). Figure 3.2 presents the wireframe complemented by some clipping from the prototype.

The header is composed of three subareas: logo and website's name, random advertisement's images and accessibility resources. These subareas address relevant concepts raised in the GEM activity such as: identity and identification; visibility; and various needs for access. Moreover, the logo and website's name area appeared in every consolidation of the BrainDraw activity. We adapted a proposal that appeared in BrainDraw that was a top bar displaying images of the local community, to join user identification with the visibility of his/her content, as illustrated in the random advertisement's area. At the right side of header there are some accessibility resources such as font size, contrast, and skip links. Despite of this specific area, accessibility is considered transversal to every interface element as pointed out in GEM. The footer contains the sponsors' area as presented in section 3.3.2.


**Figure 3.2. Mapping concepts and ideas from GEM and Braindraw to an ISN system design proposal.**

In the left column there are two subareas: navigation and users' presence indicator. The navigation area situates the menus. The ISN proposed implements two kinds of menu - based on the BrainDraw results - a sequential and a circular. Both of them are supposed to be universally accessible and available at any time according to users' preference. Just below the navigation are located the users' presence indicator. This area presents a list of online users and their status (*e.g.*, available, away, occupied).

The column on the right was brought by the designers who identified its need. The context in which *Vila na Rede* is immersed calls for a Meta-Communication area, aiding especially the digitally illiterate in the interaction with the system. This region should display a mechanism, *e.g.* an avatar, which will contain online help in diverse formats. For this same column, a tool to group participants' opinions was thought as a way to allow the community to express its view as a collective whole. These opinion polls would address a different topic each month and display the results.

Both the GEM and the BrainDraw technique highlighted the demand for multimedia content, which was provided in the central area, furnishing the advertisement feature with audio-visual material. The designers complemented this idea adding the possibility of having Libras[18] - besides the text, image, sound and video - to be used in the advertisement. In order to navigate through the ads, different formats came up in the drawings, like horizontal arrows, tabs and dropdown menu. A horizontal navigation bar

[18] LIBRAS - Portuguese acronym for Brazilian Signal Language.

was adopted and thumbnails will be used to help this task. Besides these features, others are going to be included, that will help users to identify other's presence and broaden the possibilities of communication (*e.g.* instant messaging, text message to cell phone), which came from the GEM concepts. Other challenging design issues are discussed in next section.

## *3.4 Discussion on Design Issues*

The use of participatory techniques throughout the design process of ISNs enabled the identification of design issues to be overcome so these systems can be effectively used by all. Thus, issues regarding tailoring, privacy and security, reputation, coordination model, awareness, meta-communication and physical place should be considered.

Tailoring is the activity of modifying a computer application within the context of its use. By using tailorable applications, communities and the users themselves could adapt and maintain the system according to individual and collective interaction requirements. Regarding tailoring, it is still necessary to investigate how to model the different interaction needs in such a way that they can be managed and supported by a software application. Further, how to present the possibilities of tailoring in the interface, in a way that makes sense for all users especially for those that are novice in the use of computers, still need to be addressed.

Concerning privacy and security, more specifically the user authentication method, the usual options are password, predefined questions, biometry, and images. In the context of ISN, it is important to provide more than one authentication method due to the diversity of possible functional restrictions. At *Vila na Rede*, we are evaluating the use of password and also login through images.

As in real life, when people interact through an ISN system they usually want to know if they can trust in the person (or group) they are interacting to. However, to determine reputation is a very critical activity because of impacts in how a person feels in relation to others and how people choose who they want to interact. Therefore it is necessary to think about metrics and strategies to assign or deliberate on a certain reputation and how they will evolve through the time.

On the subject of coordination model, we believe that users' groups should be able to define their own coordination models according to their needs and preferences. Therefore, decisions like "who can do what" and "what is right and what is wrong" can be made by the group members supported by the system.

Another relevant aspect of social networks is the feeling of "being part" of a community. To make viable this sensation it is necessary mechanisms to provide information about users' actions and status, objects, groups, tasks, etc. When a user is

capable of understanding that information and use them to establish and maintain communication and to collaborate we say he/she is aware. However, when constructing an ISN it is necessary to provide different awareness information to address different needs and preferences. Currently there are questions that demand research: How to present awareness information considering users diversity? What is relevant awareness information in each presentation style (*e.g.*, text, sound)? How to keep communication even in situations when users choose very different system views? How to make these scenarios possible in inclusive context?

Moreover, the establishment of a communication channel within the ISN, through which users can find help to overcome obstacles in the interaction with the system, is very important especially when considering the digitally illiterate. This communication about communication must be carefully designed. Further research is still needed in order to present this information, how to do it and when to do it - considering the diversity of the communities that will make use of it. That involves considerations not only about the tasks that one can perform during the use of the system but also language and metaphors that make sense to them.

Finally, our research indicates that people want to use ISN systems as a way to establish contacts in the real world and to give more visibility to their community, products, events and ideas. In addition, our target community is characterized by low computer literacy. Due to these facts, besides the ISN system, it is necessary to provide a friendly physical environment, a place where people can extend their social interaction and get training in the use of computers.

## *3.5 Conclusions*

In this paper we pointed out some of the major challenges to the design of systems to support online ISNs. We employed a participatory approach to the design of such systems. The approach involves participatory practices, such as GEM and BrainDraw, and collaborative activities for the identification of requirements and for the formulation of a design proposal. We presented and discussed major questions and contributions that resulted from this work.

Considering the challenging social context we have, the involvement of the user as "part of the team" provides to designers and developers the possibility to better know the differences present in the social context. This knowledge coming from the source and the participation of users in the design proposals legitimate the obtained solutions.

This work is a first step in an endeavor to contribute to the proposal of new methods that could deal with the difficulties of designing for diversity and collaboration with special focus on systems to support online ISNs. Future work involves other participatory

activities within the target community, when it will be possible to experience the design solutions.

# Capítulo 4:

# *Conversas* Online: A Synchronous Communication Tool Integrated to Inclusive Social Networks

## *4.1 Introduction*

The structure of the Internet - and all related Computer Mediated Communication (CMC) - was constructed in such a way and around such a culture that makes it all open in nature, which warrants public access and restricts governmental or commercial control to that access (Castells, 1996). We believe that the Web environment has an important role to play towards the digital inclusion. Online Social Networks (OSN) appears as a common ground to leverage interaction among people despite their differences. Boyd & Ellison (2008) define OSNs as web-based systems where people can create their profile - be it public or not - and browse around their list of connections, viewing and traversing other people's profiles and shared connections. An Inclusive Social Network (ISN) is a type of OSN for all; *i.e.* a system which allows the vastest diversity of people to integrate a group and interact to produce information (tangible and not tangible things) that can be shared with other persons and groups (Neris *et al.*, 2009a). ISN differs from other OSN in relation to its special attention to the universal aspect in which each functionality is designed considering the diversity of their target audience, and its potential to help people feel comfortable while interacting with computer systems.

CMC is increasingly changing the way people use computers, which affects both the social and professional environments. Instant Messaging (IM) tools (*e.g.* Windows Live Messenger[19]) are CMC tools that in the past had been usually available as desktop

[19] Windows Live Messenger. http://home.live.com/.

applications and are currently migrating to the Web - and lately have been integrated to OSNs. IDC (2005) *apud* Avrahami & Hudson (2006) evidenced the popularity of IM in a report showing that 12 billion instant messages are sent each day. Some popular OSN websites (*e.g.* Orkut[20] and MySpace[21]) already offer resources for synchronous communication. However they are usually intended to the "average user" and, consequently, presuppose a certain level of computer skills and literacy levels; moreover they usually disregard physical and situational disabilities.

This paper investigates the design and integration of IMs to ISNs. We explore the design and prototyping of a synchronous communication tool integrated to the *Vila na Rede*[22] ISN. *Vila na Rede* is result of the project e-Cidadania (2010) which investigates solutions and methods for the constitution of a culture mediated by Information and Communication Technology (ICT) in the Brazilian society.

The Brazilian context, and also other developing countries, present a situation characterized by vast differences with regard to socio-economics, culture, and geographical region differences as well as access to technology and knowledge. Social indicators presented by the Institute of Applied Economic Research (2010) show that in 2009, 60 million Brazilians - or 31.1% of the population - lived in poverty. Furthermore, according to the Indicator of Functional Literacy (IPM, 2009), in 2009, 29.66% of Brazilian population between 15 and 59 years old were functionally illiterate - *i.e.* they are not able to perform simple tasks involving reading words and phrases. The illiteracy indicator does not have a normal distribution and it increases significantly with the age of the population. Additionally, the last census of 2000, promoted by the Brazilian Institute of Geography and Statistics (2010), revealed that 24.6 million Brazilians or 14.5% of the population have impairments. Brazil is a relevant scenario to the development of inclusive solutions because it represents the diversity usually found in many "developing" countries as China and India.

Considering this scenario of diversity, our investigation started with a participatory workshop aiming at eliciting people's requirements for a synchronous communication tool to be integrated to the *Vila na Rede* ISN. Based on information from the workshop, we designed and prototyped a synchronous communication tool we call *Conversas* Online and its awareness mechanisms. After that, we conducted some practices with target people aiming at evaluating the first impact on them, when interacting with this kind of tool. These activities provided us with some insights about synchronous communication

[20] Orkut. http://www.orkut.com.
[21] MySpace. http://www.myspace.com.
[22] Vila na Rede. http://www.vilanarede.org.br.

mediated by computer and about the awareness information needed to establish and maintain communication.

This paper is organized as follows: the next session presents the methodological background. After that, we present our approach starting with the requirements elicitation activity, the tests of the resulting prototypes and discussion on the results obtained. Finally, we present our conclusions.

## *4.2 Methodological Background*

The methodological background for this work has roots in the combination of Participatory Design (PD) practices conducted on Organizational Semiotics artifacts (OS), as briefly presented in this section.

### 4.2.1 Participatory Design

One of the challenges for developing systems that meet the needs of the population with great skill diversity is the lack of knowledge about the user's needs and intentions. In an attempt to reduce this gap, we have applied methods and techniques from the PD, since it promotes the users' involvement throughout the system development lifecycle.

The PD had its beginning in the early 70's in Scandinavia. Initially, this approach proposed the development of strategies and techniques for supporting the participation of workers, and trade unions in decision-making processes related to developing technologies for the workplace (Schuler & Namioka, 1993). Some of the expected results with this approach are: a mutual learning process between designers and users; increased understanding of the users' characteristics, preferences and needs, besides the democratic development of new technologies (Melo & Baranauskas, 2006b). PD provides a variety of techniques to drive the design with users during all the project lifecycle. Moreover, according to Braa (1996), since PD activities provide a better understanding of the work developed by users and combine different participants' knowledge during the design process, we have the opportunity to improve the quality of the resulting system.

### 4.2.2 Organizational Semiotics

In order to complement the techniques from PD to model the social context, a formal methodology for modeling systems is required. The design of systems that make sense to the users' community and that respect its diversity demands socio-technical views and increased knowledge of the involved parties. Therefore, as a frame of reference for problem understanding, modeling of the organizational context, as well as user and system requirements gathering we have based our approach on OS (Stamper *et al.*, 1988; Liu, 2000), its methods and artifacts. OS is a discipline that has roots in Semiotics applied

to organizational processes. OS studies the nature, characteristics, function and effect of information and communication within organizational contexts. Organization is considered a social system in which people behave in an organized manner by conforming to a certain system of norms (Stamper, 1992).

The use of Semiotics for the context of human-computer interaction allows studying the information systems involved in the interaction with computer technologies, and investigating the way these technologies alter or are altered by this interaction. Besides providing a well founded theoretical background, OS has a wide range of methods, techniques and artifacts to support the modeling of information systems. Methods for Eliciting, Analyzing and Specifying User Requirements (MEASUR) (Stamper *et al.*, 1988; Liu, 2000) is a set of these methods with techniques that can be used by researchers and users to understand, develop, manage and use information systems, enabling the modeling of information systems from the technical to the social aspects. The main methods of MEASUR are: Problem Articulation Method (PAM), Semantic Analysis Method (SAM) and the Norm Analysis Method (NAM) (Liu, 2000). OS artifacts and methods have been used in workshops that consider the participation of users, designers, developers and other stakeholders (Baranauskas *et al.*, 2002). These workshops have been called "Semio-participatory" as they combine the use of artifacts from OS with techniques coming from PD within a not homogeneous group of people.

## *4.3 A Synchronous Conversation Tool for ISN*

Before determining any characteristic of the conversation tool, we first conducted investigations within the target community of users. The objective was to understand how communication takes place in face-to-face basis in their real environments. We expected to identify behavioral patterns and thus get some system requirements.

In order to figure out the dynamics of conversations in the natural social networks, we prepared and applied specific activities during a Semio-Participatory workshop. In this section we describe the activities planned for this workshop and present characteristics of the participants. Then we show the development of the communication tool and finally, our approach for evaluating the designed software within the community.

### 4.3.1 Eliciting the requirements

The activities for eliciting the requirements for *Conversas* Online consisted of three separate moments: Initial discussion, Simulation of online conversations, and Final discussion. To form the group of participants that took part of the activities, people with different profiles were invited. People who had never had former contact with any kind of communication tools, as well as no contact with computers, worked together with

experienced computer users. Ages ranged from 23 to 60 years old, and they presented different literacy and schooling levels. Also, they came from different states from Brazil. Almost thirty individuals were at the workshop, from which 12 represented the local community. These community representatives covered the three larger groups: 1. Associations or NGOs; 2. Society; and 3. Government. This selection provided us with a broad range of participants and thus a diverse and rich source of opinions and ideas to contribute at the workshop. It was expected that the opinion, abilities and needs from this group could be representative to the Brazilian diversity in population.

#### 4.3.1.1 Initial Discussion

This phase was meant not only as a preparation for the next moment, but also to gather information to base the researchers' hypothesis. First, a set of decisions to be made was listed. These decisions would be incorporated into the specification document that characterizes requirements of the tool to be used in the ISN.

In order to initiate the discussion, a scenario was proposed with the objective of identifying social norms related to the interactions that take place during conversations. The scenario described a handcrafts' fair and all interactions among attendees and sellers. This fair would be similar to the fairs this community uses to prepare in the neighborhood (not online).

After proposing this interaction scenario, a non structured set of questions were discussed with all the participants of the workshop. The objective of the discussion was to understand the participants' behavior in the real (physical) world. The questions were supposed to conduct the participants to different interactive situations allowing us to identify their behavior in public scenarios where each one could talk about a specific object or any other subject. The discussion allowed us to perceive behavioral patterns and main differences among the participants' preferences. The complete discussion can be found in (Hayashi *et al.*, 2009) (in Portuguese).

#### 4.3.1.2 Simulation of online conversations

We wanted to simulate dialogs among the participants in a way to register these conversations. This data should be easy to access and review. Only the recording of the talking would not be enough, since it would demand extra effort in the retrieval of the information during a posterior analysis phase (*e.g.* searching specific part of the conversation in a MP3 file). For that, post-its were used to simulate conversations in a poster hanging on the wall.

Each participant received a pack of post-its. They would write their messages on the post-its and paste them on a poster, as if they were posting their messages on the ISN. In

order to provide a context for the conversations, the poster had screenshots of an announcement from *Vila na Rede*. Since we expected to have a group of about twelve people, we decided to have three different announcements. The group was then divided into three smaller groups and they would talk among them inside these subgroups, using the post-its. That way, the amount of people in front of the same place of the poster would be reduced, allowing the activity to be conducted in a more fluent manner.

In order to select only three from all of the announcements found on *Vila na Rede*, we searched for the adds following these guidelines: a. the most visited ones; b. the probability of the "owner" of the announcement to be present at the Workshop (based on their frequency in past Workshops) and c. the number of comments received.

Participants were instructed not to make use of oral communication: they were supposed to talk only by using the post-its. Nothing was mentioned about the obligation of writing, meaning that there were also the possibilities of drawing and using any other symbols (*e.g.* smileys). Moreover, intentionally, instructions did not specify the order of the post-its nor their positions on the poster.

During the activity, the researchers observed participants' actions and behaviors. Researchers took notes about the interaction on pre-elaborated forms (Hayashi *et al.*, 2009). Figure 4.1 illustrates the activity being conducted and the final poster.


**Figure 4.1. The online conversation simulation dynamics and its registration.**

The conversation simulation resulted in 95 messages exchanged. From these messages, 63 were signed and 32 were not signed - but it was possible to identify the author based on the post-it color, author's calligraphy or conversation context. The authorship was not identified in 3 of them and 6 were posted in the context of a different group. Two messages were directed to the entire group, including researchers that were

only observing the activity. These two messages revealed emotional response from one of the participants.

The original poster where the messages were posted is 142cm x 90cm (55.9in x 35.4in) large. In order to facilitate its reading, a digital representation of the poster was created (available in Hayashi *et al.*, 2009), as the pictures taken did not show enough resolution to read.

The conversations generated in Group 1 (regarding the announcement of ecological bags) were related to the participants' reality. Many post-its (9 out of 44) were about the same subject: the meeting that they were expecting to have later that week. It is important to notice that the participants from this group were all members of the same cooperative (handcrafts women) and already knew each other. One participant from another group tried to join in the conversation by asking personal questions. For the first question, the person did not receive a straight answer, but only a note asking her to identify herself first. For the second question, the answer obtained seemed to have been the result of an oral communication that took place during the activity (the post-it with the answer was written with the same handwriting as of the post-it with the question).

The second group focused their conversations on the advertisement, which was about "*pão de queijo*" and other homemade snacks. The same participant who tried to join in the conversations in Group 1 also posted a question in this group. Again, the person did not receive a straight answer and the conversation did not meet the expected end (the question completely answered). As mentioned before, the poster had the image of the announcement as it is on *Vila na Rede*, including its comments. Surprisingly, one of the messages was an answer to one of the comments, which suggested an idea for business (the author of this comment was not part of this group).

The advertisement to work as a trigger for the conversations in Group 3 was in the format of a video. Thus, participants were not able to acknowledge what the advertisement was about. Interestingly, participants got in the mood of the role play situation and conducted the conversations as if they really were in front of the computer. They asked about the content of the video stating that they were facing problems to see the video. Two messages were posted outside the context of the three groups. These messages contained affective responses from one of the participant towards the whole activity and it was directed to all participants, including the researchers. The messages stated: "I love you all" and "Thank everyone for this opportunity".

#### 4.3.1.3 Final Discussion

Looking from outside to the simulated conversations taking place, the researchers could see that the participants were very active, generating much more dialogs than they

expected. In order to have a view from the inside (the point of view of the participants), after the activity, the whole group got back together in a circle and they exchanged their experiences and opinions about the activity, sharing with the researchers how they felt. The objective here was to understand how interactions take place in order to elicit requirements for the synchronous communication tool of an ISN. It is interesting to note that some of the participants had no experience with instant message software or chat rooms.

One of the participants reported that at first she was not sure about what she was supposed to do, but after receiving the first responses, she felt that the conversations came naturally. This uncomfortable feeling was probably, as the participants said, due to the fact that the announcement was in the format of a video, and in the poster only an image of the video was shown, which left the participants from that group with no information on the subject of the announcement. The same participant described her basic behavior in the activity: to write a question and wait for the answer.

In order to overcome the problem posed by one of the rules of the activity (they were not supposed to talk), they said they communicated through gestures, by expressing something with facial expressions or with signs (pointing to a specific post-it) and by writing (meta) information on post-its that were not intended to be pasted on the poster. For example, one of them wrote: "I can't speak" and put it [the post-it] on his mouth, a behavior that was taken with humor by his fellow participants, as they reported it laughing and making jokes during the discussion. At this point, the facilitator commented that it is also a form of communication.

An issue concerning identification was mentioned when the sender of the message did not write his name on the post-it. They said that they were able to know who the author was, only because they saw who was writing, but they expressed that they wanted everyone identifying themselves.

Another way to identify the author of the message was by the color of the post-it, which could be seen at distance. In one group, the flow of the conversation was followed by the proximity of the post-its. As for the subjects of conversation, they varied depending on the theme of the announcement. One of the participants said that she had many issues pending to be solved with other participants and she was able to have them all solved during the activity. She said: "Can you imagine if we would be able to do this more often?" Another observation made regarding the ISN: besides seeing an announcement, one can also chat with other people and therefore end up spending more time in the internet. This participant was able to identify, through this activity, a different use of the internet that was new for her. This, as highlighted by the facilitator, contributes to the creation of a digital culture. That is what is happening now, when people who are

not familiar with ICTs discover the universe of possibilities and information that they can find in the web. Most participants agreed that it is all a matter of "creating the habit", by inserting digital interactions in their daily routines.

#### 4.3.1.4 Workshop Results

The activities described in this section were an important contribution to the understanding of how social interactions could take place in practice when mediated by an artifact. Participants managed to transmit their feelings and other concerns out of the written format presented in the post-its. In order to add meaning to or to clarify the written material, they made use of gestures and other physical expressions.

The three moments of the activities provided elements to characterize a communication tool for ISN and what it should have, that distinguishes it from the commercial chat tools available today (*e.g.* MSN, Skype). One example is the interest in knowing about all the conversations that are taking place at the moment. This requires the development of a visualization feature for the conversations.

Although it had been mentioned in the initial discussion that the identification was not a concern, participant's behavior during the activity of simulation did not reflect it. It seems that, in fact, it is important to know who is talking to whom. Table 4.1 summarizes the requirements that were extracted from the activity.

Other ideas about what to do online came up. Also other things that are of interest of that community and that could be done with the aid of the ISN. For example, posting ideas, news, alternative recipes (cooking with the peal of aliments), etc. One subject that was raised in the 3$^{rd}$ group was related to an environmental initiative. During the discussion, the author of the announcement invited all participants to join them in the activity to plant trees in order to preserve their (the community's) river. The facilitator pointed out that this invitation is very important: although *Vila na Rede* is in a virtual world, it will only make sense if a link with the non-virtual world is kept (in this case, the physical act of planting trees and the announcement of the idea in the ISN).

### 4.3.2 The Prototype

This section presents the functionality created based on the participatory elicitation workshop named *Conversas* Online. This is a multimedia synchronous conversation tool integrated to *Vila na Rede*. First, we present the software environment employed. Following we describe the functionality characteristics and user interface (UI).

**Table 4.1. Summary of main characteristics observed in the communication activity and the requirements extracted.**

| Characteristic | From the Workshop | Requirements |
|---|---|---|
| Conversation scope | A participant can talk to more than one person at a time. | User can start a new conversation or add another user to an existing conversation; One or more simultaneous conversations. |
| Representation | People want to know who is talking at the moment. | Graph to represent ongoing conversations (in which one may browse using keyboard or mouse). |
| Focus/position | People usually talk about objects; They should be able to visualize them along the conversation. | Conversation window located at the outer part of the main field of vision; Conversations intersect every page of the system. |
| Up-to-date information | People signed their messages; They called attention of the receiver to the posted messages by pointing to them. | Provide information on the context/environment: *Textual* - who is in the conversation, new message, others typing, invitations (*e.g.* join audio conversation); *Graphical* - video/audio transmission, file transferences; *Aural* - new message, others typing, invitations (*e.g.* accept file from user). |
| Media | During the simulation, people tried to communicate by gestures; Low literacy. | Communication using different medias (video, audio, text, and by sending files). |
| History | People would like to watch and review past conversations; They want to decide which conversations will be recorded. | User decide when to store the history of the conversation; This history can be deleted; Multimedia; The scenario of the conversation should be constructed considering the events' timestamps. |

### 4.3.2.1 Software environment

*Vila na Rede* uses a Content Management System[23] Drupal 5 to manage users accounts, content types and other general functionalities; a JBoss Application Server[24] 4.2 hosts

[23] Drupal. http://drupal.org.

specific functionalities of the ISN as password by images, multimedia comments, collaborations to others contents; a Red5[25] 0.7 flash server manages the multimedia input as, for example, online video and audio recorder. Figure 4.2 summarizes the software environment.

*Conversas* Online uses Flash ActionScript in its UI and a Red5 flash server to establish multimedia conversations sections. The management of current and past conversation sessions as the history logging of conversations is stored in a PostgreSQL[26] 8.3 database. Graph of Conversations uses JGraph[27], a graph visualization library. A web service of the ISN provides the information to be rendered in the graph.

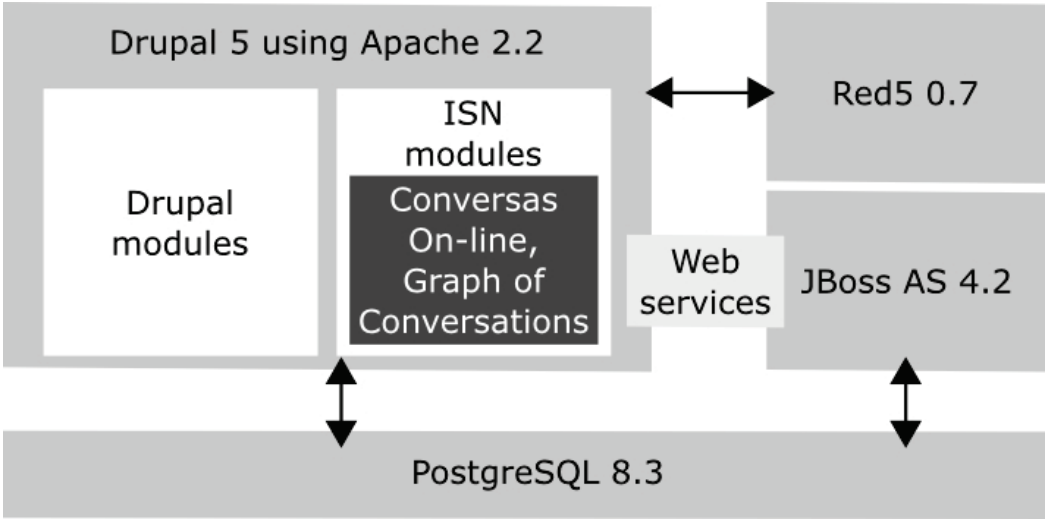


**Figure 4.2. *Conversas* Online: software environment.**

## 4.3.2.2 User Interface

Figure 4.3 presents a conversation session taking part among three people in *Vila na Rede*. Figure 4.3.a is an instance of the *Conversas* Online UI. The respective graph of the conversation is presented in Figure 4.3.b.

### 4.3.2.2.1 Synchronous Conversation Tool

*Conversas* Online aims at adding new communication perspectives to *Vila na Rede* by allowing people to interact with others. People in *Vila na Rede* already have some interaction functionalities as multimedia comments and collaborations, although those are

[24] JBoss. http://www.jboss.org/.
[25] Red5. http://osflash.org/red5..
[26] PostgreSQL. http://www.postgresql.org/.
[27] JGraph. http://www.jgraph.com/.

asynchronous resources. One relevant characteristic of *Conversas* Online is that it provides the conversation resource in a contextualized way, so that access points to the tool are available in every place where a person´s name is displayed. Additionally there is an online people list situated at the left column in every page of the ISN.

People can establish conversation sessions with up to 3 fellows in each session. More than one conversation session can be maintained simultaneously. When inviting people to talk, the person who is inviting is prompted about whether he/she wants to start a new conversation session or add the invited person to an existing conversation session.

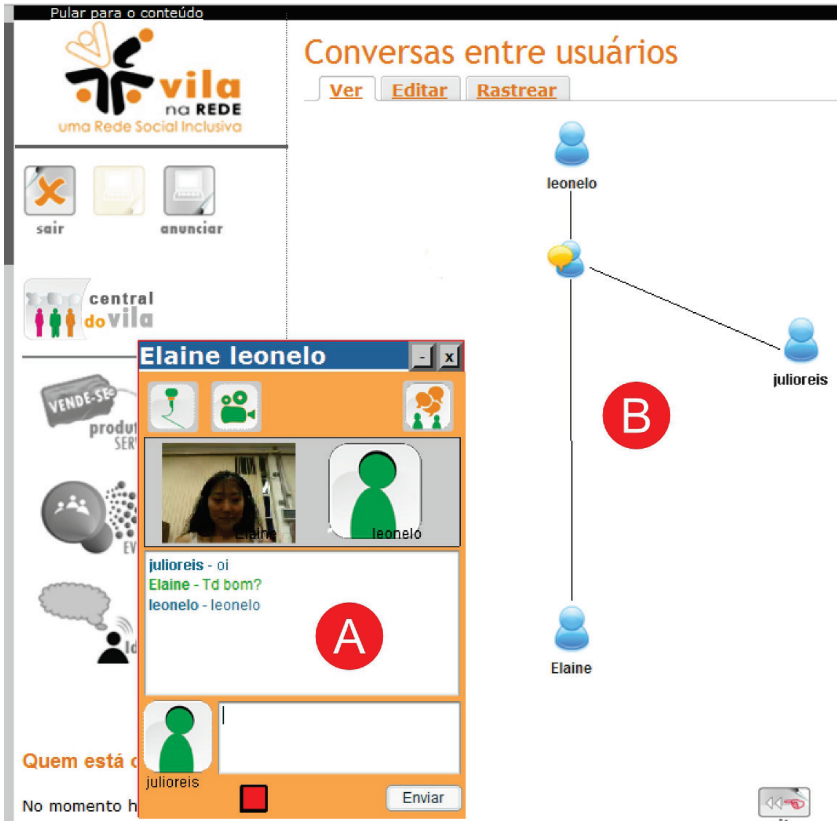


**Figure 4.3. A *Conversas* Online session.**

The conversation user-interface (as presented in Figure 4.3.a) is composed of these sections:

**Participants identification**. Involves the title bar and the participants bar. In the participants bar, there are graphical representations that can be photos or pictures of the participants as defined in their respective profiles. Moreover, when sending messages

using video or audio, the video and audio streams replace the person graphical representation;

**Functions Bar**. Aiming at minimalist design for the target public, *Conversas* Online has four basic functions at this bar. They are: communicate by video stream, communicate by audio stream, send files, and activate history logging. People can select any different functions during a conversation session *e.g.* one person can communicate using sign language, other can use textual messages to answer him/her, while a third one can send a file to them;

**Logging.** All the textual messages, notifications and warnings are displayed in this area, which is situated right bellow the Functions Bar;

**Messages input.** This area displays the input for text messages and the video and audio streams feedback for the person. When communicating only by text, the person graphical representation replaces the streams area, as occurs in the Participants Bar.

One concern in modeling a synchronous communication tool considering the context of this work is to provide people with enough awareness of others to establish and maintain the communication. In *Conversas* Online, awareness elements are present in diverse aspects as identity, audience, media, authorship and action. By means of identity, participants in a conversation session are represented by their graphical representation and name. Audience is updated changing participants' graphical representations to a gray scale image. Media are naturally informed by the video and audio stream presentation and by an audio equalizer bar. Authorship is presented along with textual content by means of senders name. Other media authorships are determined by the video and audio streams per se. Actions are registered in the logging area. Instant actions as "who is typing" are present along with the author graphical representation. Actions from previous sessions can be retrieved by the history logging resource.

As *Conversas* Online is available online without installation of any specific local component, the history logging is stored in the web server. This resource allows the logging of not only textual content but the multimedia content as well. Thus, conversations based on gestures and voice can be recovered along with textual context and displayed as they were generated.

#### 4.3.2.2.2 Graph of Conversations

During the workshop for eliciting requirements we verified that people want to be aware of what is happening in the social network, especially who is talking to whom. This requirement differs from what we experience in mass communication tools (*e.g.* Google Talk and Windows Live Messenger) so we designed a new widget for the ISN.

Previous researches as Chat Circles (Viégas & Donath, 1999) and Babble (Erickson *et al.*, 1999) explored the use of graphical representations for representing the current

conversations in the workspace. However, in mass communication tools, it would probably be impossible to view and keep up-to-date a representation of the whole network of conversations. In ISNs where the number of simultaneous online people is reduced or there are well defined groups, this is an interesting resource, due to the fact that it brings characteristics of a public place in the virtual world.

The graph of conversations, presented in Figure 4.3.b, consists of a representation of online people and conversation sessions. People are represented by their graphical representations and names as occurs in the tool user-interface. By right-clicking in a person representation it offers interaction options as start a conversation and view the person profile. Conversation sessions are represented by a graphical representation too. By clicking on a conversation session it offers options as to join the conversation. Person and conversation nodes are connected by edges that reflect who are participating in it.

Different from Chat Circles, The Graph of Conversations presents the information about conversations separated from the conversations UI; this enables people to keep isolated conversations with a number of people. While Babble is concerned with a conversation session, the Graph of Conversations is able to represent all the conversations that are currently taking place in the ISN.

### 4.3.3 An Exploratory Study

The prototype described above was used by the researchers after its implementation and it was later made available to the final users in a controlled way, during another encounter of a Semio-participatory workshop.

The objective of this workshop was to observe users reaction to this new ISN application. Participants were already familiar with *Vila na Rede*, but they had never used this specific functionality in this ISN. Among the participants there were 6 people who had never experienced this kind of interaction before. In this section we describe the activities that were conducted in order to evaluate the proposed communication mechanism and its results.

**Scenario and participants**. The activities took place in a lab of the university with which the authors are affiliated. In the first edition, twelve participants worked at a laboratory that had six desktops and six laptops. The laptops were fully equipped with multimedia resources, whereas the desktops did not allow audio input. The second edition hosted one single participant, the facilitator and a researcher working from another country (with whom the participant communicated using the feature in evaluation). For both activities, one person was designated for video taping the experiment and for picture taking. The researcher in charge explained the task to the users.

The group of participants from the first edition aged from 23 to 61 years old. The second edition of the activity had one 18 years old participant. He had the specific characteristic of being deaf. In order to conduct this activity we had the aid of an interpreter for LIBRAS (the Brazilian sign language). This participant was fully digitally literate and was familiar with other communication tools. The activities from the screens of the computers were captured and recorded with specific software for screen capture.

**Activities**. Participants worked from a different station (either a desktop or laptop) and there was one facilitator available for guidance for each two participants. The role of the facilitator was to help with the use of the tool. The facilitator was allowed to interfere in the interaction in order to obtain the information that researchers were expecting. Such information included: how users explore the interface and the system's basic functionalities; identification of conflicts and social protocols that could be created to make the conversation flows possible; users' perception about new participants in the conversations; their perception regarding the functionalities of "history" and "Graph of Conversations".

At the beginning of the activities, participants were told about the communication tool and allowed its exploratory use. The facilitators let them alone identify how to start the use of the tool. Furthermore, facilitators asked questions to direct users to the use of as most features as possible.

During a certain point of the activity, facilitators informed the users about the possibility of having a conversation with more than one person at the same time. Besides, at another moment, facilitators also asked users whether they knew who were engaged in conversations at that moment and invited them to use the Graph to check that information. Figure 4.4 illustrates the activities.

After the interaction, users answered a written and anonymous questionnaire. The form had illustrations of the communication tool and spaces to be filled. The purpose was to check how users made sense of the elements of the interface and identify possible problems in its interface.

#### 4.3.3.1 Results

From the interactions and from the collected material we were able to identify problems in the UI. The result indicates elements that might need to go to the redesign process. The main concern lies in the affordance given by the icons used. Most participants did not make sense of the icons for history logging, audio and video streaming and text color. Table 4.2 provides an overview of participants' sense of the features.

**Figure 4.4. Two moments from the workshop.**

**Table 4.2. Summary of the results from the workshop.**

| Feature/understanding | Correct | Incorrect or null |
|---|---|---|
| Funcionality: | | |
| Text input | ✓ | |
| Sent message | ✓ | |
| Group conversation | ✓ | |
| Icon: | | |
| Audio streaming | | X |
| Video streaming | | X |
| History logging | | X |
| Video/picture from the user | ✓ | |
| Video/picture from others | ✓ | |
| Text color | | X |
| Who is typing | | X |

All evaluated features, except for the icons, were created in a conjoint effort with users and researchers, who gathered together throughout the project, during various Semio-Participatory workshops. Hence, we consider that the development of any system should always involve user participation, in all phases and levels of the design process, including the design of the graphic elements to be used in the interface. This practice might have resulted in less incorrect/null understandings from users.

## 4.4 Discussion

Based on the activities described in this paper, this section discusses some of most relevant findings. We articulate perceptions, issues and ideas toward a preliminary set of considerations for designers of information systems.

The participatory methodology adopted raised some requirements as the manner in which communication multimedia is provided: people can interact by using different media simultaneously, and without the need for a protocol message (*e.g.* asking before establishing a video session) to start a conversation or to change a media; the Graph of Conversations since people demanded to be aware of the conversations taking place in the social network; and the integration of *Conversas* Online to the ISN *Vila na Rede's* context, as people usually initiate conversations in real life from subjects as products, events and ideas.

In non contextualized IM applications people keep contact lists that frequently reflect their relationships in real life. A social network is a prominent provider of contact possibilities as it usually contains diverse interests groups and opinions. Moreover, during the eliciting workshop people disagreed about the protocol to engage new conversations. Some of them wished for a filter showing who would be able to talk to them, others said they want to be asked before engaging each conversation, while others expressed to feel comfortable in engaging any conversation if the other person is authenticated in the application. In such case people have an inclination to trust in the IM as a consequence of the confidence they have in the application.

In *Conversas* Online we wanted to allow people to collaboratively decide the interactive shared social protocols for most of the functionalities of the tool such as history logging status, and turn on/off video and audio sessions. We believe that this characteristic promoted more natural behavior in social interactions.

Computer mediated information systems have not only the potential to represent real life scenarios but also to extend them. In *Conversas* Online two aspects show how extensions are incorporated to everyday life: Maintaining two or more conversations without any relation among them, and also the multimedia history logging. In face-to-face conversations one person is able to maintain two or more conversations too, however in such case there will be overhearing among people they are talking to. From the requirements of multiple media and awareness of history logging, we envisage some challenges to the interaction design and technical aspects to represent logged conversations in multiple media properly merged. The representation should consider the multiple media and all the actions of the participants as joining and leaving the conversation.

Differences due to literacy and digital literacy became evident from the eliciting workshop to the test activities. In the eliciting workshop we observed the discomfort due to the restriction of talking only by text messages. People with low literacy levels were highly worried about orthography. Consequently other communication modes as gestures and facial expressions were employed by them. During the test activities the effort to type text messages and to keep awareness about others' messages was not considered an issue by the participants (6 considered that it demands some effort and 5 considered it easy to keep). This behavior overcomes our expectations considering that those participants basically use telephone and face to face talks for synchronous communication.

Multimedia is usually considered the natural solution for literacy-related communication problems. Indeed it helps solving accessibility issues. However, considering that the intended people might have restrictions other than literacy – *e.g.* economic restrictions - we should take into account the fact that there might not be multimedia devices available in the computers and that there might not be Internet connections with enough bandwidth. In this way it is necessary to consider other simpler expression resources as smiles like we pointed out in the eliciting workshop. In the test activities the deaf participant (that had previous experience with this kind of application) reported that he missed smiles to complement text messages.

From the awareness resources of the prototype we want to highlight the Graph of Conversation and the access points for *Conversas* Online. As reported in the eliciting workshop, people in real life usually become aware about others presence and the conversations that are taking place in the same context. In Graph of Conversations, despite of the information it presents, people experienced some difficulty to understand its graph representation (8 of 11 participants of the test activities said they prefer the list representation). After they were informed about the objective of the graph people changed their opinion regarding their preference. We suggest further investigation about other types of representation as for example a list of adjacencies in addition to the list of online users.

Access points are intended to help people to be aware of others status considering object (*e.g.* inside adds) or general (*e.g.* list of online users) contexts. In the test activities, 8 people considered that it was easy or that it demanded a little effort to find the access points, and only 3 people considered it hard to be found. We suppose that their previous experience with other similar tools, without the access points along with people's names, is a very probable reason for the difficulty faced by 3 of the participants.

We also have identified some limitations in the dynamics of both workshops. The first was the physical space reserved for people to interact with, by pinning the post-its. Due to the size of the poster and the configuration employed in it, some messages were posted in

wrong contexts and it hindered the approach to read and post messages. Considering the second workshop we had problems regarding some of the equipments used.

Next we present a set of considerations. First we highlight the concern about the requirements and the referential adopted to capture them. It is important to employ methodologies that allow us to understand the everyday life of the target audience. With that, we expect to be able to better reflect the real life in the virtual, developing solutions that are more natural to people. In this context, it is necessary to consider the social protocols that are shared and that make sense for these people, eliciting their roles and facilities during communication. Moreover, we consider that multimedia messages can overcome the barriers that people of the considered context have; generating possibilities for all people interact despite their limitations. The solution cannot inhibit the means of expression that people have to communicate, which go far beyond the written text. Thus, multiple media, allied to other manners to signal objects are important and necessary. The access points for *Conversas* Online bring new opportunities for interaction and communication. The last consideration refers to representation. Sometimes important things to people in real life, when transformed into a software feature, can lose its purpose being misinterpreted by people due the way its representation was done (*e.g.* Graph of Conversations). Therefore we need to care about the requirement implemented with tests and evaluations in order to observe the real impact on people, observing whether that makes sense to them as expected.

CMC goals should try to reproduce communicative possibilities as close as possible to the real life, making the digital world more natural to people. For that, the design and development of technological tools that make sense to the digitally illiterate require a deeper understanding of the context of their life. In this paper the intention was to investigate the meanings the participants make of "conversation" within social interactions, in order to prospect a more adequate online inclusive environment regarding IM.

Several contributions from this paper to the state of the art can be identified: first the methodology adopted to accomplish our goal, from eliciting the requirements to evaluating the solution; considering the target audience, the requirements extracted *per se* is also a relevant contribution; and the set of considerations for designers can help in designing more adequate solutions regarding IM. Besides, the Graph of Conversation was an interesting attempt to represent the conversations that are taking place. In general the solution enables different characteristics such as: the natural creation of the interactive shared social protocols; the real life extension; the use of other communication modes and multimedia; and contextualized awareness resources.

## 4.5 Conclusion

This paper explored the requirements for synchronous communication tools integrated into ISNs. Our methodology consisted of an initial participatory workshop for prospecting requirements, the design and development of a prototype tool for synchronous communication - the *Conversas* Online - and awareness mechanisms to support people in establishing and maintaining communication. Finally we conducted tests to evaluate the users' first experience with the *Conversas* Online.

Resulting from the activities we identify relevant signs to the questions that motivated this work. The first is about the differences between non contextualized IM and contextualized ones. As we have perceived, context contributes to the confidence people have about their counterparts. Also, starting conversations from context objects helps the target audience people to feel more instigated to engage in new talks. The prototype evaluation activity helped us to understand how people non-experienced with IM tools act in their first contact with them. Surprisingly people have not much difficulty to cope with more than one separated conversation session. Another finding was the difficulty the audience had in interpreting the Graph of Conversations. In summary, we confirmed our expectations that the involved people demand different requirements when compared to the "average users"; and we have evidences that IM tools contextualized in ISN have attractive characteristics for this audience.

This work also instigates further investigations: the observation of the behavior of the *Conversas* Online audience in a 2-3 months continuous use; the exploration of HTML5 support for multimedia in order to reduce the use of non standard languages; the change in presentation needed for the Graph of Conversations and its refinement to fit a greater number of data; new widgets to ease people's reference to content from the ISN in a conversation session; and testing of the tool contextualized with other category of social network mediated by computer.

# Capítulo 5:

# Mapping Technical Guidelines for Accessible Web Content into Universal Design Principles: Theory and Practice

## *5.1 Introduction*

Web accessibility has been of increasing concern in web-based systems that are supposed to be used by a diverse audience, including socio-economic diversity. In situations of great diversity such as the one usually found in developing countries, such as China, India and Brazil, the demand for accessible solutions becomes a critical factor for coping with the "digital divide". Providing websites with accessible solutions that rely only on being approved by semi-automatic evaluation tools is not enough. The developers of web content must take into account the implications of designers' decisions for the target audience. Moreover, many accessible solutions are designed to accommodate specific interaction needs, resulting in solutions that segregate rather than diminishing the "digital divide".

There is an international effort to establish standards for accessibility on web-based systems. Examples include the Web Accessibility Initiative (WAI), kept by the World Wide Web Consortium (W3C)(2010) and other governmental initiatives such as the Section 508 (EUA, 2010), the Stanca Act (Itália, 2004), and the Act 5.296/2004 (Brasil, 2004). Even with the variety of sources of recommendations available for web content development, designers frequently fail to write accessible products. Many factors contribute to this problem as those related to accuracy and coverage of the recommendations in relation to the wide diversity of website usage: a) the lack of information flow between the recommendations and the needs that leverage them (Choi *et al.*, 2006; Sloan *et al.*, 2006); b) the diversity of the target public, including geographical,

political, economic, social and cultural aspects (Santana *et al.*, 2008); c) other factors such as physical restrictions (*e.g.*, environment illumination, assistive technology); and d) the fact that recommendations are usually not situated; thus, designers tend to use only semi-automatic validation tools without considering the impacts of their decisions in specific situations.

In an attempt to help designers to write "accessible for all" web content, we have articulated recommendations coming from the Universal Design (UD) (Connell *et al.*, 1997) principles and guidelines for universal access (initially focused in the physical world), the Web Content Accessibility Guidelines 2.0 (WCAG), from WAI (W3C, 2008) for web content, and ISO 9241 parts 1, 3, 4, 5, 6 and 9 (ISO, 1992, 1997, 1998a, 1998b, 1999, 2000a, 2000b) for environmental considerations. Our approach aims to gather the best aspects from UD and from the WCAG, to facilitate understanding of the principles and objectives addressed by the guidelines, while offering specific criteria for web content creation. In addition, we adopted the environmental aspects of ISO 9241 to cover the UD principles related to the physical aspects of design. The mapping is currently implemented in the module for universal accessibility of the FAware framework, which is intended to support the design of awareness mechanisms for inclusive collaborative systems.

Our proposal is illustrated with a case study in which two different groups of designers evaluated five URLs of a Brazilian governmental website. The first group was composed of undergraduate and graduate students; and the second involved specialists in web accessibility. Our findings show that even for the specialists, the approach offered significant new contributions to the results of a semi-automatic evaluation tool.

This paper is organized as follows: Section 5.2 presents the methodological references for the work, Section 5.3 presents the mapping of web content and physical accessibility guidelines into UD principles and guidelines, Section 5.4 presents the way the approach is embedded in the FAware framework, Section 5.5 presents the case study, Section 5.6 discusses the most relevant perceptions, issues and strengths of the approach, and Section 5.7 concludes the paper.

## *5.2 Methodological References*

Universal Design (or Design for All), as defined by Connell *et al.* (1997), consists of designing products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. The objective of Universal Design is challenging and, despite the difficulty – or even the impossibility, due to the current technological and scientific limitations – of developing products for all, its practice encourages designers to potentially produce better solutions.

In order to help designers adopt UD practices, Connell *et al.* (1997) compiled a set of 7 principles and 30 guidelines. Story *et al.* (1998) present examples for each guideline, considering various scenarios and knowledge areas, including computer systems. Other researchers in computer science have sought universal solutions (*e.g.*, Abascal & Nicolle, 2005; Shneiderman, 2000; Vanderheiden, 2000) in software applications and their user interfaces. While UD offers a concise orientation for the design of accessible physical products, its principles and guidelines are still far from easily applicable by designers of web content and other non-tangible products.

From another perspective, the WAI contributes recommendations and techniques specifically intended for accessibility on the Web. Its guidelines for web content currently hold great influence in the web design community (Abascal & Nicolle, 2005). WAI has three foci: User Agent Accessibility Guidelines (UAAG) for browsers, multimedia players, and assistive technologies, Authoring Tool Accessibility Guidelines (ATAG) for web content authoring tools, and Web Content Accessibility Guidelines (WCAG) for web content. This work refers to the WCAG principles, guidelines and success criteria.

WCAG offers specific recommendations and techniques (there are currently 12 guidelines and 61 success criteria) for the development of accessible web content. Some of the major problems faced in adopting WCAG guidelines are related to factors such as the fact that they are not totally "machine testable" guidelines (Reid & Snow-Weaver, 2008), and designers find it difficult to understand the accessibility goals intended by the guidelines (Connell *et al.*, 1997; Sloan *et al.*, 2006). Consequently, semi-automatic evaluation tools, *e.g.*, AChecker (ATRC, 2009) and Cynthia Says (HiSoftware, 2009), frequently fail to enable designers to understand and separate the possible issues that are actually problems from those that are not, considering the website context. For example, when validating the URL http://vilanarede.org.br, AChecker returned, in the report of possible errors, the message *"<title>Vila na Rede - Uma Rede Social Inclusiva</title>, Check Line 4, Column 1: title might not describe the document*" and other information regarding the guideline used. The message lacks information regarding the criteria employed in the evaluation. In this example the issue is raised by default because the evaluation tool is not able to interpret the text semantics in the title. Inexperienced designers would spend some time trying to understand why the title is considered inadequate.

Some guidelines are not "machine testable" because of their contextual, social and cultural dependency. However, guidelines should provide information to help designers interpret the technological and social contexts of their web applications. For this intent, articulating Universal Design in terms of WCAG principles and guidelines could be

helpful in providing a concise and broad perspective on users' needs and environmental characteristics.

## *5.3 Mapping WCAG – UD*

In this section, we present the methodology of this study and the resulting mapping, and we discuss the coverage and applicability of such an approach to the production of web content. The approach consisted of a three-step process:

- Analysing each information unit of WCAG and UD starting from the more abstract levels (*i.e.*, principles) to the more concrete levels (*i.e.*, success criteria), considering both discursive and codified content, in order to find the correct alignment among the hierarchy of both WCAG 2.0 and UD. The objective was to find the best matching units so that designers could understand the mapping without the need for further information or analysis such as, for example, dividing a unit into parts or combining a number of parts into one unit in order to make sense of the content;
- Mapping WCAG elected units into UD elected units;
- Analysing the results and identifying limitations of the mapping, and indicating possible solutions to overcome each limitation.

The mapping tried to maintain the characteristics of minimum number of mapping units, precision (units addressing the same specific theme) and accuracy (not involving other themes or requiring external information to fully understand the content), and applicability and scope of evaluation of the mapped units related to the authoring of web content.

In the first step of our method, we analysed the information units. For Universal Design, the book of Story *et al.* (1998) and the website "The Center for Universal Design" (Connell *et al.*, 1997) were the main references. For WCAG, we considered the online guidelines in version 2.0 (W3C, 2008).

The WCAG hierarchy organizes the units into 4 levels (principles, guidelines, success criteria and techniques); UD has 2 levels (principles and guidelines). Following the objective of concision for the mapping we started trying to match the principles of WCAG to UD principles. Although this is apparently possible, the result of this mapping does not fit our objective of accuracy. Then we repeated the same procedure for the lower levels of each hierarchy until a satisfactory result was reached. The best matching was obtained by employing UD guidelines (30 units) and WCAG success criteria (61 units).

Each mapping unit is composed of one UD guideline and its WCAG analogue, which can be:

- Zero or more WCAG success criteria;
- An additional external reference (in this work we considered only ISO 9241 recommendations);
- A suggestion or comment.

For the mapping, we decided to associate WCAG success criteria to the UD guidelines, to reduce the number of mapping units and because of the UD guidelines' coverage of environmental aspects. For the majority of units, the expected concision was achieved (see Table 5.1 for an example). In some cases, the opposite occurred (see Table 5.2 for an example), when a WCAG success criterion was mapped into more than one UD guideline.

**Table 5.1. Example of mapping more than one WCAG success criteria to one UD guideline.**

| UD guideline | WCAG success criteria |
|---|---|
| 2.4. Provide adaptability to the user's pace. | 1.4.2. Audio Control |
| | 2.2.1. Timing Adjustable |
| | 2.2.2. Pause, Stop, Hide |
| | 2.2.3. No Timing |
| | 2.2.4. Interruptions |
| | 2.2.5. Re-authenticating |

**Table 5.2. Example of mapping more than one UD guideline to one WCAG success criterion.**

| UD guideline | WCAG success criterion |
|---|---|
| 3.4. Arrange information consistent with its importance | 2.4.10. Section headings |
| 4.4. Differentiate elements in ways that can be described | |

In UD principle 1, we understand that the guidelines 1.1 "Provide the same means of use for all users: identical whenever possible; equivalent when not", 1.2 "Avoid segregating or stigmatizing any users", and 1.4 "Make the design appealing to all users" represent the general objectives of UD; therefore, they are transversal to web content creation and, consequently, to all WCAG guidelines.

Table 5.3 presents examples of parts of the mapping of UD principles 4 and 6. UD guidelines 4.1 and 4.2 are good examples of how technical recommendations from WCAG can be grouped into a UD guideline, thus facilitating understanding of the context in which they are necessary. UD guideline 6.2 is a case in which elements of ISO 9241 were employed. For the complete mapping, consult the Appendix (Apêndice A).

To understand the relative coverage of the WCAG success criteria to the UD guidelines, we summarize them on the principles level in Table 5.4. For each relationship, we present the absolute number of matched WCAG success criteria and their values relative to the total success criteria in the respective WCAG principle. WCAG success criteria that appear in more than one UD guideline of the same UD principle are counted only once.

**Table 5.3. Examples of mappings for the principles 4 and 6 of UD.**

| UD guideline | Mapping |
|---|---|
| **4. Perceptible Information** | |
| 4.1. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information. | 1.1.1. Non-text Content; 1.2.1. Audio-only and Video-only (Pre-recorded); 1.2.2. Captions (Pre-recorded); 1.2.3. Audio Description or Media Alternative (Pre-recorded); 1.2.4. Captions (Live); 1.2.5. Audio Description (Pre-recorded); 1.2.6. Sign Language (Pre-recorded); 1.2.7. Extended Audio Description (Pre-recorded); 1.2.8. Media Alternative (Pre-recorded); 1.2.9. Audio-only (Live); 1.3.1. Info and Relationships; 1.3.3. Sensory Characteristics; 1.4.5. Images of Text; 1.4.9. Images of Text (No Exception) |
| 4.2. Provide adequate contrast between essential information and its surroundings. | 1.4.3. Contrast (Minimum); 1.4.6. Contrast (Enhanced); 1.4.7. Low or No Background Audio |
| **6. Low Physical Effort** | |
| 6.2. Use reasonable operating forces. | ISO 9241-4 (ISO, 1998a) Sections: 6.2.3 Key displacement and force; 6.2.7 Key repeat function; ISO 9241-9 (ISO, 2000b) Section 4.4.2 Biomechanical Load/Effort |

The coverage analysis (Table 5.4) reveals a considerable level of compatibility between UD and WCAG principles. This is supported by the following observations: the

WCAG principle “Perceivable” matches 86.36% to the UD principle “Perceptible Information”; the WCAG principle “Understandable” matches 70.59% to the UD principle “Simple and Intuitive”. The WCAG principle “Operable” is fragmented across the majority of UD principles except in “Size and Space for Approach and Use”. Considering these results, we make some observations:

**Table 5.4. Coverage analysis of WCAG (columns) in relation to the UD principles (rows). Each cell presents the number of WCAG success criteria that address the UD principle, followed by the value relative to the total number of WCAG 2.0 success criteria in the respective WCAG principle. WCAG success criteria are counted only once in each principle relation.**

| UD principles | WCAG principles | | | |
|---|---|---|---|---|
| | **Perceivable** | **Operable** | **Understandable** | **Robust** |
| Equitable Use | - | 2(10%) | - | - |
| Flexibility in Use | 4(18.18%) | 10(50%) | - | - |
| Simple and Intuitive | 1(4.55%) | 7(35%) | 12(70.59%) | - |
| Perceptible Information | 19(86.36%) | 4(20%) | - | 2(100%) |
| Tolerance for Error | - | 3(15%) | 5(29.41%) | 1(50%) |
| Low Phys. Effort | - | 1(5%) | - | - |
| Size/Space Approach/Use | - | - | - | - |

**Physical aspects**. The UD principles “Low Physical Effort” (see Table 5.3 for an example) and “Size and Space for Approach and Use” demand specific guidelines. Even considering that WCAG is focused on web content, we believe that web designers must have concerns regarding aspects of the environments surrounding users when interacting with digital artefacts, especially the mobile ones. For this purpose, we employed some recommendations of ISO 9241 that address environmental aspects: Part 3: Visual display requirements (ISO, 1992; 2000a), Part 4: Keyboard requirements (ISO, 1998a), Part 5: Workstation layout and postural requirements (ISO, 1998b), Part 6: Guidance on the work environment (ISO, 1999) and Part 9: Requirements for non-keyboard input devices (ISO, 2000b). ISO 9241 concerns the ergonomics of human-system interactions. ISO 9241 Part 1 (ISO, 1997) defines the scope of ergonomics as “... *matching the design of products or systems, including displays, input devices, software, workplace, working environment and tasks, to the characteristics, capabilities and limitations of potential users*”. Thus, we believe that designers should accept a holistic view of the context in which their systems will be used.

**Granularity.** The levels of granularity chosen (*i.e.*, UD guidelines and WCAG success criteria) seem to be adequate. As each WCAG success criterion is mapped into a UD guideline, we can say that, considering the WCAG success criteria (61 units), it was possible to reorganize the WCAG success criteria into 19 UD guidelines. For UD, the number was not modified. We observe some other signals that reinforce its adequacy:

- Only 19 of the 61 WCAG success criteria are repeated in different UD guidelines;
- Only 2 of those 19 WCAG success criteria are repeated more than twice (they are repeated 3 times);
- 9 of those 19 WCAG success criteria are repeated in the same UD principle.

Considering this data, we can conclude that in about 84% of the mapping, WCAG success criteria were mapped directly to an UD guideline (69%) or were matched more than once in the same UD principle (15%). About 16% of the WCAG success criteria were mapped to different UD principles. Mappings involving different principles do not imply a bad matching; however, they require more attention from the designer to address the goals of the WCAG success criterion in the contexts of different UD principles.

Examples of repeated WCAG success criteria in the same UD principle are 1.4.5 "Images of Text" and 1.4.9 "Images of Text (No Exception)", which are mapped to the UD principle 4 "Perceptible Information", in the UD guidelines 4.1 "Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information" and 4.4 "Differentiate elements in ways that can be described (*i.e.*, make it easy to give instructions or directions)". Table 5.2 presents an example in which a WCAG success criterion is mapped to UD guidelines from different UD principles.

**Hands and Reading directions**. Identifying success criteria in WCAG 2.0 was not possible for the UD guideline 2.2 "Accommodate right- or left-handed access and use", because this problem is solved by hardware devices such as keyboard and mouse or other assistive technology. However, an analogous problem could be considered in the sense of providing support for different reading directions (see WCAG success criteria 1.3.2 "Meaningful Sequence"), such as occurs in Arabic or Hebrew texts.

Ubiquitous (or Pervasive) Computing proposes the use of Information and Communication Technologies (ICT) spread out throughout the environment in which people are immersed. Considering the tendency of computers to become "unremarkable" (Weiser, 1991; Russell *et al.*, 2005), it raises a number of possibilities and challenges that affect the way web content becomes available. Streitz *et al.* (2002) propose the concept of Roomware, an environment in which ICT are integrated into room elements as, for example, doors, walls and furniture. These environments can potentially contribute to the

"access for all" objective by providing more natural interfaces due to their use of real life elements. On the other hand, if ICT do not take into account the recommendations for universal access (*e.g.*, UD and ISO 9241) it will reinforce the problem of exclusion by transferring the current computing problems to the activities and objects of ordinary life.

## *5.4 Integrating the Mapping into FAware*

FAware is a framework to support the design of awareness mechanisms for web-based inclusive collaborative tools. By "inclusive", we intend to express the objective of developing tools based on Universal Design principles. FAware is currently available as a web-based application.

To accomplish the challenging objective of FAware, designers should be provided with methods to facilitate their understanding of the information system surrounding their target audience, in eliciting requirements and evaluating applications; moreover, a knowledge base of existing awareness mechanisms that could inspire the development of new "inclusive" mechanisms should also be provided. To support understanding of the information systems of the target audience during the system development lifecycle, we adopted methods and techniques from Organizational Semiotics (OS) (Stamper, 1988; Liu, 2000) and Participatory Design (PD) (Muller, 1997; Mumford, 1964).

OS contributed directly with the PAM (Problem Articulation Method), from MEASUR (Methods for Eliciting, Analysing and Specifying Users' Requirements). From PAM we used two artefacts: the Stakeholders Analysis Chart (Kolkman, 1993; Liu, 2001), to support identifying the parties involved in the information system that influence and are influenced by relationships in it, and the Semiotic Framework (Stamper, 1993) that helps designers to clarify the requirements by organizing them in six layers of signs. The Semiotic Framework extends the three layers from Semiotics (syntactic, semantic and pragmatic) by adding three other layers (physical world, empirics and social world) to identify more aspects of the human information system. In addition to the PAM artefacts, we adopted the Evaluation Framing (Baranauskas *et al.*, 2005), which allows the elicitation and discussion of problems and issues from the stakeholders, as well as ideas and solutions for these problems.

FAware's knowledge base is organized following a taxonomy that considers three categories of awareness: workspace (users, actions, objects), context (group, shared objectives, social protocols), and conversational (information for establishing and maintaining communication). Each category is organized by its objective (*e.g.*, provide information about presence, identity, action) and timing (*i.e.*, present and past). The awareness tools considered in the knowledge base involve both academic and market

(free source and private) solutions (*e.g.*, Babble (Erickson *et al.*, 1999), Gmail Chat (Google, 2010), Fisheye Text Viewer (Greenberg *et al.*, 1996)).

Figure 5.1 presents the FAware architecture. At the user interface layer, designers can interact with some modules in which they can specify the model they are working on, interact with the OS artefacts and the Evaluation Framing, perform universal accessibility evaluations using the mapping described in this paper, and ask suggestions about awareness mechanisms and accessibility aspects that can contribute to their model's specifications. FAware[28] is built on an Apache 2[29] web server, server-side scripts using PHP 5, and Oracle Database 10g Express Edition Release 10.2.0.1.0[30].

In the designer model module, designers can select the collaborative tool category (*e.g.*, instant messaging, collaborative text editors) they are working on and describe the model. Based on the collaborative tool category, FAware is able to select and suggest requirements (*e.g.*, bandwidth, media for input, group size) within the semiotic framework module. The universal accessibility module is built upon the mapping described in the previous section. It consists of a user interface where designers can register evaluations of any website and an internal database for the classification of the awareness mechanisms in the knowledge base.

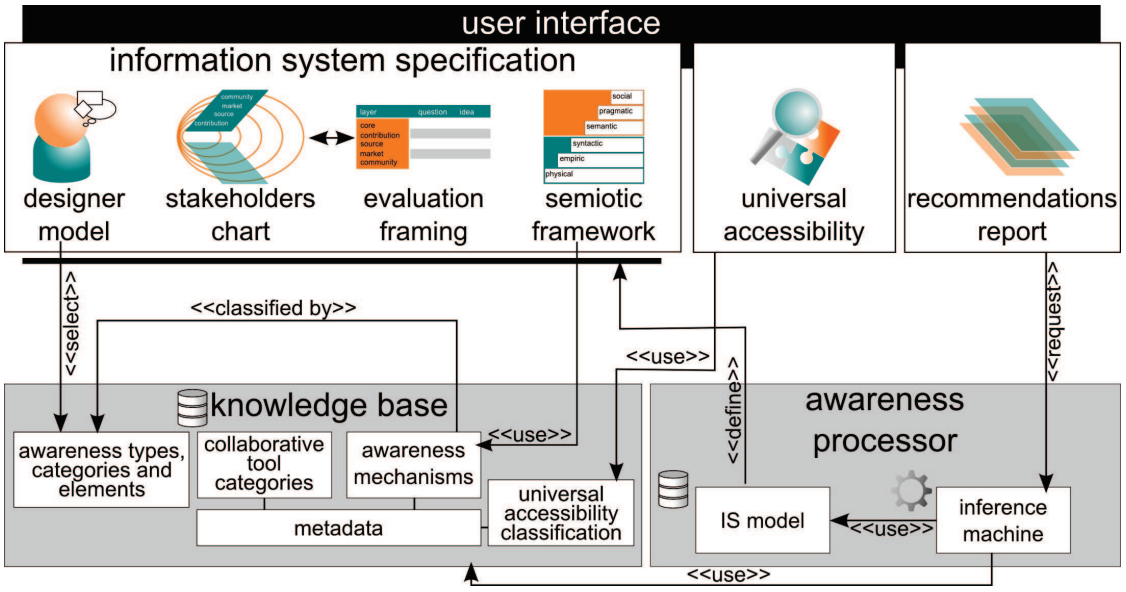


**Figure 5.1. FAware architecture.**

[28] Currently, FAware is available only inside the domain of the University of Campinas.
[29] Apache Software Foundation. http://www.apache.org/.
[30] Oracle Database 10g Express Edition. http://www.oracle.com/technology/products/database/xe.

Based on the information system specifications provided by designers, FAware is able to process the data and produce reports containing suggestions about existing awareness mechanisms and their respective classifications in terms of universal accessibility.

The work in this paper focused on the universal accessibility module as a resource for evaluating websites in general. The module consists of two pages: one presents the listing of the evaluations already registered and offers options for updating, deleting, exporting and creating evaluations. The other is a form for inserting, updating and deleting data from existing evaluations or adding a new evaluation.

In the evaluation's identification section (see Figure 5.2), designers are expected to identify the URL being evaluated and the semi-automatic evaluation tool that will be used. Three evaluation tools are currently available: ATRC Web Accessibility Checker (AChecker) (ATRC, 2009), Cynthia Says (HiSoftware, 2009) and DaSilva (Acessibilidade Brasil, 2010). The evaluation guidelines are subsequent to the identification section. Initially, only the UD principles and guidelines are visible, as shown in the bottom of Figure 5.2. To show or hide the details of an UD guideline, designers should click on the icon "plus" or "minus", respectively, locate to the right of each guideline. To perform these operations for all the UD guidelines, designers can click on the larger icons available at the right of the section "Evaluation Guidelines" title.

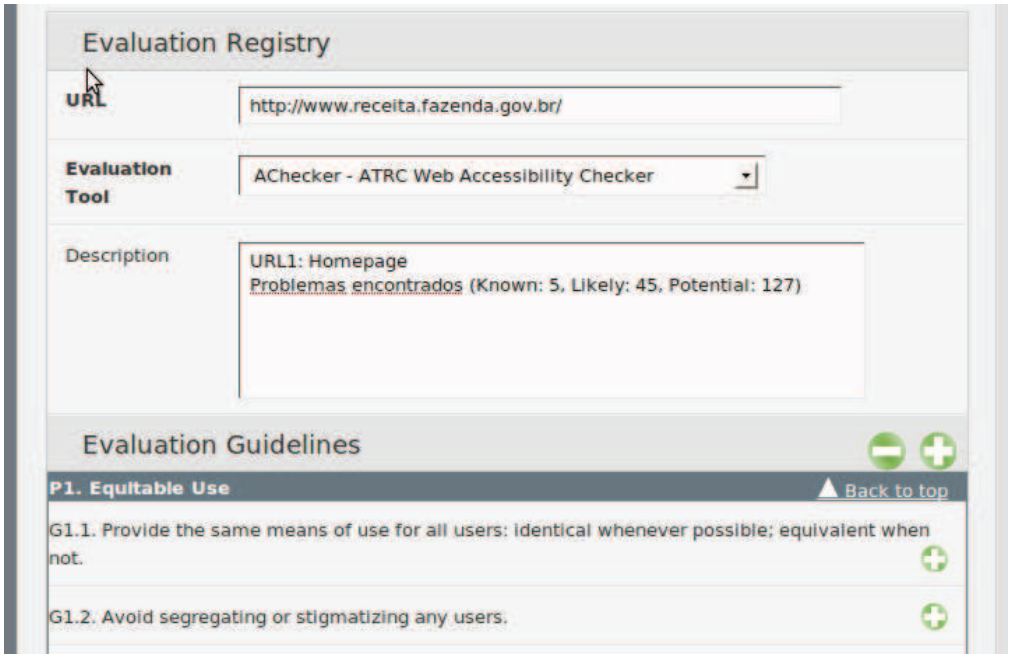


**Figure 5.2. FAware web-based evaluation registration. The top section identifies the object of evaluation, and the bottom section shows the UD principles and guidelines.**

Figure 5.3 presents the UD guideline "Accommodate a wide range of literacy and language skills" with its details expanded. As mentioned in the previous section, for a given UD guideline we can have zero or more WCAG success criterion, ISO 9241 recommendations or a comment not addressed by these two guidelines sets. The title of each WCAG success criterion is linked to its definition at the WAI website. Each ISO 9241 describes a part section and links to the ISO website.

To insert an evaluation of a mapping unit, designers should indicate their agreement regarding the result obtained from the semi-automatic tool and their rationale about the item. Designers can easily delete evaluations of mapping units by setting the agreement field to "Not informed". Designers are able to perform one or more insert, update and delete operations or any combination of them without the need to submit the form.

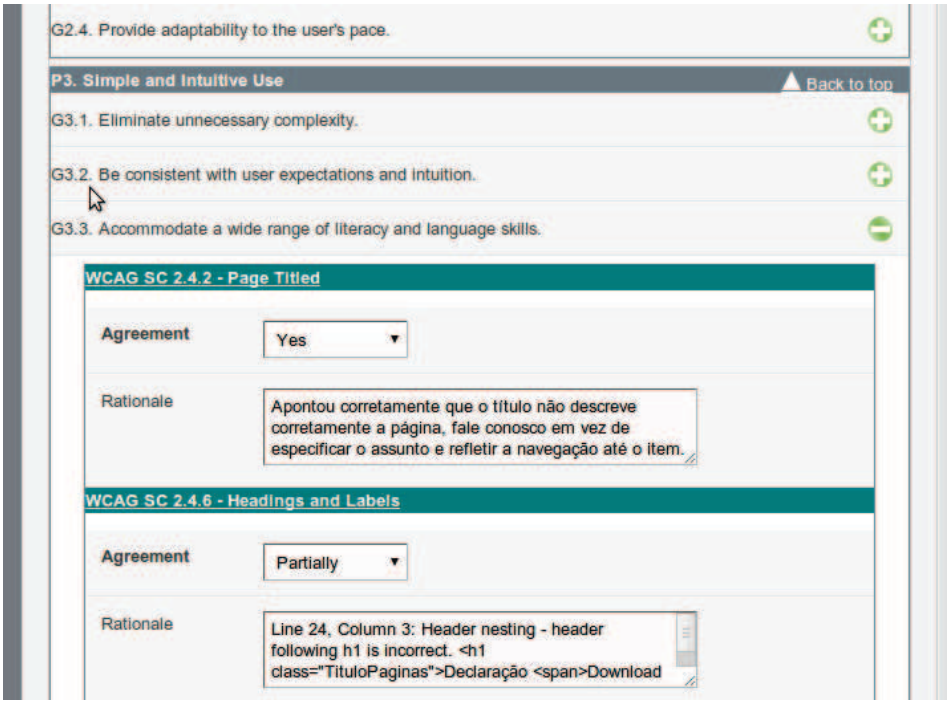


**Figure 5.3. The detailed view of the UD guideline "Accommodate a wide range of literacy and language skills" presents some of the WCAG success criteria linked to it.**

## *5.5 The Evaluation in Practice: a Case Study*

The exploratory study involved 20 subjects (including 17 Human-Computer Interaction (HCI) students and 3 specialists), and the activities consisted of evaluating URLs from an e-Government website and registering the results in FAware. After the activity, the subjects answered a questionnaire. We summarize the results and then discuss observations, limitations and strengths of the approach.

The chosen website was the Secretariat of the Internal Revenue in Brazil (Brasil, 2010) because it is supposed to be used by all Brazilian citizens. We selected the URLs to be evaluated based on the variability of page layouts and error types found in them:

- Homepage, http://www.receita.fazenda.gov.br/;
- Proof of Registration and Registration Status in CPF (*i.e.* the Brazilian registration for individuals), http://www.receita.fazenda.gov.br/Aplicacoes/ATCTA/CPF/ConsultaPublica.asp;
- IRPF2010 (*i.e.* the annual declaration of income tax from individuals) Statement, Software Downloads, http://www.receita.fazenda.gov.br/PessoaFisica/IRPF/2010/declaracao/download-programas.htm;
- Form for sending questions to the Internal Revenue of Brazil, https://www18.receita.fazenda.gov.br/dvssl/atbhe/falecon/comum/asp/env_msg.asp?id=515;
- Exemption from IPI / IOF for People with severe or profound physical disabilities, visual, mental and autistic, http://www.receita.fazenda.gov.br/GuiaContribuinte/IsenIpiDefFisico/IsenIpiDefiFisicoLeia.htm.

After the evaluation session, the subjects were invited to fill in a questionnaire about the activity. The questionnaire was composed of 6 questions using the Likert Scale (Likert, 1932) related to the subjects' knowledge of accessibility, the quantity of items to be evaluated, the integration provided by the mapping, the mapping coverage, the evaluation results, and the FAware module, followed by a free space for subjects to write down their perceptions about the activity.

### 5.5.1 The Activity involving undergraduate and graduate students in Computer Science

The first activity involved 17 subjects enrolled in the Project of User Interfaces discipline of the Institute of Computing at the University of Campinas, Brazil, working in pairs. The activity took about four hours in a laboratory (two hours in the initial presentation and evaluation and two hours for completing the questionnaire and discussing the results), and the subjects completed the two components a week apart. There were no particular requirements for hardware and software except an Internet connection in the laboratory.

In the initial presentation, students were informed about the objective of the activity and saw demonstrations of the universal accessibility module in FAware for registering the evaluation results and of the semi-automatic evaluation tool. During the evaluation session, students were free to choose their partners. In the first step, they had to create a user account in FAware. After that, they could choose one or more of the URLs from the Secretariat of the Internal Revenue to evaluate. Students were supposed to register in FAware the errors found by them or by the semi-automatic tool used for web accessibility evaluation. In addition to the error messages reported, students were asked to indicate their level of agreement on each evaluation item. The agreement possibilities were:

- Yes - the semi-automatic evaluation tool identified an existing problem;
- No - the semi-automatic evaluation tool identified a false problem or did not identify an existing problem;
- Partially – the semi-automatic evaluation tool partially identified a problem, *e.g.*, it did not provide precise feedback, or pointed to the wrong line in the code for the problem.

### 5.5.2 Activity involving specialists in web accessibility

The second activity involved 3 specialists in web accessibility, all Ph.D. candidates of the Institute of Computing at the University of Campinas, Brazil. They collaboratively evaluated all 5 URLs from the Secretariat of the Internal Revenue of Brazil. Each evaluation lasted about 2 hours. The specialists decided to perform a 2-phases evaluation procedure. First they used a semi-automatic evaluation tool, AChecker, and registered the results in FAware. Second, they reviewed all the mapping units from FAware that were not identified by AChecker. After the evaluation process, they completed the same questionnaire as the students.

### 5.5.3 Results

The results from the case study are based on the questionnaire results and the evaluations registered in FAware. From the activity involving students, we obtained 17 questionnaires. In 16 of them, students made suggestions about the web-based interface.

Table 5.5 presents the questions and a synthesis of the students' questionnaire results. As we employed the Likert Scale to elaborate the questions – values from 1 to 5, except on question 5 (6 options), with 1 as the lowest rating, we analysed the median and the mode of each question to analyze the distribution of the data and adjust the results. Except on question 3, the median and mode values were the same, showing strong agreement among the answers. The results from questions 1, 2 and 4 revealed that: 1) most of the

students already had some knowledge of accessibility (from previous classes); 2) they considered that the evaluation had too many items to be considered, but they understood that most of the items are necessary in performing this kind of evaluation, and 3) they considered that the evaluation method covers most of the accessibility aspects to be considered when evaluating web applications.

Question 3 requires some other considerations than the median data. Question 3 has median 3 and mode divided between 3 and 4, representing about 70% of the responses. The results represent an understanding of the benefits of the method of integrating UD, WCAG and ISO 9241, and most of the students felt that the mapping made the evaluation process more laborious. Question 5 had a median and mode of 3. Students considered that the activity took too much time; however, by using it, they discovered various problems beyond those identified by observation. The median of question 6 (about the FAware´s user interface) is 4, what means that most of the students believed that the FAware user interface contributed to facilitate the evaluation process.

**Table 5.5. Results of the students' questionnaire.**

| Question | Median (Likert Scale) | Mode (Likert Scale) |
|---|---|---|
| 1 – About your knowledge in accessibility | 3 | 3 (82%) |
| 2 – About the quantity of items to be evaluated | 2 | 2 (82%) |
| 3 – About the integration of Universal Design, WCAG and ISO 9241 | 3 | 3 and 4 (35% each) |
| 4 – About the coverage of the evaluation | 4 | 4 (53%) |
| 5 – About the results of the evaluation | 3 | 3 (53%) |
| 6 – About the web interface to register the evaluation results | 4 | 4 (47%) |

The responses from the specialists to the questionnaire revealed they thought that the process demands many items to be evaluated but that these items are necessary. For question 3, they verified that the method provided relevant contributions and did not consider the evaluation process more difficult to conduct. As regards the coverage, in question 4 they agreed that the mapping covered most of the aspects of web accessibility. They considered that the merge helped them to identify various items not discovered by simple observation (in Question 5). Finally, in question 6, the subjects agreed that the universal accessibility module brought some benefits to the evaluation process.

In addition to the questions using Likert Scale, in the free edition field the subjects wrote down their perceptions about the experience. In the activity involving students, most of the comments were directed to the universal accessibility module and the semi-automatic tool used. As regards the FAware web-based interface the comments are related to:

- The need for a faster mechanism to find evaluation items;
- Importing the content from WCAG success criteria to FAware. This would be desirable only if the WCAG website offers some service to keep the success criteria data up-to-date;
- A Portuguese version of FAware and its content;
- The session timeout in FAware is too short (This issue has already been solved);
- WCAG success criteria repeated in more than one UD guideline. This is a consequence of the "n to n" relationship between UD guidelines and WCAG success criteria in the mapping. However, considering that in many cases users only want to fill out one occurrence of a WCAG success criterion, we that believe an automatic replication of the data through the repetitions could facilitate the registration process;
- A student expressed satisfaction with the proposal: "*FAware offers complete support for what is supposed to be evaluated*".

Comments involving AChecker were about the various items in the "Potential Problems" section. Many of them are put in by default if certain HTML elements are present, *e.g.*, the message "Link text may not be meaningful" for each "<a>" tag in the document. Also, there were some cases in which the tool pointed out the wrong line of an error, *e.g.*, when pointing repeated element IDs "*caixa*-links" to the Homepage evaluated. A last comment was about the integration of the AChecker results into FAware, to enable users to avoid shifting constantly from one system to the other.

From the specialists' comments, we wish to highlight those related to the "agreement" field of the evaluated items. They suggested an extension of the field to allow registering not only agreement with the semi-automatic tool, but also the items that were identified by observation. Like the students, the specialists revealed they would appreciate the integration of AChecker results to FAware. Other relevant comments revealed their perceptions of the mapping – *"[the integration] helps evaluators with analysing questions in different levels i.e. principles, guidelines, success criteria, etc*." - and the rationale

focused evaluation process – "*the idea of including UD principles arouse a "thinking" process instead of only filling a list of items*".

By analysing the data from the specialists' evaluations, we observed that they registered 145 mapping units regarding the 5 URLs, distributed almost uniformly through the URLs (mean of 29 items by URL and standard deviation of 4.36). Only different error types by URL are considered, *i.e.,* repeated error types in the same URL are computed only once. From the evaluated mapping units, 80 of them were identified in the first phase (*i.e.*, by semi-automatic evaluation) and, the other 65, in the second (*i.e.*, by observational evaluation through FAware). Also, 41 of the 80 mapping units from the first phase were reviewed in the second phase. We thus observe that the FAware approach contributed significantly to the traditional process of accessibility evaluation.

From the mapping units observed by the specialists, 77 rationales indicated agreement to the semi-automatic evaluation tool (the problems pointed out by the tool were actual problems or the tool correctly verified that there were no problems regarding a given error type), 49 indicated disagreement (false positives and imprecise information), and 19 indicated partial agreement (correct and incorrect/imprecise indication of problems). As initially supposed, most of the mapping units indicated agreement in the first phase, using a semi-automatic evaluation tool (61 items or about 76%), and disagreement in the second, performing evaluation based on the units of the mapping (45 items or about 69%).

## *5.6 Discussion*

WCAG mapped into UD and complemented with ISO 9241 environmental recommendations seems to represent a comprehensive set of information about web content accessibility. The organization of UD principles and guidelines in this way has the potential to help designers gain a deeper understanding of the technical recommendations promoted by WCAG and ISO 9241. Moreover, reading UD through the lens of WCAG and ISO 9241 allows the adaptation of principles and guidelines usually inspired by the physical world to the virtual world. In this section we highlight some characteristics of the mapping, its coverage and the results from the case study that merit further discussion.

**Reading level**. WCAG success criteria 3.1.5 "Reading Level" states that texts should not require reading ability more advanced than the lower secondary education level or must offer an alternative presentation of the information. The lower secondary education level is defined by UNESCO (1997) as "*... the two or three year period of education that begins after the completion of six years of school and ends nine years after the beginning of primary education*". Despite the international acceptance of this definition, it may not be adequate when considering developing countries (*e.g.*, India and Brazil); regarding this aspect, in the following we analysed the social and educational demographics of Brazil.

First, we consulted the 2007 Brazilian National Research by Household Sample from the Brazilian Institute of Geography and Statistics (IBGE, from its Brazilian acronym) (IBGE, 2007). The average schooling of the Brazilian population between 15 and 59 years old is 7.83 years. This information shows that, in terms of years at school, Brazil fits the UNESCO classification. However, when considering the Brazilian population of 60 years old and above, the average falls to only 3.8 years.

In addition, we have to consider the quality of those years of school attendance; we consulted the Indicator of Functional Literacy (INAF, from its Brazilian acronym) (IPM, 2009). INAF investigates the ability of the population to read and understand texts and graphic representations. In contrast to the data from IBGE, according to INAF, in 2009, 29.66% of the Brazilian population between 15 and 59 years old were functionally illiterate (*i.e.*, they were not able to perform simple tasks involving reading words and phrases even if some of them were able to read numbers - *e.g.*, telephone numbers, prices, etc. or to find explicit information in short and known texts - *e.g.*, an advertisement or a short letter, to read and write numbers and to perform simple operations to handle money for payment of small amounts or perform length measurements using a tape-measure). We observed that the illiteracy indicator does not have a normal distribution and that it increases significantly with the age of the population. Thus, we believe the choice of the literacy level of the website target audience should take into account the context in which it is used.

**Operability of user interface elements**. In our research, the UD guideline 7.3 "Accommodate variations in hand and grip size" is interpreted in the sense of pointing devices (*e.g.*, mouse and touch screen). While WCAG does not address this subject directly, ISO 9241 treats the question and offers clear directions for the design of buttons. In addition, we wish to address such situations as, for example, users with little or no experience with computers, the elderly, people with low accuracy in their hand movement, and other conditions that limit their accuracy when using pointing devices.

Beyond identifying limitations of the standards for the design of UI elements, here we wish to highlight the relevance of considering the target audience needs and context. One way of dealing with the problem of UI operability in the context considered (low literacy and low skills for using digital artefacts) was presented by Almeida *et al.* (2009), who proposed the adoption of techniques and methods from Participatory Design with the target audience. Some UI elements, extracted from that reference, illustrate ways of helping those users to operate pointing devices. One of them is a set of arrows that complement the browser scroll bar and help users by moving a larger portion of the web page and by associating the direction of the movement more closely with the graphical

representation used (see Figure 5.4.a) and clickable radio and check buttons labels that provide an increase of the clickable area (see Figure 5.4.b).

**Parsing**. WCAG success criterion 4.1.1 "Parsing" addresses the syntax of mark-up content, aiming to contribute to the correct interpretation by user agents. Even considering that mark-up is the heart of web content, the use of other technologies cannot be ignored. Statistics show that JavaScript is enabled in 95% of the web browsers (W3Schools, 2008), and the flash player is installed in 99% of web browsers (Adobe, 2009). Moreover, between 30% and 40% of websites contain flash files, and about 74.5% use some kind of scripting (Wilson, 2008). W3C already includes WCAG techniques using JavaScript codes. Nevertheless, there are other languages currently being used on a large scale (*e.g.*, ActionScript, Microsoft Silverlight) that demand attention. Even for JavaScript, it is difficult to cover all sorts of scripts that can be added to mark-up content. One alternative could be to develop accessibility evaluation tools that do not rely only on static pages: as is usual, in addition to checking the code, the evaluation could simulate scenarios to identify when the execution of a script generates a non-accessible output.


**Figure 5.4. Techniques for improving the operability of UI elements. Item (a) presents directional arrows that complement a browser's scroll bars. Item (b) presents a list of checkboxes that can be selected by clicking in any place of the highlighted area. Images extracted from the Vila na Rede inclusive social network (http://www.vilanarede.org.br).**

**Environment of use**. ISO 9241-6 "Guidance on the work environment" can contribute to UD and WCAG. Consider the UD guideline 4.2 "Provide adequate contrast between essential information and its surroundings", which is mapped to WCAG success criteria 1.4.3 "Contrast (minimum)", 1.4.6 "Contrast (enhanced)", and 1.4.7 "Low or no background audio". Even in a successful scenario (a scenario in which all the WCAG success criteria are satisfied), the accessibility may still be limited due to environmental conditions, as described in ISO 9241-6 Section 6 Guidance on sound and noise.

Therefore, by including ISO 9241 in the mapping, our system offers designers technical recommendations that are not restricted to the web content *per se*.

**Social and emotional factors**. WCAG principles can partially capture the Model of Human Information Processor and its basic mechanisms as proposed by Card *et al.* (1983). The WCAG principle "Perceivable" may relate to the Perceptual Processor, the "Operable" principle to the Motor Processor and the "Understandable" principle to the Cognitive Processor. The "Robust" principle deals with computer coding issues. UD principles and ISO 9241 focus on the physical world that enables or restricts users when interacting with computers.

Stamper (1988) proposed the Semiotic Ladder, a representation of information systems that extends the semiotic classical 3 layers (or divisions) of signs (syntactic, semantic and pragmatic) to 6 layers (physical, empirical, syntactical, semantic, pragmatic and social world). Ideally, a good design should take into account all the 6 layers to model any information system. UD and ISO 9241 address primarily the physics and empirics layers, while WCAG emphasizes syntactics and semantics. The pragmatics and social layers are not yet addressed by any set of recommendations. Because pragmatics and social issues are becoming the focus of a new generation in Human-Computer Interaction and mark the expansion of the area beyond considerations of human cognition, usability, and GUI, a holistic view of people, including affective aspects and considerations of the pragmatic and social nature of interaction with computers, must also be addressed.

From the case study, we made some observations about the method, the universal accessibility module implemented in FAware and some further adjustments. Finally, we comment on the semi-automatic evaluation tools employed.

**Benefiting from automatic and manual evaluations**. From the evaluation results stored in the FAware system, we verified that the method represented an addition to the results got with the semi-automatic evaluation even for the specialists in accessible development. For instance, when considering the evaluation of the "Form for sending questions to the Internal Revenue of Brazil" page, conducted by the specialists, we verified they identified 18 problems from the semi-automatic tool and another 16 using the mapping in FAware, after the semi-automatic evaluation. Examples of issues found by using the mapping in FAware are: a) WCAG success criterion 3.2.4 "Consistent identification". As the semi-automatic evaluation tool verified only one page at once, it was not able to verify that the HTML inputs for a document (*i.e.*, CPF - person national identification) had different behaviours in different pages. One was presented as a single input and the other divided into four inputs; b) UD guideline 7.3 "Accommodate variations in hand and grip size" and ISO 9241-9. These guidelines led the evaluators to identify that HTML inputs of radio type are too small. They suggested that the label of the

respective radio should be selectable too; and c) UD guideline 1.2 “Avoid segregating or stigmatizing any users”. Evaluators identified that only citizens who had an e-mail account could use the contact form.

**Thinking instead of just correcting errors**. An important issue in accessibility evaluation is that they are often limited to correcting of errors pointed out by semi-automatic evaluation processes without being aware of their causes and consequences (or even whether the phenomena identified are in fact errors). Our approach encourages designers to do some thinking about the errors pointed out, by providing situated information for each item. The results presented in the previous section give us some evidence for this, especially when considering questions 4 and 5.

**Evaluation effort and coverage**. In the results of the questionnaire, we observed that our approach still requires significant effort from the participants. Some modifications could facilitate the interaction: integrating content from WCAG (possibly using diverse language translation) to FAware, to avoid shifting from one website to another. Also, as mentioned by subjects in the case study, for the WCAG success criteria that are repeated in more than one UD guideline, a mechanism should be provided to keep them synchronized when desired. Regarding the effort to perform the evaluation, we did not find any problems that were not covered by the mapping.

**Enhancements to the universal accessibility module**. The subjects of the case study pointed out some possible enhancements to the universal accessibility module in FAware. One was to provide search mechanisms for evaluation guidelines in FAware UI, because semi-automatic evaluation tools usually provide the WCAG success criteria identifiers in the evaluation results list. Another is to enhance the agreement field to address more cases as false positives, items verified by observation, and so on. A recurrent request is the integration of the evaluation results generated by the semi-automatic tool to the FAware user interface. The subjects mentioned that this would probably save time in the evaluations.

AChecker results, especially those from the “potential errors” category, caused some discomfort to the subjects of the case study because they are usually automatically generated and the evaluation tool engine is not able to evaluate them. Most of those problems were related to semantic issues such as text alternatives and labels. One suggestion is to group those problems in categories and clarify to the users that they were not evaluated by the tool.

In summary, we believe that our approach offers positive contributions to the way accessibility evaluations should be conducted, by encouraging thinking about the issues pointed out by semi-automatic tools and making sense of their rationale. The results also indicate that the mapping provides wide-spread coverage of the accessibility issues found.

Nevertheless, many other enhancements are still necessary to reduce the effort involved in performing this kind of evaluation.

## 5.7 Conclusion

Developing web content to be "accessible for all" is a complex activity, especially due to the difficulty of knowing the target audience, which can no longer be assumed to be homogeneous. The scientific community and international organizations have sought to propose sets of recommendations (principles, guidelines, technical criteria) to aid designers in the tasks of creating accessible web content. In order to support designers in making sense of those different sets to create technical solutions to their products, this paper mapped WCAG success criteria to UD guidelines. From this mapping, we identified a need for additional recommendations to address physical aspects of the environment in which people are immersed in interacting with computers. For this purpose, we complemented the WCAG criteria with some ISO 9241 recommendations. The resulting mapping offers designers accessibility information grounded in the real world from UD, articulated with a technical orientation for computing technology from WCAG and the environmental components of ISO 9241.

To validate our approach, we conducted a case study with two groups of subjects: undergraduate and graduate students in Computer Science and specialists in web accessibility. Both activities consisted of evaluating URLs from an e-Government website using the universal accessibility module hosted in FAware. The results indicate that the mapping contributed to widening the coverage while promoting thinking about the results of semi-automatic evaluation tools. Nevertheless, accessibility evaluation is not a simple subject, and the evaluation process still demands efforts consistent with that complexity.

Social and emotional aspects are increasingly becoming objects of investigation in HCI (*e.g.*, Morris, 1995; Norman, 2002). The analysis conducted in this paper revealed that knowledge of these aspects should also be considered in creating web content. Regional and cultural characteristics must also be taken into account when applying general recommendations, as we argued in relation to the reading level in different social contexts.

Future research should include investigating other recommendations such as the software-related parts of the ISO 9241, aiming at improving the coverage of the UD guidelines, formulating recommendations for web content based on social and affective aspects, integrating WCAG content dynamically into FAware, aiming at keeping it synchronized and benefiting from the translations available at the W3C website, integrating FAware to semi-automatic evaluation tools, eliminating the need to fill out

repeated WCAG success criteria repeatedly, and developing search mechanisms for the evaluation guidelines in FAware.

# Capítulo 6:

# Awareness of Others in Collaborative Systems: the contribution of a design framework

## *6.1 Introduction*

Computer-mediated collaborative systems have assumed a relevant role in the Web, especially with applications supporting social interaction, such as online social networks, multiplayer games, and instant messaging. A study from IBM (2009) projected that by 2012, online social networks will reach 800 million people, and the interaction in such systems will consume approximately 90% of the Internet bandwidth. Even when considering developing countries, the current number of users of social networks is impressive (in Brazil it represents 15.14% of all Internet visits (Serasa Experian, 2010)). Therefore, the collaborative systems industry has a challenging task of dealing with the vast diversity of people interacting with such systems without segregation of the less capable.

Research on computer-mediated collaborative systems began in the 80s with systems to support distributed work environments (Grudin, 1994); this research area was called Computer-Supported Cooperative Work (CSCW). In subsequent years, other areas emerged from CSCW as Computer-Supported Cooperative Learning (CSCL) and Computer-Supported Social Networks (CSSN); and as evidenced by some of the main CSCW conferences (ACM, 2010; IEEE, 2010), it is possible to identify a number of contexts in which they are applied, such as healthcare, e-commerce, project management, games, animation, geographical location, sustainability, social inclusion, to name a few.

As observed by Cadiz *et al.* (2002), aspects related to awareness were present in approximately a quarter of the publications in the main CSCW conferences of the 90s.

Currently, awareness is an underlying concept in a large number of collaborative systems works. Nevertheless, as awareness is usually a supportive resource to collaborative functionalities, and due the lack of principled information available for awareness, designers are constantly reinventing mechanisms to support awareness (Gutwin & Greenberg, 2002). Therefore, designers should be provided with artifacts to stimulate the thinking process about awareness, while designing ICS.

Awareness of other people – including peoples' profiles, actions, events, locations, moods, context and shared objects – becomes a key requirement to support interactions among people in collaborative systems. The importance of awareness in such systems is reinforced when considering the increasing diversity of people joining those virtual shared environments. In this work, collaborative systems that provide adequate conditions for people interaction without segregating them are called Inclusive Collaborative Systems (ICS). The design of ICS demands consideration of the wider information system in which the collaborative system is embedded, in contrast to the strict technically focused approaches.

In order to address the complexity of awareness issues, previous work proposed models and tools to support the design of collaborative systems, including mechanisms to support awareness, *e.g.*, the conceptual model of groupware (Ellis & Wainer, 1994), the Denver model (Salvador *et al.*, 1996), the model for workspace awareness (Gutwin & Greenberg, 2002), the frameworks MArq-G* (Barbosa *et al.*, 2005) and Manas (Barbosa, 2006), the F@ framework (Tran *et al.*, 2006), the BW-M framework to support awareness (Kirsch-Pinheiro *et al.*, 2005), or the framework for collaborative e-commerce (Chen *et al.*, 2010). Although historically relevant, these contributions do not completely address aspects related to the whole information system people are involved in, as discussed in Almeida and Baranauskas (2008b).

This work presents FAware: a framework to address the design for awareness in web-based ICS, and discusses preliminary results of its use. The FAware framework includes a knowledge base of mechanisms that extends the framework proposed by Gutwin and Greenberg (2002) by adding the conversational and contextual awareness types. In addition, FAware provides artifacts to support the design of information systems by addressing awareness elicitation and recommendations and a module for evaluating the web-based designed application. FAware articulates methods and artifacts from Organizational Semiotics (OS) and principles and guidelines from Universal Design (UD), with the objective of providing a socio-technical vision of information systems.

To investigate the potential of FAware in supporting designers in transforming requirements into design solutions, we conducted an exploratory study involving interaction designers. The involved designers were engaged in the "Social Networks and

Professional Autonomy: new directions for remote continuous formation of AEE (Portuguese acronym for specialized educational support) teachers". That project aims at designing an ICS system to support the collaboration of teachers working with students with sensory or cognitive impairments, or high intellectual skills, in Brazilian regular schools. In the exploratory study, designers were initially invited to use FAware to model the information system (stakeholders, problems, questions, solutions, ideas, and requirements) and use the Recommendations Report module to support the redesign of awareness elements in a synchronous communication tool integrated to an Inclusive Social Network (ISN) system.

This paper is organized as follows: the next section presents the theoretical and methodological background. Following, we present the framework for supporting the design of awareness in ICS. Afterwards, we present the exploratory study and a discussion on results. The last section summarizes and concludes the work.

## *6.2 Theoretical and Methodological Background*

Supporting awareness in web-based inclusive collaborative systems design demands considerations coming from different disciplines involving:

- Investigation about the target audience to understand the meanings, communications, social protocols, intentions, and other signs shared in the information system;
- Search for solutions reaching the greatest extension of people without segregating them in their differences.

Based on this demand, we adopted methods from OS (Stamper, 1973; Liu, 2000), and principles from UD (Connell *et al.*, 1997), as described in the next sections. Both OS and UD were employed within the framework lifecycle itself, and contributed to the elicitation of requirements, the creation of the framework's knowledge base (based on literature analysis and participatory activities with target audience), the design of the web-based application that materializes the framework, and as a computer artifact for the users of the framework.

### 6.2.1 Organizational Semiotics

OS is a discipline rooted in Semiotics and applied to organizational processes that investigates the nature, characteristics, functions, and effects of information and communication in organizational contexts. Organizations are social systems in which people behave according to a certain system of norms (Liu, 2000; Stamper & Liu, 1994). These norms are regularities of perception, behavior, belief, and value (Stamper *et al.,*

1988; Liu, 2000). The adoption of OS in the context of this work helped to understand complex processes involved in the interaction with computer technologies and to anticipate how such technologies would affect or are affected by the interactions of people.

Analyzed only according to the perspective of engineering, such processes are interpreted as syntactic phenomena. The analysis using OS reveals the primary function of computer systems as vehicles of signs[31] and supplies an adequate vocabulary that makes the understanding of computer systems possible in light of other types of sign systems (Baranauskas & Bonacin, 2008; Nadin, 1988; De Oliveira & Baranauskas, 1998).

In the late 80s, Stamper defined a set of methods named MEASUR (Methods for Eliciting, Analyzing, and Specifying Users' Requirements) (Stamper *et al.*, 1988; Liu, 2000; Liu, 2001) to support the use of Organizational Semiotics concepts in information systems organization. In this work, we used the Semiotic Onion artifact (Stamper *et al.*, 1973) and part of the Problem Articulation Method (PAM) (Stamper *et al.*, 1988, Liu, 2000; Liu, 2001) to help in the identification of issues and articulation of problems raised by interested parties (Stamper & Kolkman, 1991). From PAM, we used two artifacts: the Stakeholder Analysis Chart (Kolkman, 1993; Liu, 2001) and the Semiotic Ladder (Stamper, 1993).

The Semiotic Onion represents information systems in three layers of information: the informal, the formal and the technical. The informal layer considers the information system as a whole and describes agents' interactions with communities and with the social world. The formal layer represents activities structured in well-defined procedures. The technical layer represents parts of formal systems, usually supported by machines and Information and Communication Technologies (ICTs).

The Stakeholder Analysis supports the designer in clarifying the stakeholders and their potential specific interests in the target system. Complementing the stakeholders' elicitation, we adopted the Evaluation Framing (Baranauskas *et al.*, 2005) to analyze questions, issues, ideas, and solutions related to the target domain, organized according to the respective stakeholders. Although the Evaluation Framing is not part of the original PAM, it has been used in problem articulation within several projects related to digital inclusion (Bonacin *et al.*, 2006; Neris & Baranauskas, 2009).

The Semiotic Ladder represents the signs involved in communication processes distributed in six layers of information, three of them coming from the classical Semiotics

[31] Sign is defined in OS as something which stands to somebody for something in some respect or capacity, in some community or social context.

(*i.e.*, Syntactic, Semantics, and Pragmatics) (Peirce, 1974) and other three proposed by Stamper to address the Physical world, Empirics, and Social world, as follows:

- Physical World – physical distinctions, hardware, component density, etc;
- Empirics – patterns, entropy, channel capacity, efficiency, etc;
- Syntactic – formal structures, language, logic, data, records, software, etc;
- Semantics – meanings, truth, signification, etc;
- Pragmatics – intentions, conversations, negotiations, etc;
- Social World - beliefs, expectations, commitments, law, culture, etc.

The six layers of the Semiotic Ladder are intended to address the information systems as a whole, including both the technological infrastructure (physical, empirics, and syntactic) and the human information functions (semantics, pragmatics, and social world).

### 6.2.2 Universal Design

UD (or Design for All), as defined by Connell *et al*. (1997), consists of designing products and environments to be usable by all people to the greatest extent possible, without the need for adaptation or specialized design. The objective of UD is challenging and, despite the difficulty – or even the impossibility, due to the current technological and scientific state of art of the development of products for all, its practice encourages designers to potentially produce better solutions.

Researchers in Computer Science have sought universal solutions in software applications and their user interfaces (*e.g.*, Abascal & Nicolle, 2005; Shneiderman, 2000; Vanderheiden, 2000). Other researches have focused on specific issues, usually regarding people´s physical aspects such as cognitive disabilities (Bohman & Anderson, 2005), visual impairments (Murphy *et al*., 2008), and reduced mobility (Sporka *et al*., 1996).

### 6.2.3 Awareness in Collaborative Systems

Awareness of others is the up-to-date understanding of others – involving aspects such as presence, action, location, objects, context – a person keeps while interacting within a collaborative system, that contextualizes her activity (Dourish & Bellotti, 1992). Mechanisms to support awareness are artifacts that aim at providing the up-to-date information necessary to people become aware while interacting within a collaborative system.

A literature review on awareness in collaborative systems (awareness related concepts, mechanisms, and frameworks) was conducted by using the lens of OS. Results of the

analysis are represented in the Semiotic Onion artifact highlighting relevant concepts in collaborative systems distributed in the three layers of the artifact (see Figure 6.1).

Almeida and Baranauskas (2008b) observed that awareness can be addressed by these three layers because it can be materialized as a piece of software, a well-established communication protocol, a set of information gathered in informal situation, or a set of patterns shared in a sub-community, for example.

Considering this wider approach to awareness, the next step involved to identify aspects of awareness not yet addressed by literature. The Semiotic Ladder was adapted to represent contributions of the literature work distributed through its layers of information (see Figure 6.2).

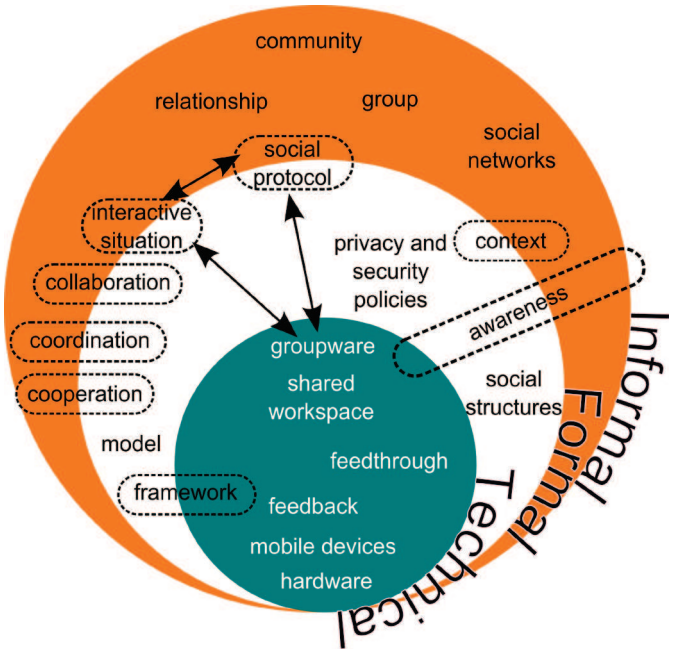


**Figure 6.1. Semiotic Onion for concepts related to collaborative systems (adapted from Almeida & Baranauskas (2008b)).**

Figure 6.2 shows that the consulted literature, in general, covers the layers of the onion corresponding to classical Semiotics (*i.e.* syntactic, semantics, and pragmatics). When addressing the other layers, as occurred in the Physical layer, the work of Vivacqua *et al.* (2006) refers to the infra-structure of their framework itself. In our approach, the object under consideration is the users' information system, which involves not only cognitive, cultural, and social aspects, but the physical world, too. In this sense, additional layers proposed by OS still remain uncovered, especially considering de design of ICS.

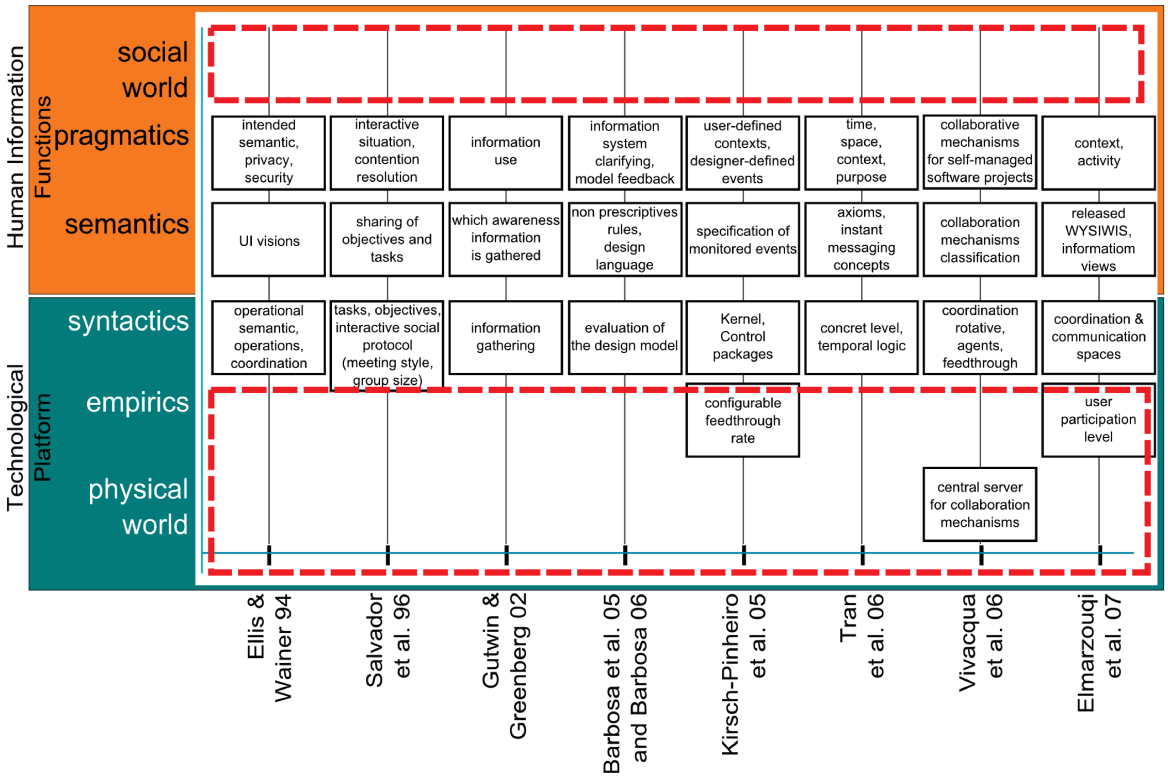


**Figure 6.2. Adaptation of the Semiotic Ladder. Dotted rectangles represent areas less addressed in the consulted literature (adapted from Almeida & Baranauskas (2008b)).**

The analysis of the Semiotic Onion and Semiotic Ladder artifacts suggests that awareness should be addressed as a component of an ICS that has technical, formal, and informal layers of information. Additionally, it is necessary to investigate the signs regarding physical, empirics, and social aspects – and review the other layers – that affect the way awareness information is gathered and understood in an ICS. With this intent, we compiled definitions and mechanisms to support awareness in different application contexts, which resulted in the following types of awareness:

- Self-awareness: awareness of a person in relation to the entire group (*e.g.*, a person knows how much work he/she has relatively done when compared to other people) (Tran *et al.*, 2006, 464);
- Contextual awareness: awareness of cooperative goals, tasks, and results (Tran *et al.*, 2006, 464). Some of the systems that use contextual awareness are those which aim at facilitating unplanned interactions (Lietchi, 2000);

- Workspace awareness: awareness of a shared workspace (*e.g.*, information about the presence of people in the workspace, properties of artifacts in the workspace, people's activity) (Tran *et al.*, 2006, 464). Workspace awareness is up-to-the-moment understanding of another person's interaction in the shared workspace. It is limited to events happening in the workspace and inside the temporal and physical bounds of the task that the group is carrying out (Gutwin & Greenberg 2002). This type is also adopted by Liechti (2000);
- Conversational awareness: awareness of a conversation between people in a group (Tran *et al.*, 2006, 464);
- Peripheral awareness: the way in which some systems present information to their users, *i.e.*, without requiring the focus of their attention (Liechti, 2000, 5);
- Artifact awareness: one person's knowledge of the artifacts and tools that other people are working with (Tee *et al.*, 2006, 99).

Considering these definitions, we take peripheral awareness as transversal to the other types as it is applicable to the other awareness types. Moreover, artifact awareness can be considered as a part of workspace awareness, and self-awareness seems to be an unavoidable consequence of being aware of others.

The type of mechanisms used to support awareness can vary significantly according to the scope and characteristics of each collaborative system. Some mechanisms to support awareness are small indicators presented in some area of the UI as an indication of mouse pointers from other participants in a collaborative drawing session (Greenberg & Bohnet, 1991) or an audio icon (or earcon) indicating a new event in an instant messaging session. Others can be an entire resource such as a contact list of a social network or a graph visualization of objects or conversations in a shared workspace (Greenberg *et al*., 1996; Almeida *et al*., 2010). In some specific situations, such mechanisms can even be a whole collaborative system, for example a way to keep a family aware of the location of each relative or a method to inform the use and availability of computers in a laboratory or office with several rooms (Sohlenkamp & Chwelos, 1994; Ljungstrand & Segerstad, 2000).

## *6.3 FAware: A Framework for Awareness in Web-Based ICS*

As observed in the previous section, frameworks usually do not address questions regarding physical, empirics, and social layers of information systems. We argue that those layers should be investigated to contribute to the design of ICS, especially if we consider the marked differences among people as found in developing countries. This

section presents our approach and framework to guide the design of mechanisms to support awareness in web-based ICS.

FAware has three major components (see Figure 6.3): the Knowledge Base, the User Interface, and the Awareness Processor.

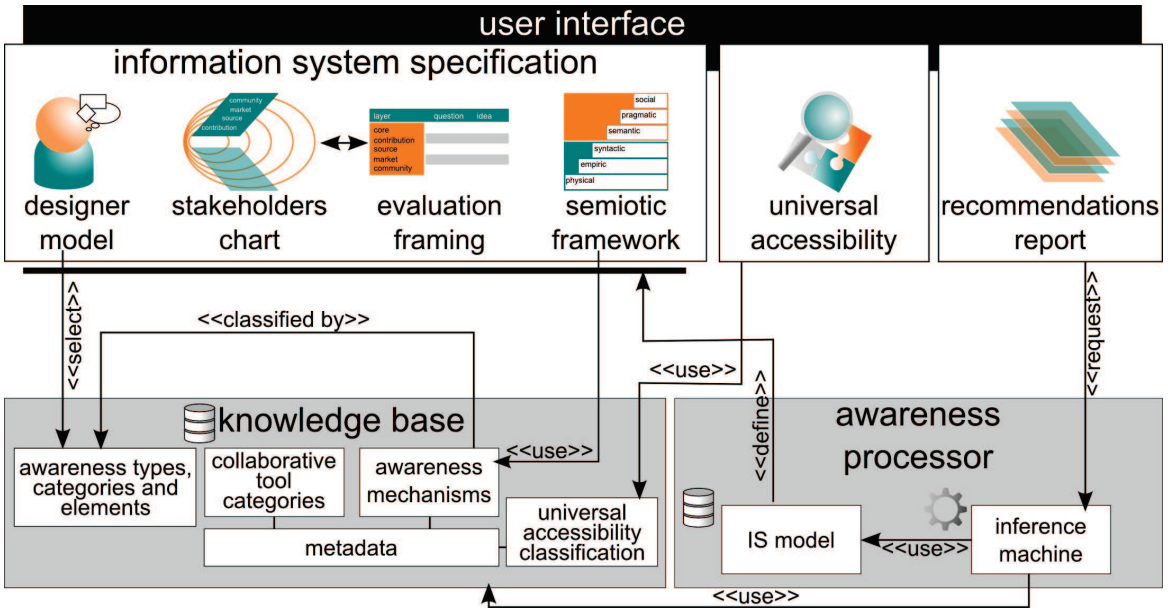


**Figure 6.3. Overview of the FAware framework.**

FAware was developed using Oracle Database 10g Express Edition Release 10.2.0.1.0[32] and WampServer 2.0 (Apache 2.2.11 and PHP 5.3.0)[33]. The User Interface component is organized in three layers (using XHTML 1.0 Strict, CSS 2, PHP, and JavaScript) as follows: presentation, data validation, and database communication. The Awareness Processor component is developed using Oracle PL/SQL Release 10.2.0.1.0, as inference machine, allowing it to process all the necessary information from the IS model without the overhead to communicate to the web-server (currently it processes a complete report in approximately half second). The Awareness Processor is organized in two packages: the Processor, which is responsible for processing calls from the User Interface component to the Recommendations Report, and the Metadata package, which

[32] Oracle Database 10g Express Edition. HTTP://www.oracle.com/technology/products/database/xe.

[33] WampServer. HTTP://www.wampserver.com.

calculates matching for the references and designers' models determined by the Processor package.

### 6.3.1 Knowledge Base

The knowledge base is composed of: 1) a categorization for collaborative tools according to the last editions of key conferences in CSCW (ACM, 2010; IEEE, 2010), 2) a taxonomy, based on Gutwin and Greenberg (2002), that organizes awareness mechanisms and concepts, 3) a base of mechanisms to support awareness that contains academic works, public, and private collaborative tools, 4) a set of metadata used to index the base mechanisms to support awareness and to guide designers in modeling an information system, and 5) a mapping of UD and web accessibility guidelines that constitutes a rationale-oriented process to evaluate web-based applications.

Figure 6.4 presents the elements that compose the taxonomy of mechanisms and concepts for awareness. As proposed in Gutwin and Greenberg (2002), FAware's taxonomy is based on elements, questions, and answers. Each element (*e.g.*, actions, authorship, and presence) is related to a category (*i.e.*, what, who, when, how, where), an awareness type (*i.e.*, workspace, contextual, and conversational), and a position in time (*i.e.* present, past). There can be zero or more specific questions (*e.g.* "Who is doing that action?", "Who are the authors of that object?", "Who is currently logged in?") related to an element. The answers for these questions come from the base of mechanisms to support awareness. One answer may refer to one or more mechanisms and may focus on one or more categories of collaborative tools.

Each reference in the base of mechanisms to support awareness may refer to an academic work or a public or private collaborative tool. Still, one reference can refer to the whole content or a specific subject inside a wider context. For instance, the reference Raikundalia and Zhang (2005) has three subjects: the Task Allocation Tree, the Use-Based History Tracking, and the User Action List. This level of granularity is useful for a more precise indexing of the references. To perform a first evaluation of FAware, we loaded the knowledge base with approximately one hundred references and approximately fifty questions.

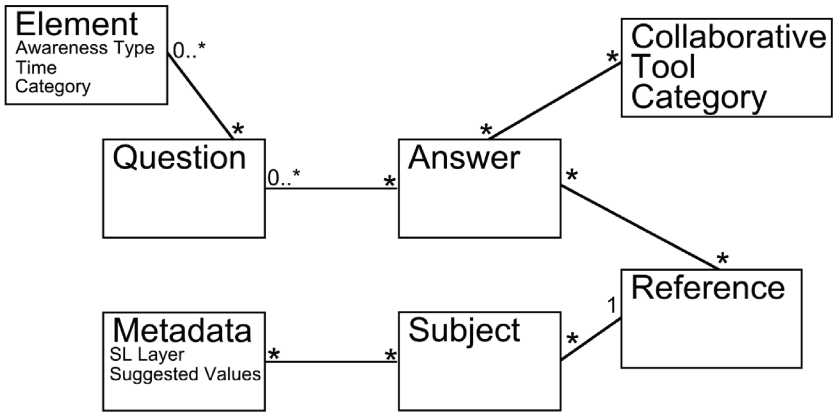


**Figure 6.4. Taxonomy's elements.**

The references indexation is based on a set of metadata. The metadata were extracted from available literature that summarizes contributions from CSCW, (Almeida & Baranauskas, 2008b), participatory studies for modeling collaborative tools for the context of users´ diversity (Almeida *et al*. 2010; Neris *et al*., 2009), and a survey of awareness in collaborative systems (Almeida & Baranauskas, 2008a). The set of metadata is not an exhaustive list and can be improved along with the indexation of new references to the knowledge base. Each metadata has a name, a description, a range of values, and a type for the ranged values (examples in Table 6.1). There are three types of possible values: Exclusive (only one value can be selected), Multiple (more than one value can be selected), and Cumulative (there is an implicit order among the values, so that selection of one element also selects previous elements, *e.g.*, in a list of five elements, if the third one is selected, the first and second are selected, too). Additionally, each metadata is indexed in one layer of the Semiotic Ladder so that there is an instance of the Semiotic Ladder for each reference and subject in the knowledge base.

### 6.3.2 User Interface

FAware's User Interface component is composed of three modules: the Information System Specification, the Universal Accessibility (not covered in this work), and the Recommendations Report. The Universal Accessibility module was covered in a previous work (Almeida & Baranauskas, 2010).

**Table 6.1. Examples of metadata employed in FAware.**

| Metadata | Possible Values | Type | Layer |
|---|---|---|---|
| hardware available | microphone, webcam, headphone or speaker, cell phone, scanner, printer, touch screen | Multiple | Physical |
| internet bandwidth | very low, dial-up, 128 kbps, 256 kbps, 512 kbps, 1 mbps, more than 1 mbps | Cumulative | Empiric |
| awareness presentation | peripherally, along with the main content, separated functionality | Cumulative | Syntactic |
| groups constitution | automatically by the system, explicit by the users, implicit according to the users interaction and communication | Multiple | Social |
| meeting style | unidirectional, mixed, multidirectional | Exclusive | Syntactic |
| license of use for users' content | attribution, share alike, noncommercial, no derivative works | Multiple | Syntactic |

### 6.3.2.1 Information System Specification

The Information System Specification offers four artifacts: the definition of the Designer's Model, the Stakeholder Analysis, the Evaluation Framing, and the Semiotic Ladder. The definition of the Designer's Model is the initial modeling step. Beyond the model name and description, designers should choose one of the collaborative tool categories. The other artifacts (see Figure 6.5) refer to the model created in this artifact.

The Stakeholder Analysis supports the designer in clarifying the stakeholders and their potential specific interests in the target system. In this work we adopted the classification of Kolkman (1993) and Liu (2001) that distributes stakeholders into four categories:

- Contributions - Actors (those who actually perform the desired idea, producing the system consequences) and Responsible (those who conceived the main idea or issue) are stakeholders who directly contribute to the system and who are most affected by it;
- Sources - Clients (those who benefit from the consequences of the actions taken or those who receive the outcomes) and Suppliers (responsible for providing the necessary conditions for the system to function);

- Markets - Partners (collaborate by dividing resources and joining forces in order to solve issues together) and Competitors (often represent a challenge as they either conflict or concur with the system's interests);
- Community - Spectator and Legislator (those responsible for establishing the rules, whether official or by social protocols) comprehend the whole community that will receive the gains or losses as consequence of the implementation of this system.

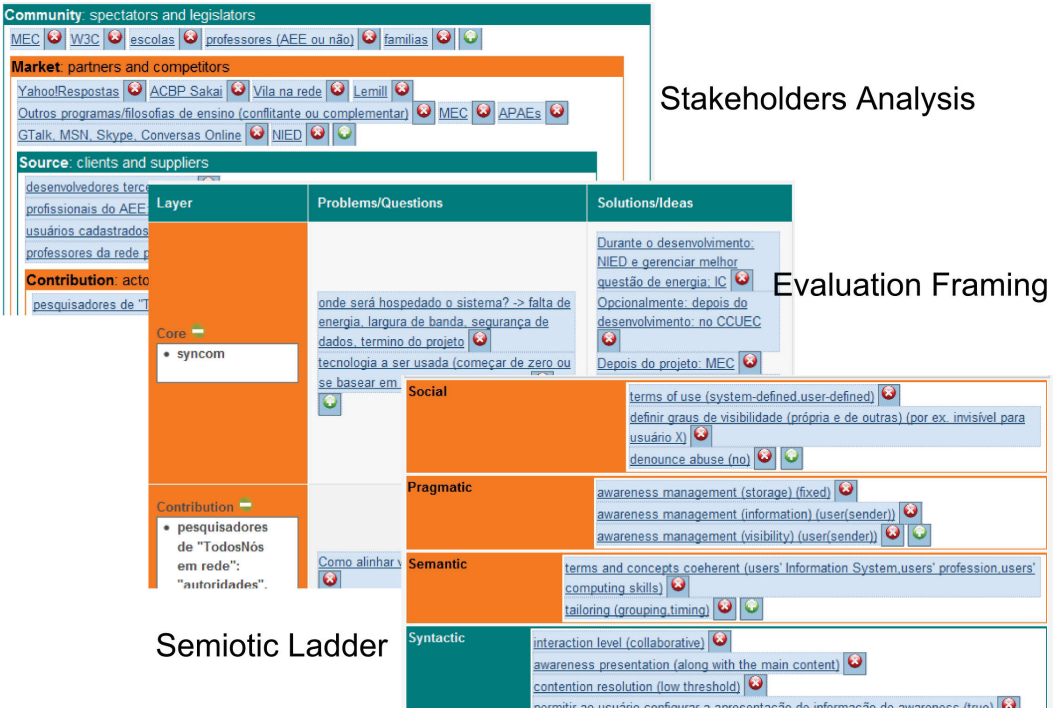


**Figure 6.5. Artifacts from the Information System Specification.**

Complementing the stakeholder elicitation, the Evaluation Framing (Baranauskas *et al*., 2005) represents the stakeholders' questions, issues, ideas, and solutions related to the target domain. As the artifact is generally applied at the beginning of a project, it is possible not to have solutions for all the problems pointed out; however, a set of initial ideas start to be elicited. In FAware, the Stakeholder Analysis and Evaluation Framing artifacts are linked, so that stakeholders identified in the first artifact are imported to the second.

The Semiotic Ladder in the User Interface component follows its original proposal (see Figure 6.5). The ladder style of the artifact expresses dependence among the layers. In a ladder, the lack of a step makes climbing harder or even impossible. The same occurs in the Semiotic Ladder; if a layer is not considered, the resulting product will probably not fulfill the users' needs or will become useless. To support designers in thinking about awareness when using this artifact, FAware provides the same metadata used to index the references of the knowledge base, in the respective layers. Thus, designers can either specify new requirements or use the metadata to choose among the available possible values.

### 6.3.2.2 Recommendations Report and Awareness Processor

After supporting designers in clarifying the targeted information system, FAware is able to provide a set of recommendations, based on the tool category and the requirements informed in the Semiotic Ladder. The Recommendations Report module allows designers to add filters to the report, discard recommendations, and adjust their relevance. Figure 6.6 presents the report configuration, at the left, and an example of the report body, at the right.

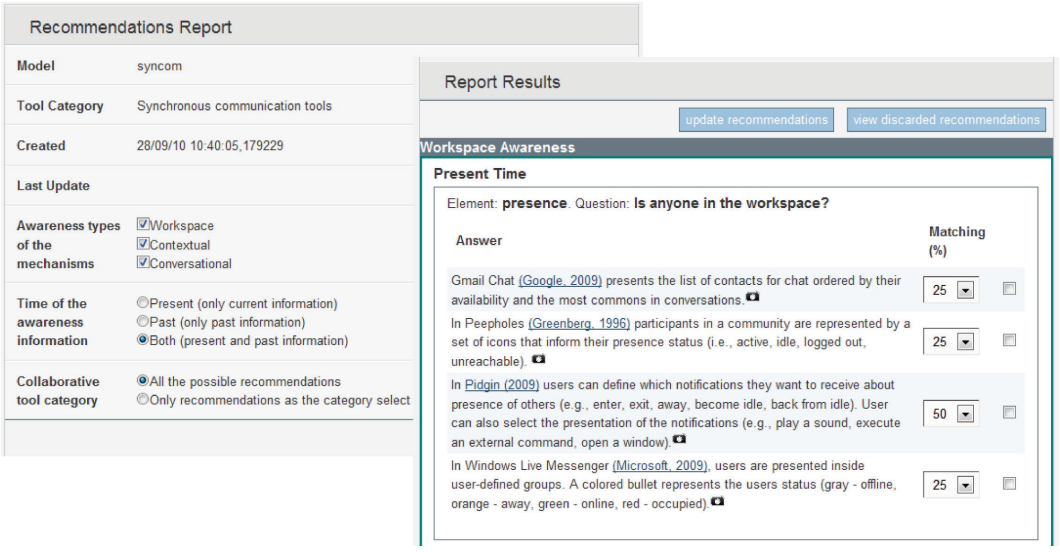


**Figure 6.6. Recommendations Report. On the left are the report filters, and on the right are examples of recommendations in the report body.**

The filters provided in the Recommendations Report module are those related to upper levels of the taxonomy. Designers can select the type of awareness (one or multiple), the

time that the awareness information are related (present, past or both), and whether the report should present only results related to the designer's model of collaborative tool. Functionality for discarding recommendations is also available for analysis of relevance after the report is generated.

The recommendations in the report are grouped by awareness types of the mechanism, time, element, and question. Each answer involves one or more references that address the same question. The answer match is the maximum matching value among the references used in the answer. The matching is presented in a scale of 0 to 100% (100% represents an answer that matches all the requirements given by the designer in the Semiotic Ladder). To determine the matching of each reference, the Awareness Processor compares the indexed metadata for each reference with the metadata given in the Semiotic Ladder, considering the type of metadata (*i.e.*, exclusive, multiple, and cumulative) and the filter informed in the report header. As one of the main objectives of the recommendations report is to promote the thinking process about the elements, questions, and mechanisms to support awareness, FAware provides resources for the designers to adjust the report results by discarding recommendations or changing their matching values.

## *6.4 Preliminary Use of FAware: an Exploratory Study*

To evaluate the potential of FAware in assisting designers throughout the design of mechanisms to support awareness in web-based ICS, we conducted an exploratory study, described in the sequence, using the Designer's Model, Stakeholders Analysis, Evaluation Framing, Semiotic Ladder components, and the Recommendations Report module.

### 6.4.1 Subjects and method

The exploratory study consisted of redesigning *Conversas* Online (Almeida *et al.*, 2010), a system developed to be integrated to an ISN, named *Vila na Rede* (2010). *Vila na Rede* was developed as part of the *e-Cidadania* project (2010), which aims at the investigation of systems and methods for the constitution of a culture mediated by ICT. Figure 6.7.a presents a *Conversas* Online session involving three people in conversation. *Conversas* Online is a floating element, so that users can keep navigating in the network. Each participant can choose different media to communicate. Figure 6.7.b presents Graph of *Conversas*, a graph representation of people and conversations that are taking place in a moment. A case study previously reported with Conversas Online (Almeida *et al.*, 2010) identified some issues in the current version such as: the difficulty to associate the buttons in the upper bar with their respective functions, difficulty to understand the graph representation of conversations, the users' status is automatically determined and cannot

be changed by the users, and the lack of protocol to start a conversation or request some media (*e.g.* audio and video streaming).


**Figure 6.7. *Conversas* Online. In a) we present the synchronous conversation user interface, and in b) the graph of the conversations that are taking place in the ISN (image from Almeida *et al.* (2010)).**

The exploratory study described in this work involved three researchers (two Ph.D. candidates in Computer Science, and one graduate in Computer Science) working as designers for the AEE project. One of them had previous knowledge about OS and the *Conversas* Online. The other two had no previous experience with subjects or the system. Additionally, they had no specific knowledge about awareness in ICS. By the time of the exploratory study, the project was in the initial phase and the participants were investigating candidate systems to host their social network. *Vila na Rede* was one of these candidates, and the researchers were interested in understanding *Conversas* Online and aspects regarding awareness that could contribute to their project.

The dynamics of the exploratory study involved five co-located meetings of approximately four hours each. As resources, the participants had a computer with Internet access and materials to make sketches and annotations. A facilitator was present in all meetings, making notes and providing support when necessary. The activities that the participants were supposed to perform during the exploratory study were:

- Create an account in FAware;

- Create a model by using the Designer's Model;
- Elicit the information system by using the Stakeholders Analysis, Evaluation Framing, and Semiotic Ladder artifacts, in an order chosen by the researchers;
- Project the changes towards redesign by exploring the Recommendations Report Module;
- Redesign *Conversas* Online;
- Answer a questionnaire and briefly discuss the experience.

The participants were free to choose how much time to spend in each activity and when to shift from one to another.

### 6.4.2 Results from the meetings

In the first meeting, the AEE researchers participating in the study created a user account in FAware and worked in the Stakeholder Analysis and Evaluation Framing. Since not all researchers were familiar with OS, the facilitator explained some conceptual aspects during the activities. In the second meeting, they started thinking about the additional requirements and considering the context of the AEE project, which potentially could demand modifications in current version of *Conversas* Online, by using the Semiotic Ladder. In the third meeting, they finished the requirements elicitation using the Semiotic Ladder and started using the Recommendations Report. In the fourth, they finished analysis of the Recommendations Report and started the redesign of *Conversas* Online. The redesign occupied all of the fifth meeting, and the researchers decided to finish it remotely.

In the Designer's Model artifact, they created a model named "syncom" and chose "Synchronous Communication Tools" as the collaborative tool category. The initial sequence of the artifacts they worked on was: Stakeholders Analysis, Evaluation Framing, Semiotic Ladder, and Recommendations Report. However, while interacting with the artifacts, they frequently shifted from one to another to add or change information.

In the Stakeholders Analysis, the researchers faced some challenges deciding in which layer a stakeholder should be placed; at the end of the activity they identified 20 stakeholders. In the same meeting they started thinking about questions, issues, solutions, and ideas related to stakeholders and the communication tool. Most of the items of the Evaluation Framing were inserted in the first meeting; however, some of them were completed or updated in the next two meetings. Table 6.2 presents some examples of items elicited in these two artifacts.

The Semiotic Ladder provides a set of specific requirements for the awareness context. The researchers decided to start with those requirements and complete the artifact on demand. By the time of the exploratory study, the researchers did not have enough information to decide about some of the requirements regarding awareness provided by FAware, such as floor control (*i.e.*, the competition among participants for the ability to control the interaction (Salvador *et al.*, 1996)), treatment style, and user roles. In such cases, they decided to insert a question in the Evaluation Framing to link to the requirement. The researchers highlighted the possibility of using the FAware metadata as requirements or issues to be discussed with the target audience. In addition to Faware's metadata, the researchers inserted other requirements such as "*client-side software platform (browser (ie8+, ff 3.6+, chrome 6+, opera 10+), no flash!!!)*" at the syntactic layer, "*definition of visibility degrees (how someone sees him/herself and how he/she sees other people) (example: being invisible to user X)*" at the social layer.

**Table 6.2. Examples of items elicited in the Stakeholders Analysis and Evaluation Framing.**

| Layer | Stakeholder | Question/Issue | Idea/Solution |
|---|---|---|---|
| Core | syncom | Where the system would be hosted? | After the end of the project, at MEC (Ministry of Education). |
| Contribution | Researchers (project), designers, initial focus group (28 teachers) | How to align values among participants?<br>How to establish norms and rules regarding ethics? | Know the philosophy and work style of each subgroup and negotiate conflicts. |
| Source | Outsource, AEE professionals, teachers, coordinators | How to ensure the ethical use of the tool and ethical contents?<br>How the constitution of groups would happen in the system? | A mechanism to negotiate when a conversation should be recorded or not.<br>Representation of users' reputation in conversations. |

After the information system elicitation, at the end of the third meeting and during the fourth, the researchers interacted with the Recommendations Report module. In the report filters (see Figure 6.6, left side), they opted for the less restrictive options (*i.e.*, all three

awareness types, both present and past time, and no filtering by the model's collaborative tool category). After generating the report, the researchers decided to read the entire report to discard and adjust recommendation matching. For the analysis, the researchers considered the features already available in *Conversas* Online and the viability of the improvements and changes given the current software architecture provided by *Vila na Rede*.

They considered too detailed the scale of 0 to 100% attributed to the recommendations used in the matching and instead created a new scale of four values to adjust all the matching:

- 100%: relevant recommendations that will be used in the solution as presented in the reference;
- 50%: relevant recommendations that will be used in the solution, but they do not know how they will be adapted to the solution;
- 25%: interesting recommendation, but they do not know if they will use them in the solution;
- 0%: disposable recommendation.

FAware generated a set of 95 recommendations based on the researchers' information system and the report filters. During the analysis, the researchers performed 122 adjustments to the recommendations report (*i.e.*, discards and changes in the matching) involving at least one change by recommendation. From these changes, 45 were discarded actions. The other 56 recommendations that were considered in the redesign were distributed in the researchers' scale as follows: 5 recommendations rated as 100%, 15 recommendations rated as 50%, and 36 recommendations rated as 25%.

In the last step of the exploratory study, the researchers proposed a redesign based on the FAware artifacts and recommendations. The requirements in the Semiotic Ladder were used as the starting point. Table 6.3 presents some decisions and observations made by the researchers based on the requirements. Additionally, they decided to keep *Conversas* Online directed to small group of conversations (up to five people) because they believe that this configuration more adequately represents the behavior of people when interacting using online social networks. Consequently, conflict resolution mechanisms (*e.g.*, moderation in forums and e-mail lists) were discarded because the researchers argued that people could solve conflicts by social protocol when in small groups.

**Table 6.3. Examples of decisions and observations considered in the redesign based on the Semiotic Ladder.**

| Layer | Decision/Observation |
|---|---|
| Physical | Display size: for mobile devices the implementation must be modified to a mobile application. |
| Empirics | Need to change the interface to allow more users (up to five) in synchronous conversations [currently it is limited to three users]. |
| Semantics | Terms and concepts coherent to the user's information system, profession, and computer skills. |
| Syntactic | Allow users to configure their awareness preferences according to the report [Recommendations Report].<br>Try to eliminate, or at least reduce, the use of Flash technology. |
| Pragmatics | A mechanism for receivers control if they want to receive audio and video from others. |
| Social | A mechanism to control which users will be present in the online users list (implicit group constitution). Currently there is no filter. |

The redesigned *Conversas* Online is presented in Figure 6.8. Figure 6.8.a presents a conversation session involving four users. The user "Júlio" is transmitting video, while "Marcelo" is transmitting audio, and "Roberto" (the current user) and "Vinicius" are sending only text messages. Figure 6.8.b presents examples of access points that are available and the user name every time it is presented though the ISN (*e.g.*, authors of announcements and comments in the ISN). Currently this is available only at the list of online users provided by *Vila na Rede*. When online (in this example "Marcelo"), it is possible to start a conversation by using access points. Figure 6.8.c presents a list of online users with a corresponding status icon. In the list, "Carlos" is already in a conversation session, "Maria" is occupied, "Incógnito" and "LourdesEspecial" are available, "Marcela Lima" is available to talk, and "gouvea" is away (currently, at *Vila na Rede*, users' status is automatically determined and cannot be modified by the users).

After the redesign, the researchers answered a questionnaire about the experience along with FAware. The questionnaire was composed of a question using the Likert Scale (Likert, 1932) regarding the use of FAware to support the design (scale of five items, from the more negative to the more positive), an open question about whether they would like to use FAware in other design activities, four questions using the SAM (Self-Assessment Manikin) as proposed in (Lang *et al*., 2005) to evaluate the emotional feedback for the FAware artifacts and modules (*i.e.* Stakeholders Analysis, Evaluation

Framing, Semiotic Ladder, and Recommendations Report), 2 questions using Likert Scale to evaluate a) the filters and adjustments and b) the relevance of the recommendations in the Recommendations Report module, and an area to open observations, suggestions, and critics at the end of the questionnaire.


**Figure 6.8. Redesigned *Conversas* Online prototype. In a) a conversation session, in b) a access points, and in c) the list of online users.**

### 6.4.3 Analysis

The usage data from the Recommendations Report module reveals that the researchers selected 23 recommendations from the 95 provided by the report (*i.e.* recommendations rated as 100% and 50% in the researchers' proposed scale). The selected recommendations were awareness resources not present in current version of *Conversas* Online and they were supposed to be present in the redesign of the tool. Also, 28 recommendations were considered interesting however the participants do not know whether they would use them in the redesign. Other 9 recommendations already present in the current solution were discarded.

From the selected recommendations it is possible to identify a predominance of recommendations that address the categories "How" and "Who". The elements considered were: action, artifact, presence, audience, authorship, identity, media, membership, message, overview (of what is happening in the collaborative system), presence, and shared social protocol.

Figure 6.9 presents a summary of the choices made by the researchers regarding the Recommendations Report. The data is separated following the report filters so that we can verify how they affect the data quality. For the filter "Time", we observe that despite the object being a synchronous tool, they considered relevant most of the recommendations related to past information. The awareness type analysis confirmed our expectations about a special concern regarding conversational and contextual issues, given the *Conversas* Online characteristics (*i.e.* a conversation tool contextualized in a social network). Finally, regarding the collaborative tool category, we observed relevance for the acceptance of the recommendations (they accepted 73% of the same category and 31.8% of other categories). Additionally, the recommendations from other tool categories that were considered in the redesign (31.8%) indicate that, at some level, mechanisms to support awareness from different tool categories can also be useful.

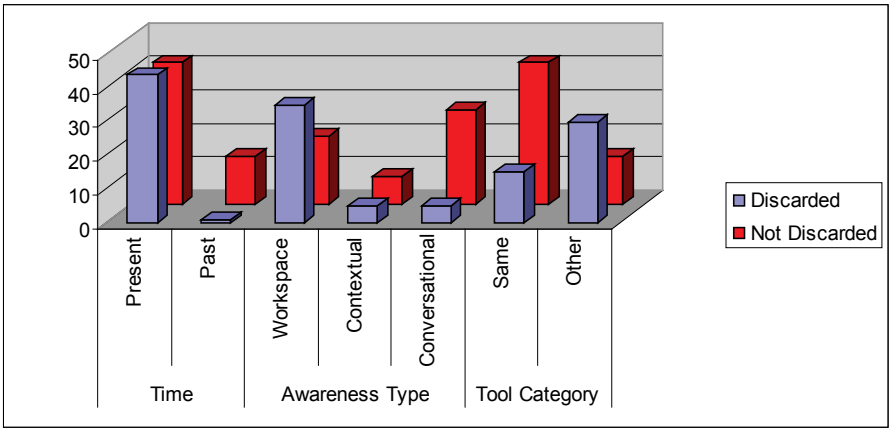


**Figure 6.9. Summary of the adjustments in the Recommendations Report.**

The exploration of the Recommendations Report module direct or indirectly inspired the redesign. Table 6.4 presents examples of the recommendations used by the researchers and the impact of these in the redesign solution.

**Table 6.4. Examples of recommendations that inspired the redesign solution.**

| Taxonomy | | Recommendation | Impact |
|---|---|---|---|
| **Type** | Workspace | In Pidgin (2009), users can define which notifications they want to receive about presence of others (*e.g.*, enter, exit, away, become idle, and back from idle). User can also select the presentation of the notifications (*e.g.*, play a sound, execute an external command, and open a window). | Status and notification of events |
| **Time** | Present | | |
| **Element** | presence | | |
| **Question** | Is anyone in the workspace? | | |
| **Type** | Workspace | In Virtual Office (Sohlenkamp & Chwelos, 1994), the objects that people are working on are represented over their desks' area. | Functionality "Where am I in Vila?" |
| **Time** | Present | | |
| **Element** | artifact | | |
| **Question** | What object are they working on? | | |
| **Type** | Contextual | In Gmail Chat (Google, 2010) and in Windows Live Messenger (Microsoft, 2010b), participants of a conversation can invite others to join the conversation. When a user is invited he/she receives a confirmation message to accept the invitation or not. | Protocol to start conversations |
| **Time** | Present | | |
| **Element** | shared social protocol | | |
| **Question** | What are the protocols shared by the group? | | |
| **Type** | Conversational | Gmail Chat (Google, 2010) offers the option to use video in the conversation. The user' status icon at the contacts list changes to one that represents a video camera when a user is available to talk using video. | Media. Buttons for stopping, starting, and requesting media from others |
| **Time** | Present | | |
| **Element** | media | | |
| **Question** | What are the media available for the interaction? | | |

Relevant differences between the redesigned *Conversas* Online and the current version of the tool include:

- Choice of users' status. Currently the status is determined automatically by the social network. The possible status choices in the redesigned tool are: online, offline, away, occupied, shown as offline, and available to talk;
- Configurable audio and visual alerts for new events in conversations;
- The upper buttons bar is removed. Buttons are positioned next to their respective effects, *e.g.*, enabling/disabling audio and video buttons right over the user's avatar;
- If a user requests audio and video from others, request message is sent before starting the transmission;
- Messages for initiating new conversations are dependent on users' statuses, *e.g.*, if the receiver is using the "available to talk" status, there is no need for confirmation messages, if the receiver's status is occupied, then the receiver can choose if he/she want to receive requests;
- A new functionality called "Where am I in Vila?" will be available below the message input area as a button. When pressed, the button informs the other participants in the conversation about the sender's location in the social network. Other solutions were proposed to allow users' localization, but the participants opted for the current method mainly for its embedded accessibility (a HTML link element) and the low cost for transmission in contrast to other solutions that involved screenshots and videos;
- As the Graph of Conversations presents very detailed information about people conversations, the researchers opted for not to use it because they believe that this type of information could bring problems related to privacy, *e.g.*, the fact that coordinators could know who is talking to whom. Instead, they use an icon (a balloon) along with the user's name in the access points. Thus, people will only know who is talking, but not to whom.

### 6.4.4 Questionnaire Feedbacks

The analysis of the questionnaire feedbacks revealed that, the researchers considered that FAware significantly supported the design process of mechanisms for awareness in collaborative tools. They also considered that the possibility of adjustments in the Recommendations Report significantly improved the use of the report. Moreover, they considered the information available is enough to understand the recommendations.

The emotional evaluation revealed that the researchers had very similar perceptions about the FAware modules. Additionally, the results indicate a consistent feeling through the system modules. Figure 6.10 presents emotional responses considering all the four evaluated modules; the size of the "X" represents the number of occurrences of a particular response. Considering the results we observe a positive feedback; the researchers felt excitement, pleasure, and dominance while interacting with the FAware modules.

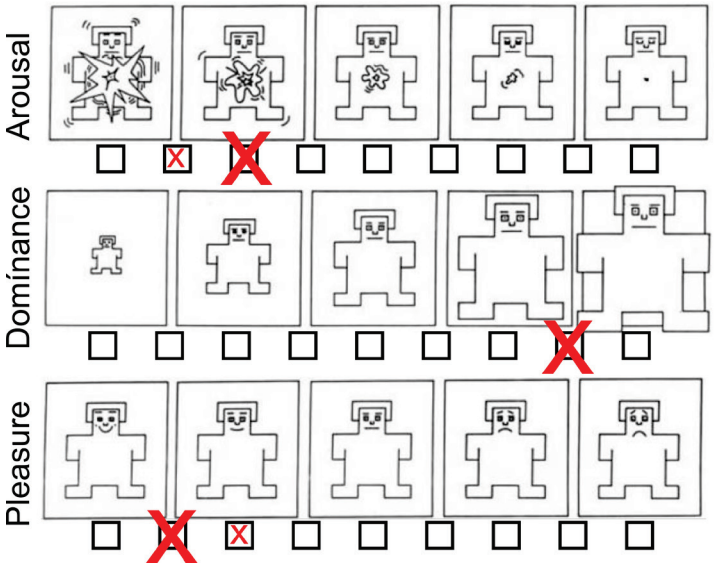


**Figure 6.10. Emotional feedback compilation of the FAware modules.**

From the open question of the questionnaire, all the researchers affirmed that they would like to use FAware to support the design process of other collaborative tools. Some comments are as follows:

"*The system contributed with new ideas and ensured we think in collaborative and awareness aspects*";

"*The questions presented by the report contributed to the designers´ search for solutions in addition to those suggested by the tool*";

"*It speeds up the use of Organizational Semiotics artifacts by providing domain content and requirements with range of values*".

Regarding suggestions and criticisms, the researchers made some suggestions relative to improvements in the user interface such as: a customizable matching scale for the Recommendations Report, an input where they could put their rationale for each

recommendation, and the ability to view questions even when there is no answer available because they consider them as valuable as the solutions.

## 6.5 Discussion

FAware aimed at providing artifacts that allow thinking on collaborative systems as social organizations. By using Stakeholders Analysis, Evaluation Framing, and Semiotic Ladder artifacts, the researchers made explicit various stakeholders, questions, ideas, solutions, and requirements that seemed too obscure without these tools (*e.g.*, awareness management regarding storage, visibility, and content; necessary hardware; a place to host the system; and an alignment of values among participants). Additionally, the articulation of such artifacts generated a dynamic process in which results and thoughts from one artifact fed back to the others.

Through the Semiotic Ladder, FAware provided a set of suggestions for requirements. Such suggestions employ the metadata used to index the knowledge base of mechanisms to support awareness. In the exploratory study, the researchers highlighted that the metadata and the range of possible values helped them to think about aspects related to awareness in collaborative systems. FAware did not restrict researchers' creativity by allowing them to choose the metadata to be considered and by providing mechanisms for including new requirements. Another aspect that evidences the contribution of the metadata set provided by FAware is that some of the suggested metadata were included as questions in the Evaluation Framing (*e.g.*, floor control, treatment style, user's roles, and group constitution), as the researchers were not able to determine their metadata values at the current status of the project.

Previous studies employing OS' artifacts reported that they can be used by people from different knowledge areas with a short learning curve, *e.g.* (Neris *et al.*, 2009). In this work we adopted the role of a facilitator to provide the necessary information to work with the OS' artifacts. An artifact-situated help (*e.g.* text hints or demonstrative videos) would be adequate to provide the operational instructions for interacting with the artifacts without the need of human support.

The Recommendations Report module was appropriated by the researchers in a larger extent than was initially intended. The researchers adopted its elements and questions as a checklist. This is evidenced by the requests for presenting elements and questions regarding the knowledge base taxonomy even when no recommendations are available. Additionally, the researchers did not pay much attention to the initial recommendations matching generated by FAware. Their focus was on classifying the recommendations according to their specific tool and considering the already existing software and the cost for changing its characteristics. Another request from the researchers was an input in

which they could inform their rationale regarding each recommendation. Currently, FAware already offers this characteristic in the Universal Accessibility module to provide evaluators with a mechanism to inform their decisions about mapping units. We expect to make available a similar mechanism in the Recommendations Report. Surprisingly, the researchers considered most of the recommendations related to awareness of events that took place in the past. This consideration is probably due to the absence of mechanisms for providing information about past events in he *Conversas* Online. Additionally, the analysis presented in Figure 6.9 gives us some clues about the utility of the taxonomy employed in the knowledge base as a confirmation of the preference for recommendations of the Conversational awareness type and of the same collaborative tool category (*i.e.*, synchronous communication).

In the exploratory study also revealed that the researchers identified a series of enhancements to the prototype redesign, such as customizable person status, audio and visual clues about new events and sharing of localization information in the host system, in this case *Vila na Rede*. The questionnaire feedbacks provided indications that FAware has the potential of being included in a collaborative tool developments lifecycle, and the taxonomy of mechanisms materialized in the Recommendations Report can promote the thinking process about mechanisms to make awareness explicit in the user interface.

## 6.6 Conclusion

Awareness of workspace, context, and conversations are key concepts for web-based ICS, especially when considering the contexts of vast diversity of people, the increasing of Internet usage, and the fast growth of social and entertainment applications in the Web. This work investigated awareness through a socio-technical lens by adopting methods and artifacts from OS and principles and guidelines from UD.

A first literature review revealed that current work is focused on the syntactic, semantics, and pragmatics aspects. Additionally, the consulted works considered as target audience people with some computer skills and a literacy level high enough to understand the application “language”. Our approach aimed at providing a thinking process and tools for helping designers in the elicitation, design, and evaluation processes regarding the consideration of awareness of others in collaborative system design. Those tools were integrated into the FAware framework.

The exploratory study presented in this work revealed that, even when considering a tool developed within an inclusive context, there was room for recommendations regarding awareness issues. Our approach focused on promoting the thinking process from the parties that are involved in the system design.

Future work in the FAware framework involves developing a module to provide mechanisms for the academic and design communities to be able to add, modify, and index new references to the knowledge base. Additionally, we want to propose mechanisms to incrementally refine the Recommendations Report based on previous designers' models, and investigate whether patterns can emerge from the continuous enhancement of the knowledge base.

# Capítulo 7:

# Conclusões

*Awareness* em sistemas colaborativos contribui para a interação e socialização entre pessoas, permitindo que elas, por meio das informações sobre o espaço de trabalho, contexto e conversas, possam estabelecer relações que envolvem confiança, reputação, privacidade, ética, entre outros fatores. Apesar de já investigado desde o início da década de 90 em sistemas com propósitos profissionais, quando tratado no contexto de SCI na *Web*, faz-se necessário que as informações de *awareness* possam ser acessadas e compreendidas pelas pessoas, respeitando suas diferenças e sem segregá-las.

A revisão de literatura apresentada no Capítulo 2 e em Almeida & Baranauskas (2008a) revelou que as abordagens e mecanismos para suporte a *awareness* disponíveis atualmente, geralmente não abordam aspectos sobre o mundo físico, empírico e social, camadas estas propostas pela abordagem da Semiótica Organizacional. Tais lacunas potencialmente criam barreiras para a apropriação da *Web* por pessoas sem familiaridade com TICs, baixa renda, deficiências físicas, baixo letramento, entre outros fatores limitantes, que podem ser de longo termo ou temporários.

Esta tese propôs o *framework* FAware para apoio ao *design* de mecanismos para suporte a *awareness* em SCI na *Web*. A abordagem adotada na pesquisa teve como principais premissas: a) prover uma visão sócio-técnica de sistemas de informação, b) o envolvimento do público-alvo em todo o ciclo de desenvolvimento, tornando a tomada de decisões uma atividade democrática e proporcionando o conhecimento profundo deste público e c) o apoio ao *design* de sistemas e mecanismos que atendam a maior extensão possível de pessoas, respeitando suas diferenças.

## *7.1 Contribuições da Pesquisa*

Esta seção reúne as contribuições oriundas dos diversos trabalhos que compõem esta tese. Apesar de o FAware ser o principal produto da pesquisa é necessário destacar outros

trabalhos essenciais para a tese. Entre eles, a revisão de literatura sobre sistemas colaborativos e, mais especificamente sobre *awareness*, que permitiu identificar que, para SCI na *Web*, era necessária uma abordagem sócio-técnica. Além disso, a participação nos projetos de pesquisa resultou em contribuições científicas relevantes, direta ou indiretamente relacionadas ao escopo desta tese, como:

- O capítulo Acessibilidade na Web (Melo *et al.*, 2009), do livro Atores da inclusão na Universidade – Formação e compromisso, o Processo de Adequação de *Websites* a Requisitos de Acessibilidade e Usabilidade (PAWRAU) (Almeida *et al.*, 2008b; Santana *et al.*, 2008) e o *website* WARAU (2010), oriundos da participação no projeto Todos Nós;

- O projeto e-Cidadania resultou na construção da RSI Vila na Rede (2010), onde foi possível desenvolver o conhecimento sobre o público desta pesquisa e em um contexto de sistemas colaborativos. Para tanto, fez-se uma imersão em práticas participativas que envolveram artefatos da SO e técnicas do DP, além de outras técnicas utilizadas pontualmente (*e.g.*, Almeida *et al.*, 2009; Almeida *et al.*, 2010; Neris *et al.*, 2009a; Neris *et al.*, 2009b).

As contribuições do *framework* FAware envolvem temas como IHC, sistemas colaborativos e acessibilidade universal. A seguir destacamos algumas dessas contribuições:

- A revisão de literatura propôs uma adaptação na forma de representação do artefato *Framework* Semiótico para que este pudesse propiciar a comparação entre diferentes abordagens em sistemas colaborativos. Como resultado dessa adaptação e do uso do artefato Cebola Semiótica foi possível verificar as lacunas em abordagens atuais, reconhecidas pela comunidade científica, o que orientou a pesquisa realizada nesta tese;

- Inspirado na abordagem utilizada no projeto e-Cidadania, o FAware propôs o uso dos artefatos da SO pertencentes ao método PAM, em conjunto com o artefato Quadro de Avaliação proposto por Baranauskas *et al.* (2005) para complementar o artefato Análise de *Stakeholders*. Dessa maneira *designers* de mecanismos para suporte a *awareness* foram instigados a refletir sobre fatores que vão além dos puramente técnicos. Eles passaram a considerar as diversas partes interessadas, que influenciam ou são influenciadas pelo sistema; os problemas, questões, idéias e soluções oriundas dessas partes e os diversos requisitos distribuídos nas seis camadas propostas pela SO;

- Outra contribuição metodológica foi a utilização e adaptação de técnicas do DP, no contexto do projeto e-Cidadania, para modelar e avaliar SCI na *Web*, tal como apresentado no Capítulo 4. Esse trabalho contribuiu para o conhecimento do público-alvo além de proporcionar um método de avaliação contextualizado;
- A taxonomia proposta para mecanismos e conceitos relacionados a *awareness* estendeu a proposta de Gutwin & Greenberg (2002). As principais contribuições são: a) a adição de outros dois tipos de *awareness* (*i.e.* conversacional e contextual), b) diversas referências adicionais envolvendo pesquisas acadêmicas, *softwares* comerciais e livres, c) a classificação das referências utilizadas conforme a(s) categoria(s) de ferramentas colaborativas relacionada(s) e os metadados para indexar as referências. Os metadados utilizados cobrem todas as camadas propostas no *Framework* Semiótico (Stamper, 1993) e são advindos da revisão de literatura e das oficinas participativas realizadas no projeto e-Cidadania. Dessa maneira, para cada referência utilizada na taxonomia foi instanciado um *Framework* Semiótico com os metadados do FAware;
- Além de utilizar o *Framework* Semiótico tal como proposto por Stamper (1993), o FAware disponibiliza os mesmos metadados usados para indexar as referências da taxonomia. Assim, o FAware provê *designers* com aspectos específicos da área de sistemas colaborativos e *awareness*. Tal como evidenciado no Capítulo 6, *designers* consideraram esta uma contribuição relevante, pois apóia o processo de reflexão durante a elicitação de requisitos;
- Por meio da taxonomia e da utilização dos metadados sugeridos no *Framework* Semiótico, o FAware disponibiliza o módulo Relatório de Recomendações. Este módulo representa uma contribuição significativa a *designers* por apresentar recomendações contextualizadas ao sistema de informação que está sendo modelado e, também, por permitir diversos ajustes e filtros nos resultados. O fato de as recomendações serem apresentadas de acordo com a classificação delas na taxonomia também foi um aspecto positivamente mencionado pelos *designers* envolvidos no estudo de caso. Eles consideraram que a estrutura da taxonomia (*i.e.*, tipos de *awareness*, tempo, elementos, questões) é tão importante quando as próprias recomendações;
- Por fim, o módulo Acessibilidade Universal contribuiu não somente para *awareness*, mas para toda a comunidade envolvida em acessibilidade na *Web* e DU. O mapeamento entre DU e diretrizes técnicas (*i.e.*, WCAG 2.0 e partes do ISO 9241) que originou o módulo representa um passo relevante para uma

articulação que contribua para a adesão e, mais importante, a consciência dos motivos pelos quais *designers* de *websites* devem se preocupar com acessibilidade desde a concepção de seus produtos.

Ainda, é interessante indicar algumas das limitações do FAware, que podem contribuir para a projeção de novos trabalhos na área:

- No estudo de caso realizado sobre o módulo Acessibilidade Universal, os participantes tiveram que alternar constantemente entre a ferramenta de avaliação semiautomática e o FAware. É desejável a integração do FAware com ferramentas semiautomáticas de maneira a trazer automaticamente para o FAWare, os resultados das avaliações daquelas ferramentas;
- Outra limitação no módulo de Acessibilidade Universal é a grande quantidade de unidades de mapeamento, o que dificulta a busca por unidades de mapeamento. A adição de uma busca por unidades de mapeamento poderia contribuir para este cenário;
- O segundo estudo de caso sobre o FAware apontou que, no módulo Relatório de Recomendações, também há muitos itens para navegação. Também observações foram feitas sobre a escala de *matching* ser muito detalhada. Para essas limitações seria interessante a adição de mecanismos de busca para os itens da taxonomia e, também, a possibilidade de simplificação ou personalização da escala de *matching*;
- O artefato Análise de *Stakeholders* no FAware tem um formato diferente do proposto inicialmente (em elipses). A mudança objetivou a acessibilidade, no entanto, é possível usando linguagem de marcação mais recente (HTML5) ou mesmo com mapeamento de imagens, obter um artefato mais expressivo graficamente ainda mantendo a acessibilidade;
- O FAware é um sistema sem suporte a colaboração online entre seus usuários. A possibilidade de colaboração seria interessante tanto para estimular a interação em grupo quanto para demonstrar os aspectos de *awareness* descritos pelo *framework*.

## *7.2 Lições Aprendidas*

Desde a revisão de literatura pode-se perceber que as abordagens atuais para o *design* de sistemas colaborativos não são suficientes para o *design* de SCI na *Web*. Apesar das abordagens analisadas serem voltadas, em sua maioria ao CSCW e em países desenvolvidos, ainda continua sendo válido pensar em acesso universal nesses contextos.

Grande parte dos aspectos que compõem a diversidade populacional não está restrita a somente questões econômicas ou de letramento. Por outro lado, sabe-se que países em desenvolvimento com grandes populações e que ainda apresentam profundos contrastes populacionais, oferecem um desafio único no que diz respeito ao acesso universal. Assim pesquisar este tema no contexto Brasileiro destaca a relevância da pesquisa sem, no entanto, limitá-la a este contexto.

O *framework* FAware representa um passo em direção à articulação entre IHC e CSCW sob a ótica de processos organizacionais e sociais providos pela SO e o DP, além de considerar e respeitar as diferenças, tal como promovido pelo DU. Os artefatos para elicitação do sistema de informação, apoiados pela taxonomia de mecanismos e conceitos sobre *awareness*, os módulos Relatório de Recomendações e Acessibilidade Universal, quando em conjunto, constituem um *framework* que contribui com ferramentas para diversas fases do ciclo de vida de um SCI na *Web*. Tais ferramentas têm sua contribuição distribuída desde informações técnicas, abordando linguagens de programação e codificação, até processos reflexivos com recomendações, questões, capturas de telas sobre ferramentas e mecanismos. Dessa maneira, foi possível acomodar interesses tanto de *designers* focados somente na interação até os daqueles envolvidos na codificação das soluções.

O ferramental teórico-metodógico adotado foi essencial para o *framework* FAware e sua capacidade de oferecer suporte aos *designers* de SCI na *Web*. É importante neste momento realizar uma breve análise de suas contribuições:

- A SO foi essencial em todo o desenvolvimento da pesquisa. Inicialmente foi utilizada e adaptada para a realização da revisão de literatura. Durante toda a duração do projeto e-Cidadania foi utilizada entre os pesquisadores e em práticas com a comunidade. Por fim, três artefatos foram utilizados diretamente no *framework* FAware para apoiar a elicitação do sistema de informação. Mais do que artefatos, a SO provê teoria que se adequou ao contexto desafiador de diferenças e contextos sociais;

- Como já mencionado anteriormente, o DP teve um papel relevante para o conhecimento de um público tão diverso e que, por vezes, se sente excluído pela tecnologia. O DP proveu com sucesso técnicas para a inclusão ativa da comunidade como co-autores do sistema de informação. Apesar de ainda não haver no FAware nenhum módulo relacionado diretamente ao DP, é considerado essencial o uso de técnicas de DP nesta pesquisa, tal como apresentado nos Capítulos 3 e 4;

- Geralmente adotado como inspiração nas pesquisas, nesta tese o DU inspirou e também foi abordado de maneira profunda e concreta. Seus princípios e diretrizes foram empregados no módulo Acessibilidade Universal e agregaram sentido real às diretrizes técnicas para acessibilidade na *Web*. O objetivo do DU, por ser desafiador – e talvez inalcançável pelo estado da arte da ciência e tecnologia atuais –, provoca *designers* a uma reflexão maior na concepção de produtos e, potencialmente, à proposição de soluções melhores e mais conscientes das diferenças entre pessoas.

Mais do que teorias e técnicas distintas, nesta pesquisa SO, DP e DU foram utilizadas de maneira integrada, o que permitiu verificar a forte sinergia entre elas. Decorrente disso, esta tese apresenta como um dos seus resultados a utilização de tais instrumentos de maneira inovadora para abordar *awareness* em SCI na *Web.* Tal abordagem envolve o conhecimento e participação ativa do público-alvo, promovendo o entendimento mútuo de processos e signos compartilhados nos sistemas de informação em que estão inseridos, e que resulta em soluções computacionais que refletem a consciência, o respeito e o suporte às diferenças entre pessoas.

## 7.3 Trabalhos Futuros

Esta seção apresenta algumas indicações de trabalhos que poderiam se beneficiar e estender a pesquisa realizada nesta tese. As sugestões envolvem aquelas relacionadas a aspectos teóricos e metodológicos e as relacionadas ao *framework*.

Em busca de alimentar e refinar a base de conhecimento do FAware seria interessante aplicá-lo a diversos contextos de uso e diferentes tipos de sistemas colaborativos. Uma sugestão de tipos de sistemas colaborativos seria a lista de tipos de ferramentas colaborativas do FAware que inclui, entre outros: editores colaborativos (*e.g.*, editores de texto, imagem, vídeo e áudio), ferramentas de comunicação síncrona (*e.g.*, mensageiros instantâneos e sala de bate-papo), ferramentas de comunicação assíncrona (*e.g.*, e-mail, fórum, *blog* e *flog*), social (*e.g.*, redes de contatos, *tagging*), *awareness* (*e.g.*, localização física e *status*), trabalho (*e.g.*, gerenciamento de projetos, repositórios compartilhados) e jogos (*e.g.*, *multiplayer*, *serious games*).

Os resultados dos filtros e ajustes realizados pelos *designers* quando interagindo com o Relatório de Recomendações provêem informações valiosas. Tais informações podem ser utilizadas para refinar o componente Processador de *Awareness* e, também, podem motivar pesquisas relacionadas a padrões de ferramentas colaborativas, com o diferencial de possuir também informações sobre o contexto.

O módulo Acessibilidade Universal oferece um mapeamento entre o DU e as diretrizes de acessibilidade do W3C e partes das recomendações do ISO 9241. Apesar de constituírem as diretrizes mais amplamente adotadas, seria interessante investigar mapeamentos com outros conjuntos de diretrizes relevantes, como o Section508 (EUA, 2010) e o e-MAG (Brasil, 2005).

Participantes envolvidos nos estudos de caso sobre o FAware (Capítulos 5 e 6) apontaram disposição em considerar o uso do *framework* quando desenvolvendo sistemas colaborativos e *websites*. Para tanto, é necessário investigar maneiras de adequar o uso do *framework* em processos de desenvolvimento. Uma possível abordagem seria integrar o FAware em um modelo ágil, que já enderece questões relacionadas à IHC, como o AIPM (Bonacin *et al.*, 2009; Neris *et al.*, 2009b), utilizado no projeto e-Cidadania.

Atualmente o FAware utiliza artefatos do método PAM para apoiar a elicitação de requisitos. Artefatos de outros métodos também poderiam contribuir para especificação de sistemas de informação, como o Diagrama de Ontologias do método SAM, e a análise de normas do método NAM. Uma primeira abordagem utilizada para posicionar *awareness* em sistemas colaborativos, utilizando o SAM, pode ser encontrada em (Almeida & Baranauskas, 2008a).

Além das linhas de pesquisa mencionadas, vários ajustes no FAware foram identificados durante os estudos de caso realizados. A seguir relacionamos alguns dos mais relevantes e algumas outras idéias oriundas dessas atividades:

- Suporte a outras línguas para o conteúdo e elementos de interface dos módulos;
- Novos módulos para permitir que a comunidade de sistemas colaborativos e IHC possam alimentar a base de dados com novas referências e indexá-las segundo a taxonomia e o conjunto de metadados do FAware;
- No módulo Relatório de Recomendações, adicionar elementos de interface que permitam que *designers* expressem o *rationale* para as recomendações (tal como já oferecido pelo módulo Acessibilidade Universal). Ainda no relatório de recomendações seria possível permitir que *designers* pudessem definir escalas de *matching* personalizadas, tal como feito pelos participantes do estudo de caso descrito no Capítulo 6;
- O módulo Acessibilidade Universal obteve resultados positivamente relevantes. Em adição, diversos ajustes poderiam ser realizados para aprimorar sua utilização, como: a) a utilização de *web services* para integração com ferramentas de avaliação semiautomática, o que permitiria eliminar a necessidade de manter uma aplicação aberta além do FAware e, também, apresentar os resultados da avaliação em conjunto às unidades de mapeamento. Atualmente, está em curso a integração

com a ferramenta AChecker (ATRC, 2009); b) a integração com os provedores dos conjuntos de diretrizes de maneira que o conteúdo das diretrizes possa ser obtido dinamicamente, e nas línguas disponibilizadas pelos provedores;

- A versão atual do FAware ainda não possui recursos para a colaboração. Dessa maneira, é objetivo tornar o *framework* um SCI na *Web*.

Por fim, é necessário fazer uma última reflexão sobre tecnologias emergentes e que, potencialmente, vão gerar diversos novos desafios para a pesquisa em IHC, para a Acessibilidade Universal e para *awareness*. A seguir são apresentadas algumas das linhas de pesquisa que têm o potencial de revolucionar a maneira como a interação com TICs é realizada.

Atualmente, observamos um grande esforço científico para a questão da computação ubíqua. As pesquisas na área de computação ubíqua, apesar de abordada já há 20 anos (Weiser, 1991), somente recentemente começam a produzir soluções que têm o potencial que chegar ao público maior. Um "mundo ubíquo" poderia contribuir para que pessoas sejam mais conscientes das possibilidades, eventos e outras pessoas e, também, as exporia de maneira sensível ao ambiente em que estão interagindo. Assim, existe uma demanda em relação a *awareness* nesta área, para prover informações de maneira contínua, mas respeitando as preferências e habilidades de cada pessoa, para fazer sentido e tomar decisões a partir de tais informações.

As projeções de imagens 3D, já popular em televisores, tendem a serem substituídas em breve por animações holográficas. Nos últimos meses a ciência deu um grande passo em relação a hologramas 3D. Pesquisadores obtiveram os primeiros resultados positivos ao tratar a quarta dimensão dos hologramas *i.e.* a temporização dos hologramas (*e.g.*, Blanche *et al.*, 2010). Projeções holográficas constituem uma ferramenta interessante para o trabalho colaborativo em objetos tridimensionais, seja para pessoas em um mesmo local geográfico ou distribuídas. Além disso, o uso de sensores pode permitir a manipulação direta dos artefatos projetados. Nesse contexto há desafios relevantes para *awareness*, tais como, informar aos demais a visão de cada participante e o local que está interagindo com o objeto.

O reconhecimento de movimentos do corpo sem a necessidade de que o usuário carregue qualquer dispositivo ou pressione botões. A Microsoft lançou recentemente o Kinect, para o console de jogos Xbox 360 (Microsoft, 2010a). Kinect permite que mais de uma pessoa interaja simultaneamente e o console interpreta e projeta seus movimentos no jogo. Outra abordagem, esta da área acadêmica é a de Ghirotti & Morimoto (2010), que também objetiva a interação com base no reconhecimento de movimentos, mas com um diferencial positivo de poder ser realizada com câmeras filmadoras de baixa resolução,

como *webcams*. A partir do momento em que o dispositivo de entrada deixa de estar restrito a cliques e teclas, também se faz necessária a investigação de maneiras de prover *awareness* das ações dos demais (*e.g.* movimentos de braço e cabeça, saltos). Este cenário torna-se ainda mais desafiador quando considerando o provimento de informações para *awareness* para pessoas cegas.

Outra linha de pesquisa é a realidade aumentada, que já possui diversas soluções já veiculadas comercialmente. Algumas das pesquisas mais promissoras são o Skinput, da Microsoft (Harrison *et al.*, 2010), que usa como dispositivo de entrada de dados, as vibrações oriundas de toques feitos no próprio corpo do usuário; e o SixthSense, do MIT Media Lab (Mistry & Maes, 2009), que é um dispositivo que a pessoa traz em seu corpo (o primeiro protótipo lembrava uma gravata) e permite que ela interaja com o ambiente, como reconhecer pessoas, preços de produtos em um supermercado, realizar operações de acordo com gestos naturais da pessoa, projetar dispositivos de entrada em superfícies, entre outros. A realidade aumentada pode ser uma aliada importante para a acessibilidade e *awareness* em sistemas computacionais *e.g.* provendo entrada de dados facilitada a superfícies ergonomicamente adaptadas às pessoas com mobilidade reduzida, informações de localização e contexto para pessoas (especialmente às cegas).

Ainda incipiente, a área de Interface Cérebro-Máquina (*e.g.*, Bradberry, 2010) representa um dos maiores avanços da ciência e tem o potencial de revolucionar a maneira como as pessoas interagem com tecnologias. Outra contribuição deste tipo de interface é a possibilidade de apoio às pessoas com limitações motoras, sejam elas temporárias ou não. Algumas empresas já utilizam este tipo de tecnologia para facilitar a interação com computadores (*e.g.*, Neurosky, 2010) e também para jogos (*e.g.*, Gizmodo, 2010).

As inovações científicas e tecnológicas carregam consigo contribuições e desafios para a interação entre pessoas. Dessa maneira, *awareness* deve continuar a ser investigado de maneira que a interação possa beneficiar plenamente não somente um grupo restrito de pessoas, mas sim a maior extensão possível da população.

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# Apêndice A:

# Mapeamento entre WCAG 2.0, ISO 9241 e *Design* Universal

Referente ao apêndice indicado no Capítulo 5.

This section presents the full mapping table. In Table A.1, the first column presents the UD guidelines, and the second column contains the mapping related to the respective UD guideline. The mapping can be one or more WCAG success criteria, an ISO 9241 part or section, or a suggestion of the author.

**Table A.1. Full mapping of WCAG 2.0 and, partially, ISO 9241 into UD.**

| UD guideline | Mapping |
|---|---|
| 1. Equitable Use | |
| 1.1. Provide the same means of use for all users: identical whenever possible; equivalent when not. | Valid for every success criterion |
| 1.2. Avoid segregating or stigmatizing any users. | Valid for every success criterion |
| 1.3. Provisions for privacy, security, and safety should be equally available to all users. | 2.2.4. Interruptions; 2.2.5. Re-authenticating |
| 1.4. Make the design appealing to all users. | Valid for every success criterion |
| 2. Flexibility in Use | |
| 2.1. Provide choice in methods of use. | 2.1.1. Keyboard; 2.1.3. Keyboard (No Exception); 2.4.1. Bypass Blocks; 2.4.5. Multiple Ways; 2.4.8. |

| | |
|---|---|
| | Location |
| 2.2. Accommodate right- or left-handed access and use. | This guideline is usually accomplished by hardware devices such as keyboard and mouse or other assistive technology. It could also be considered in the sense of the reading direction (W3C, 2009) in web content. |
| 2.3. Facilitate the user's accuracy and precision | 1.4.3. Contrast (Minimum); 1.4.4. Resize text; 1.4.8. Visual Presentation |
| 2.4. Provide adaptability to the user's pace. | 1.4.2. Audio Control; 2.2.1. Timing Adjustable; 2.2.2. Pause, Stop, Hide; 2.2.3. No Timing; 2.2.4. Interruptions; 2.2.5. Re-authenticating |
| 3. Simple and Intuitive Use | |
| 3.1. Eliminate unnecessary complexity. | 3.1.3. Unusual Words; 3.1.4. Abbreviations; 3.1.5. Reading Level |
| 3.2. Be consistent with user expectations and intuition. | 2.4.3. Focus Order; 3.2.1. On Focus; 3.2.2. On Input; 3.2.3. Consistent Navigation; 3.2.4. Consistent Identification; 3.2.5. Change on Request |
| 3.3. Accommodate a wide range of literacy and language skills. | 2.4.2. Page Titled; 2.4.6. Headings and Labels; 3.1.1. Language of Page; 3.1.2. Language of Parts; 3.1.3. Unusual Words; 3.1.4. Abbreviations; 3.1.5. Reading Level; 3.1.6. Pronunciation |
| 3.4. Arrange information consistent with its importance. | 1.3.2. Meaningful Sequence; 2.4.10. Section Headings |
| 3.5. Provide effective prompting and feedback during and after task completion. | 2.4.4. Link Purpose (In Context); 2.4.7. Focus Visible; 2.4.9. Link Purpose (Link Only); 3.3.5. Help |
| 4. Perceptible Information | |
| 4.1. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information. | 1.1.1. Non-text Content; 1.2.1. Audio-only and Video-only (Prerecorded); 1.2.2. Captions (Prerecorded); 1.2.3. Audio Description or Media Alternative (Prerecorded); 1.2.4. Captions (Live); 1.2.5. Audio Description (Prerecorded); 1.2.6. Sign Language (Prerecorded); 1.2.7. Extended Audio Description (Prerecorded); 1.2.8. Media |

| | |
|---|---|
| | Alternative (Prerecorded); 1.2.9. Audio-only (Live); 1.3.1. Info and Relationships; 1.3.3. Sensory Characteristics; 1.4.5. Images of Text; 1.4.9. Images of Text (No Exception) |
| 4.2. Provide adequate contrast between essential information and its surroundings. | 1.4.3. Contrast (Minimum); 1.4.6. Contrast (Enhanced); 1.4.7. Low or No Background Audio |
| 4.3. Maximize "legibility" of essential information. | 1.4.8. Visual Presentation |
| 4.4. Differentiate elements in ways that can be described (*i.e.*, make it easy to give instructions or directions). | 1.3.3. Sensory Characteristics; 1.4.1. Use of Color; 1.4.5. Images of Text; 1.4.9. Images of Text (No Exception); 2.4.10. Section Headings |
| 4.5. Provide compatibility with a variety of techniques or devices used by people with sensory limitations. | 2.1.1. Keyboard; 2.1.2. No Keyboard Trap; 2.1.3. Keyboard (No Exception); 4.1.1. Parsing; 4.1.2. Name, Role, Value |
| 5. Tolerance for Error | |
| 5.1. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded. | 2.3.1. Three Flashes or Below Threshold; 2.3.2. Three Flashes; 3.3.1. Error Identification; 3.3.2. Labels or Instructions; 4.1.1. Parsing |
| 5.2. Provide warnings of hazards and errors. | 3.3.2. Labels or Instructions; 3.3.4. Error Prevention (Legal, Financial, Data); 3.3.6. Error Prevention (All) |
| 5.3. Provide fail safe features. | 2.1.2. No Keyboard Trap; 3.3.4. Error Prevention (Legal, Financial, Data); 3.3.6. Error Prevention (All) |
| 5.4. Discourage unconscious action in tasks that require vigilance | 3.3.3. Error Suggestion; 3.3.4. Error Prevention (Legal, Financial, Data); 3.3.6. Error Prevention (All) |
| 6. Low Physical Effort | |
| 6.1. Allow user to maintain a neutral body position. | ISO 9241-4 (ISO, 1998a) Section 6.1 Design requirements and recommendations/General design of the keyboard; ISO 9241-5 (1998b); ISO 9241-6 (ISO, 1999); ISO 9241-9 (ISO, 2000b) |

| | |
|---|---|
| | Section 4.4.1 Biomechanical load/Posture |
| 6.2. Use reasonable operating forces. | ISO 9241-4 (ISO, 1998a) Sections: 6.2.3 Key displacement and force; 6.2.7 Key repeat function; ISO 9241-9 (ISO, 2000b) Section 4.4.2 Biomechanical Load/Effort |
| 6.3. Minimize repetitive actions. | ISO 9241-9 (ISO, 2000b) Section 6.1.4.6 Button Design/Button lock |
| | 2.4.1. Bypass Blocks |
| 6.4. Minimize sustained physical effort. | ISO 9241-5 (ISO, 1998b) Sections: 5.6.1 Document holders; 6.1.4.3 Button Design/Button force. |
| 7. Size and Space for Approach and Use | |
| 7.1. Provide a clear line of sight to important elements for any seated or standing user. | ISO 9241-3 (ISO, 1992, 2000a) Sections: 5.1 Design Viewing distance; 5.2 Line-of-sight angle; 5.3 Angle of view |
| 7.2. Make reach to all components comfortable for any seated or standing user. | ISO 9241-5 (ISO, 1998b) Section 5.2.3 Standing and sit/standing postures |
| 7.3. Accommodate variations in hand and grip size. | ISO 9241-9 (ISO, 2000b) Sections: 4.3.3 Controllability/Grip Surface; 6.1.4.2 Button design/Button Shape; 6.1.4.7 Button design/Grasp stability; 6.1.4.13 Button design/Shape and size |
| 7.4. Provide adequate space for the use of assistive devices or personal assistance. | This guideline can be translated in terms of code compatibility aiming at be correctly interpreted by assistive technologies, *e.g.*, the installation of a screen reader or magnifier; to provide enough space for the person, use a head pointer. |

# Apêndice B:

# Atividades e Publicações Realizadas Durante o Período da Pesquisa de Doutorado

Este apêndice tem o propósito de prover uma visão geral das principais atividades realizadas durante o período do doutorado e que, em alguns casos não estão representadas nos capítulos da tese. No entanto, acredita-se ser relevante apresentá-las para dar melhor visualização do trabalho realizado, mesmo que nem todas as atividades tenham se convertido diretamente em publicações científicas. As informações estão agrupadas por tipo de contribuição, dado que seria difícil dar um sentido cronológico a elas.

Participação em projetos:

- (2007 a 2010) e-Cidadania: Sistemas e Métodos na Constituição de uma Cultura mediada por Tecnologias de Informação e Comunicação (FAPESP/Microsoft). No projeto e-Cidadania desenvolvi meu conhecimento sobre o *Design* Participativo e a Semiótica Organizacional. No total foram realizadas 11 oficinas participativas. Este projeto demandou esforço considerável de desenvolvimento de *software*. Como resultados de minha participação no projeto têm-se diversos relatórios técnicos e alguns artigos em periódicos, além da elicitação de requisitos, *design*, desenvolvimento e avaliação de ferramentas colaborativas e seus respectivos mecanismos para suporte a *awareness*, essenciais para esta tese;

- (2007 a 2008) Acesso, Permanência e Prosseguimento da Escolaridade de Nível Superior de Pessoas com Deficiência: Ambientes Inclusivos. (PROESP/CAPES). Neste projeto iniciei minha pesquisa em acessibilidade na *Web*. A riqueza de diversidade do grupo permitiu que eu tivesse contato com pesquisadores, sendo que alguns deles possuem deficiências físicas. Dessa maneira, além do conhecimento acadêmico e técnico, a participação neste projeto propiciou a compreensão do significado da palavra "inclusão" e o respeito às diferenças.

Como resultados do meu trabalho neste projeto, realizado em conjunto com um colega de doutorado, realizamos uma série de oficinas em conjunto com *designers* do *website* do GGBS/Unicamp, que tinha como objetivo a discussão sobre acessibilidade e usabilidade em relação às linguagens padrão da *Web* (*i.e.* HTML, CSS e Javascript). Utilizando os dados das oficinas construímos o WARAU[34], publicamos um artigo na revista RBIE e realizamos diversas palestras e cursos sobre o tema.

Prêmios:

- Melhor Artigo – IX Simpósio de Fatores Humanos em Sistemas Computacionais (IHC 2010) – 2 º lugar, Sociedade Brasileira de Computação (SBC), 2010.
- 2º lugar na Competição de Avaliação de Acessibilidade (categoria pós-graduação) no IX Simpósio de Fatores Humanos em Sistemas Computacionais, Sociedade Brasileira de Computação (SBC), 2010.

Publicações em Periódicos:

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- Santana, V. F. de, Almeida, L. D. A., Baranauskas, M. C. C. Aprendendo sobre Acessibilidade e Construção de Websites para Todos. Revista Brasileira de Informática na Educação, pp. 71-83, 2008.

Publicações em Congressos:

- Almeida, L. D. A., Baranauskas, M. C. C. Um Prospecto de Sistemas Colaborativos: Modelos e Frameworks. In: VIII Simpósio sobre Fatores Humanos em Sistemas Computacionais IHC 2008, 2008, Porto Alegre. Anais Estendidos do VIII Simpósio sobre Fatores Humanos em Sistemas Computacionais IHC 2008. Porto Alegre: Sociedade Brasileira de Computação, 2008. pp. 204-213.
- Almeida, L. D. A., Baranauskas, M. C. C. Universal Design Principles Combined with Web Accessibility Guidelines: A Case Study. In: IX Simpósio de Fatores Humanos em Sistemas Computacionais, 2010, Belo Horizonte. Anais do IX Simpósio de Fatores Humanos em Sistemas Computacionais, 2010, v. 1, pp. 169-178.

[34] Websites Atendendo a Requisitos de Acessibilidade e Usabilidade. HTTP://warau.nied.unicamp.br.

- Almeida, L. D. A., Hayashi, E. C. S., Reis, J. C., Martins, M. C., Baranauskas, M. C. C. Conversas Online: A Synchronous Communication Tool Integrated to Inclusive Social Networks. In: IX Simpósio de Fatores Humanos em Sistemas Computacionais, 2010, Belo Horizonte. Anais do IX Simpósio de Fatores Humanos em Sistemas Computacionais, 2010, v. 1, pp. 51-60.
- Almeida, L. D. A., Neris, V. P. A., Miranda, L. C. de, Hayashi, E. C. S., Baranauskas, M. C. C. Designing Inclusive Social Networks: A Participatory Approach. In: HCI International, 2009, San Diego. Lecture Notes in Computer Science - Online Communities and Social Computing. Heidelberg: Springer, 2009, v. 5621, pp. 653-662.
- Neris, V. P. A., Almeida, L. D. A., Miranda, L. C. de, Hayashi, E. C. S., Baranauskas, M. C. C. Towards a Socially-constructed Meaning for Inclusive Social Network Systems. In: 11th International Conference on Informatics and Semiotics in Organisations, 2009, Beijing - China. Proceedings of the 11th International Conference on Informatics and Semiotics in Organisations. Sydney: Aussino Academic Publishing House, 2009, pp. 247-254.
- Neris, V. P. A., Hornung, H. H., Miranda, L. C. de, Almeida, L. D. A., Baranauskas, M. C. C. Building Social Applications with an Agile Semio-Participatory Approach. In: IADIS International Conference on WWW/Internet (ICWI), 2009, Rome, Italy. Proceedings of the IADIS International Conference on WWW/Internet. Lisbon, Portugal: IADIS Press, 2009, v. 1, pp. 3-10.

Capítulos em Livro:

- MELO, A. M., Almeida, L. D. A., Santana, V. F. de. Acessibilidade na Web. In: M. Teresa E. Mantoan e M. Cecília C. Baranauskas. (Org.). Atores da inclusão na Universidade - Formação e compromisso. Campinas: UNICAMP/Biblioteca Central Cesar Lattes, 2009, pp. 101-128.

Pôsteres:

- Almeida, L. D. A., Santana, V. F. de, Baranauskas, M. C. C. *WARAU: Uma proposta de Apoio ao Processo de Adequação de Websites a Requisitos de Acessibilidade e Usabilidade*. 60 Reunião Anual da Sociedade Brasileira para o Progresso da Ciência. SBPC, Campinas-SP, 2008.
- M. C. C. Baranauskas *et al. e-Cidadania - Systems and Methods for the Constitution of a Culture mediated by Information and Communication*

*Technology*. Microsoft Research External Research Symposium. Redmond, EUA. 2010.

Relatórios Técnicos:

- Almeida, L. D. A., Baranauskas, M. C. C. Awareness em sistemas colaborativos: Conceitos e desafios, 2008.
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- Almeida, L. D. A., Neris, V. P. A., Hayashi, E. C. S., Hornung, H. H., Baranauskas, M. C. C. An exploratory design for inclusive social networks, 2008.
- Almeida, L. D. A., Santana, V. F. de, Baranauskas, M. C. C. Um processo para adequação de websites a requisitos de acessibilidade e usabilidade, 2008.
- Almeida, L. D. A., Santana, V. F. de, Bispo, D. M., Baranauskas, M. C. C. An architecture to integrate content management systems and Web applications, 2008.
- Canal, M. C., Almeida, L. D. A. O Design do Laptop Educacional da OLPC: Uma Avaliação Usando as Leis da Simplicidade, 2010.
- Hayashi, E. C. S., Almeida, L. D. A., Baranauskas, M. C. C. Virtual Presenter and Vila na Rede: augmenting accessibility in ISNs, 2010.
- Hayashi, E. C. S., Almeida, L. D. A., Melo-Solarte, D. S., Rodriguez, C. L., Baranauskas, M. C. C., Martins, M. C. Prospecting requirements for online communication in social network systems, 2009.
- Hayashi, E. C. S., Neris, V. P. A., Almeida, L. D. A., Miranda, L. C. de, Martins, M. C., Baranauskas, M. C. C. Clarifying the dynamics of social networks: narratives from the social context of e-Cidadania, 2008.
- Hayashi, E. C. S., Neris, V. P. A., Almeida, L. D. A., Rodriguez, C. L., Martins, M. C., Baranauskas, M. C. C. Inclusive social networks: Clarifying concepts and prospecting solutions for e-Cidadania, 2008.
- Hornung, H. H., Hayashi, E. C. S., Neris, V. P. A., Almeida, L. D. A., Martins, M. C., Baranauskas, M. C. C. Bringing human-computer interaction to an agile process model, 2008.

- Miranda, L. C. de, Almeida, L. D. A., Hayashi, E. C. S., Neris, V. P. A., Baranauskas, M. C. C. A participatory practice for designing inclusive social networks in the e-Cidadania Project, 2009.
- Santana, V. F. de, Almeida, L. D. A., Hornung, H. H., Baranauskas, M. C. C. Um Processo de Avaliação de Acessibilidade Web Universal, 2010.

Outros:

- (Competição de Avaliação de Acessibilidade) Santana, V. F. de, Almeida, L. D. A., Hornung, H. H., Baranauskas, M. C. C. Um Processo de Avaliação de Acessibilidade Web Universal Aplicado ao Website da Receita Federal: do Código a Testes com Usuários. In: IX Simpósio de Fatores Humanos em Sistemas Computacionais, 2010, Belo Horizonte. Anais Estendidos do IX Simpósio de Fatores Humanos em Sistemas Computacionais, 2010, v. 2, pp. 151-162.
- (Curso de curta duração ministrado na semana de comemoração dos 40 anos do IC/Unicamp) Almeida, L. D. A.; Santana, V. F. de. Desenvolvimento Web Acessível. 2009.

# Apêndice C:

# Descrição Funcional do *Framework* FAware

Este apêndice apresenta a organização do *framework* FAware (*e.g.* página inicial, mapa do *website*, referências bibliográficas, informações gerais e menus), os artefatos para especificação de sistemas de informação, a funcionalidade para avaliação de acessibilidade universal e o relatório de recomendações.

## *C.1 Organização do framework FAware*

O website do framework FAware é organizado em quatro áreas: cabeçalho, conteúdo principal, menu lateral direito e rodapé. A página inicial do FAware (Figura C.1) ilustra opadrão encontrado em todas as demais páginas do website. No cabeçalho, além da identificação do portal, existem skip links para o conteúdo e para o menu lateral direito elinks para informações (Figura C.2) e o mapa do website (
Figura C.3).

Enquanto não há usuário autenticado, no menu lateral direito fica disponível o formulário para autenticação, cadastro de novos usuários (Figura C.4) e recuperação de senha (Figura C.5 e Figura C.6).

No cadastro de usuário, além das informações de identificação do usuário e senha, são apresentadas duas perguntas aleatórias que serão utilizadas para a recuperação da senha. Dessa maneira, o processo de recuperação de senha consiste em informar o nome de usuário, seguido das respostas para as perguntas. Após a confirmação, o usuário pode redefinir sua senha.

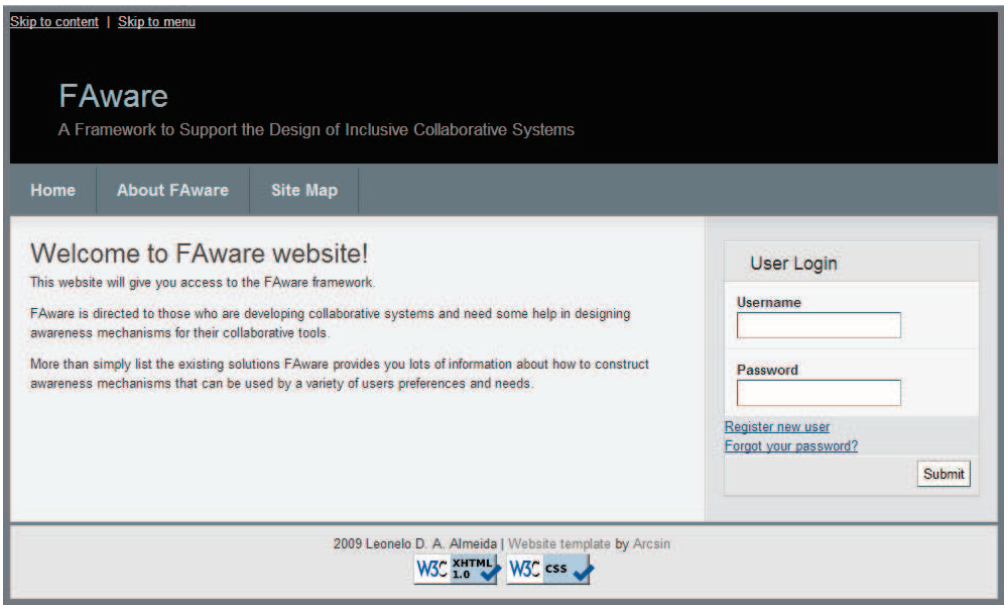


**Figura C.1. Página inicial.**

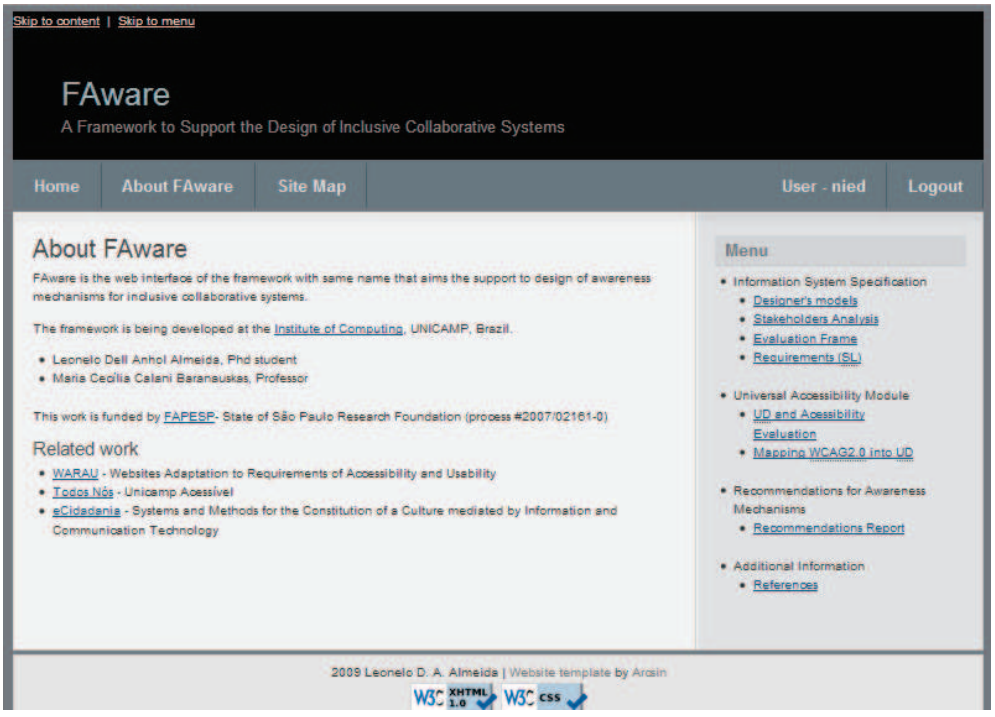


**Figura C.2. Informações sobre o *website*.**

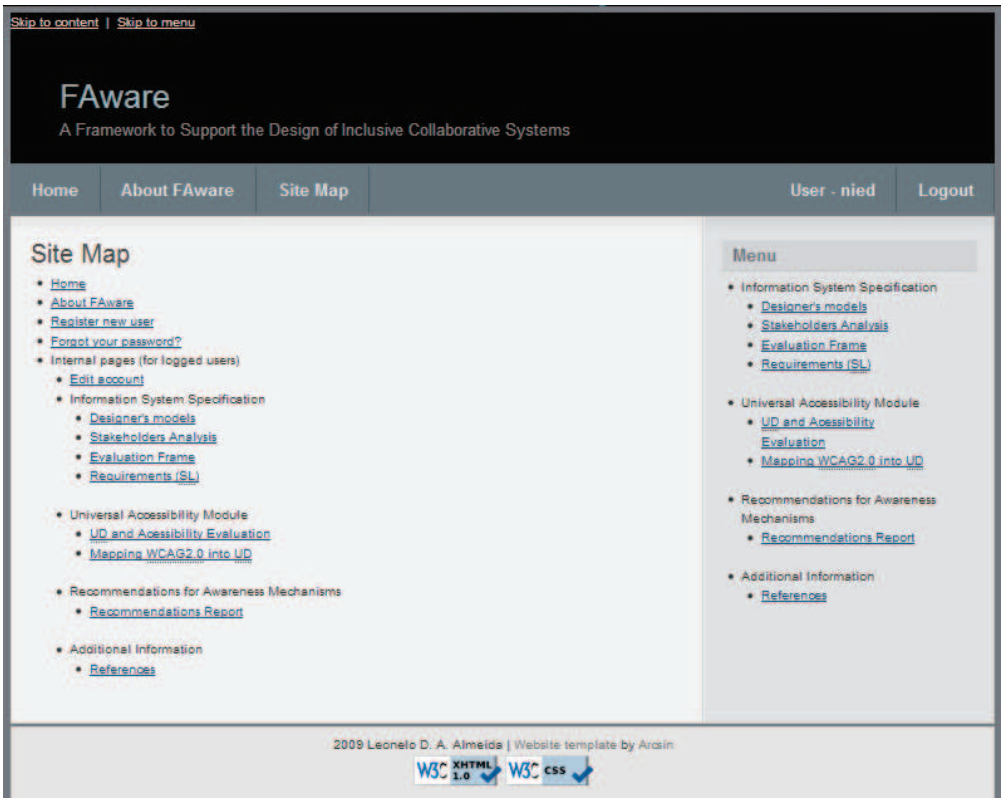


**Figura C.3. Mapa do *website*.**

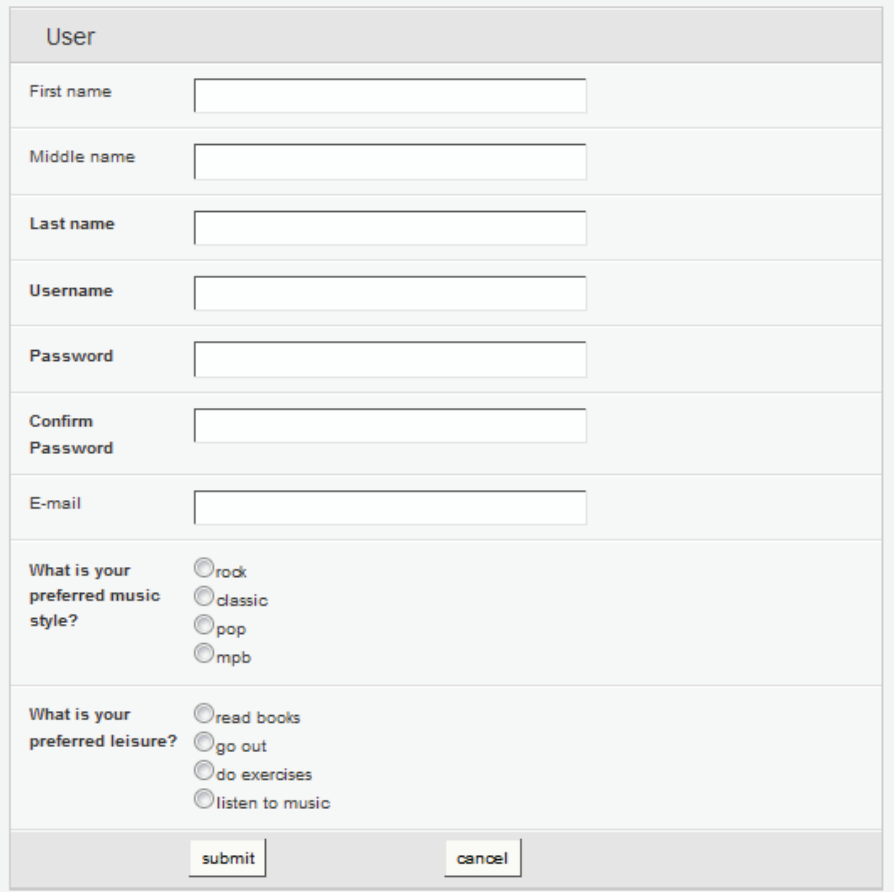


**Figura C.4. Cadastro de usuário.**

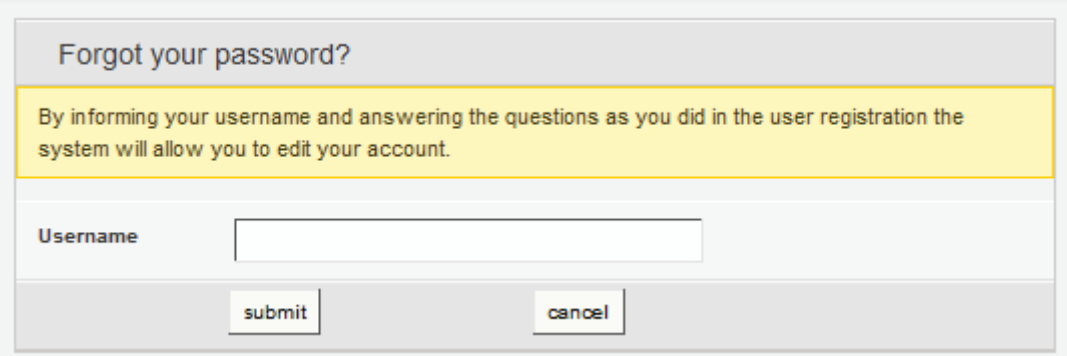


**Figura C.5. Recuperação de senha, passo 1.**

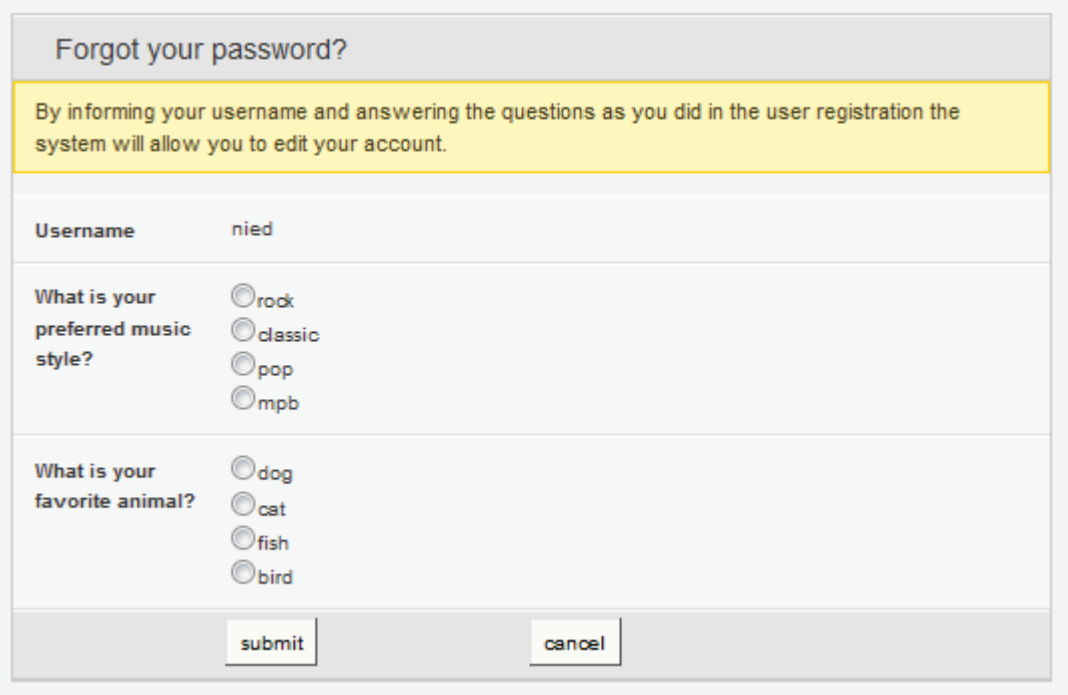


**Figura C.6. Recuperação de senha, passo 2.**

Após o usuário se autenticar no *website*, é apresentado o conjunto de módulos do sistema na área do conteúdo principal (Figura C.7). Os módulos disponíveis são o de especificação de sistemas de informação, o de acessibilidade universal e o relatório de recomendações. Além disso, todas as referências utilizadas no *website* ficam relacionadas na lista de referências.

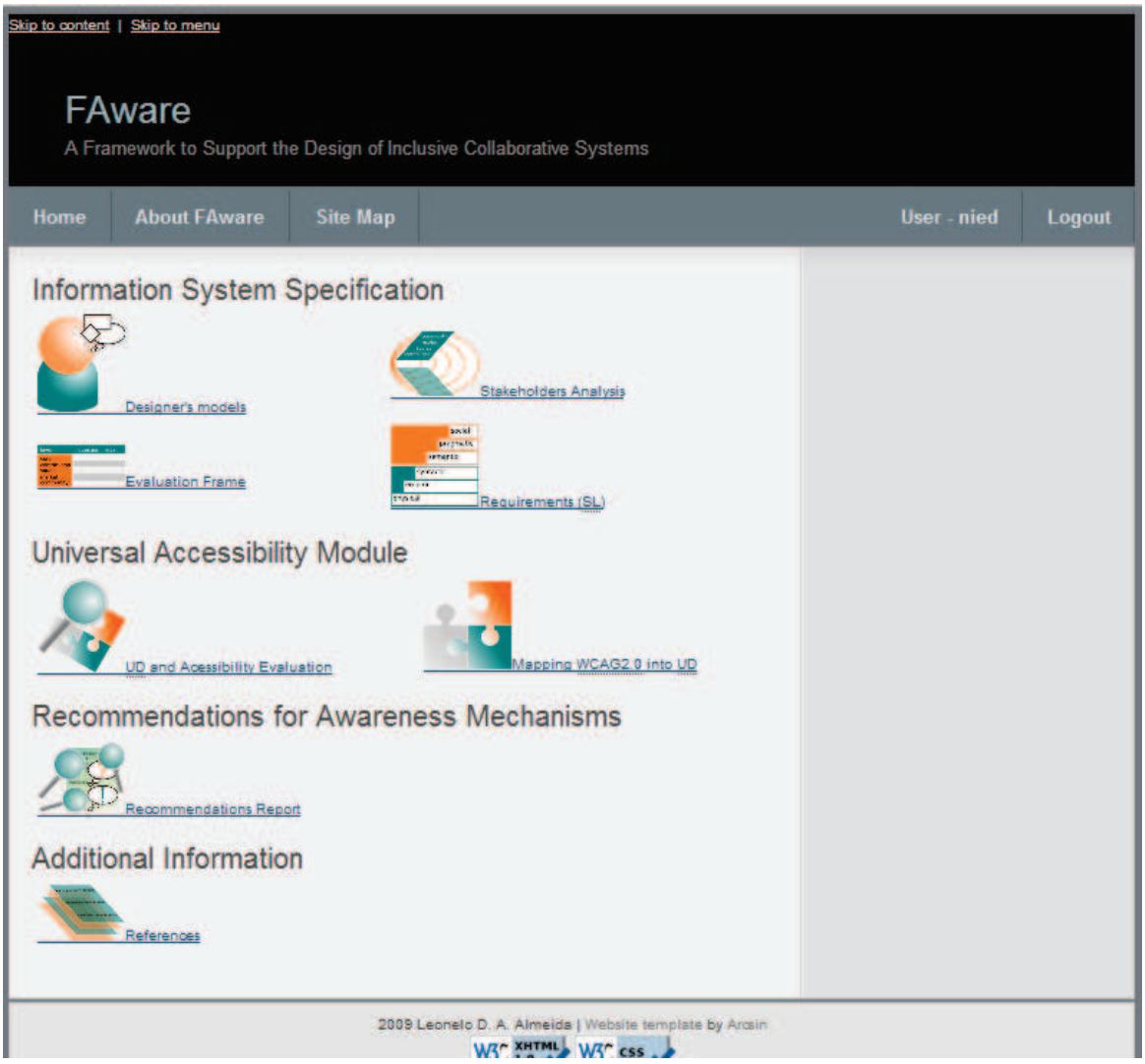


**Figura C.7. Página inicial, após a autenticação do usuário.**

## *C.2 Especificação de Sistemas de Informação*

O módulo Especificação de Sistemas de Informação é composto por quatro artefatos: Modelos do *Designer* (Figura C.8, Figura C.9 e Figura C.10), Análise de *Stakeholders* (Figura C.11, Figura C.12 e Figura C.13), Quadro de Avaliação (Figura C.14, Figura C.15 e Figura C.16) e Escada Semiótica (Figura C.17, Figura C.18, Figura C.19, Figura C.20).

O artefato Modelo do *Designer* apresenta inicialmente a lista de modelos já cadastrados pelo usuário (Figura C.8), assim como opções para incluir, alterar ou apagar

modelos. O cadastro de modelos (Figura C.9) consiste da nomeação, da seleção de categoria de ferramenta colaborativa (*e.g.* editores textuais colaborativos, jogos, comunicação síncrona) e do provimento de descrição. Todos os atributos estão disponíveis para edição tanto na inclusão como na alteração de modelos.

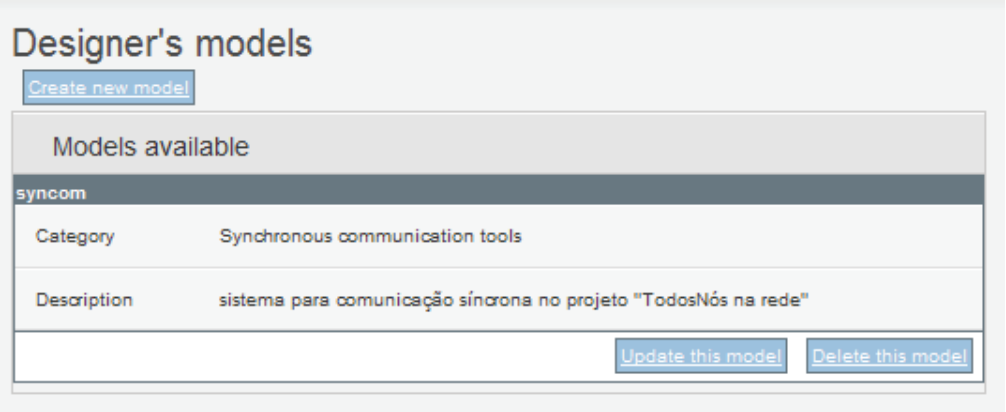


**Figura C.8. Modelo do *designer*: lista de modelos cadastrados.**

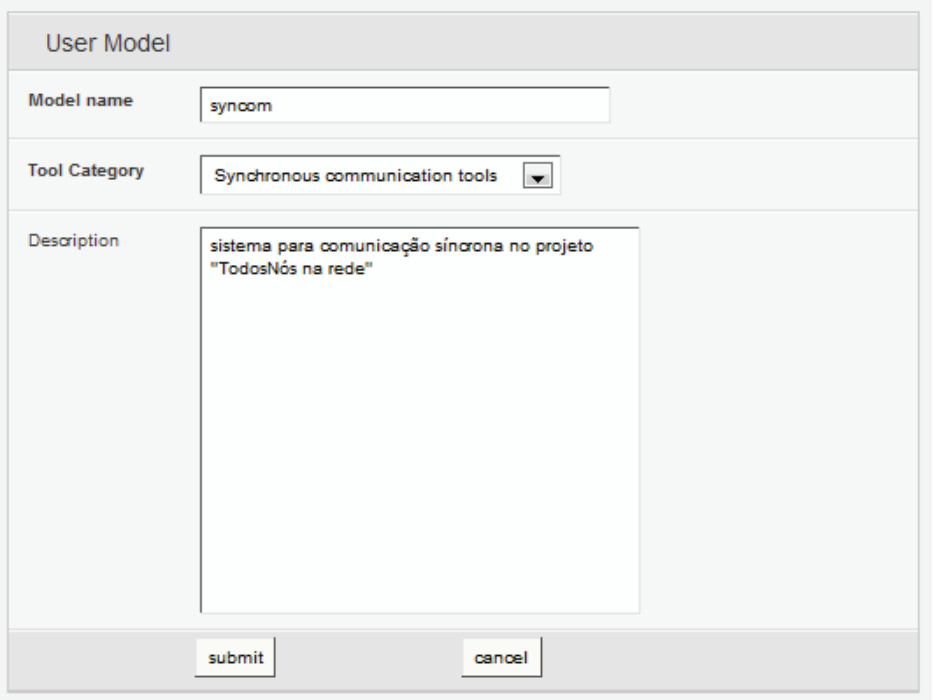


**Figura C.9. Modelo do *designer*: cadastro de modelos.**

Toda ação para apagar conteúdos no FAware é precedida por mensagem de confirmação contendo a identificação do conteúdo que está para ser apagado. A Figura C.10 exemplifica a ação de apagar um modelo.

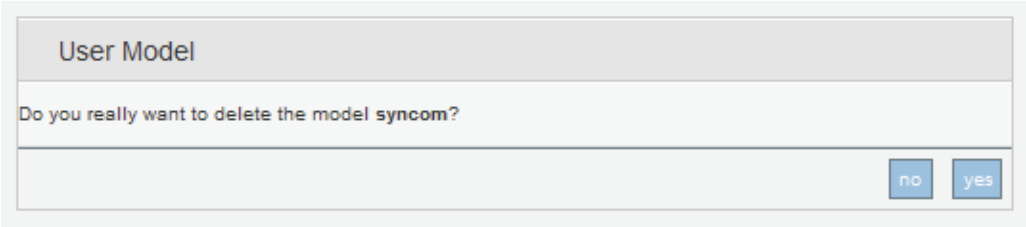


**Figura C.10. Exemplo de confirmação antes de apagar conteúdos.**

Os demais artefatos do FAware são relacionados a um modelo selecionado pelo *designer*. O usuário pode escolher o modelo a qualquer momento, tal como exemplificado na Figura C.11, considerando o artefato Análise de *Stakeholders*.

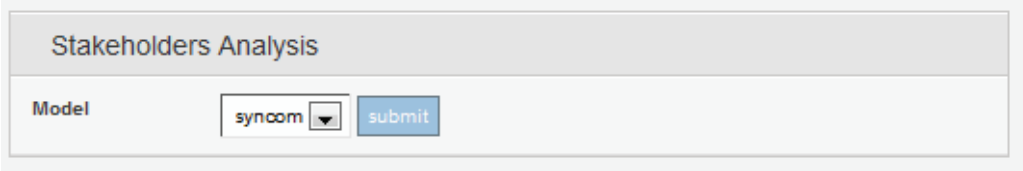


**Figura C.11. Exemplo de seleção do modelo do *designer*.**

Uma das prioridades para o FAware é o provimento de código acessível em todas as funcionalidades do *website*. No entanto, na versão atual do *website* algumas restrições foram feitas de maneira a maximizar a acessibilidade. Uma delas é o uso de uma estrutura encadeada entre as camadas do artefato Análise de *Stakeholders*, que utiliza elementos HTML para prover informação semântica adequada para o uso por pessoas com deficiência visual (Figura C.12). Como limitação, a apresentação visual foi simplificada e não foi adotada a visualização das camadas dispostas em elipses.

No artefato Análise de *Stakeholders*, usuários podem inserir, alterar ou apagar partes interessadas, distribuídas em diversas camadas que representam a relação delas com o sistema de informação. Para incluir uma parte interessada, o usuário deve clicar em um dos botões "+" da camada em que deseja incluí-lo, então será exibido um formulário para informar os dados da parte interessada (Figura C.13). Para apagar partes interessadas, basta clicar no respectivo botão "x". Para alterar partes interessadas basta clicar sobre elas.

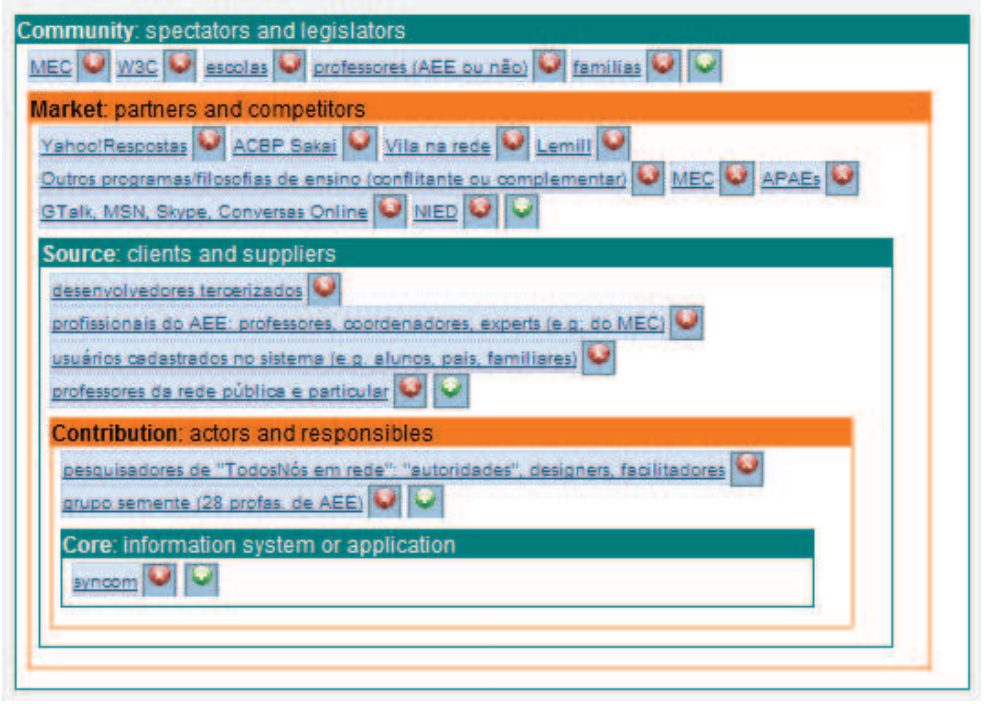


**Figura C.12. Análise de *Stakeholders*.**

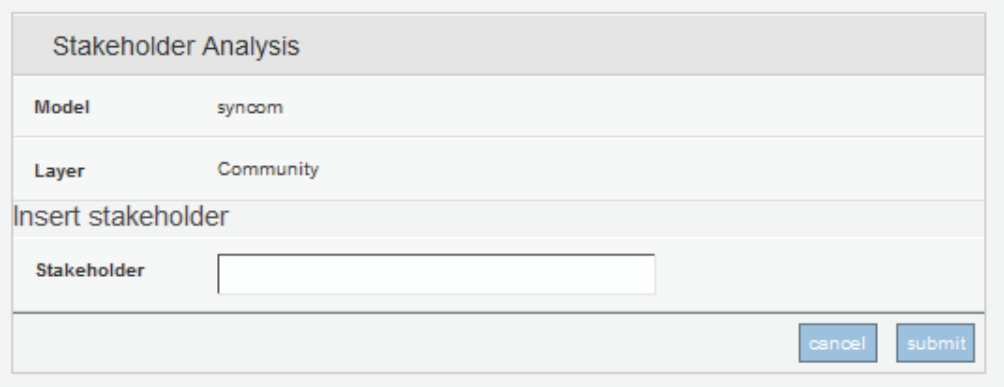


**Figura C.13. Análise de *Stakeholders*: cadastro de *stakeholder*.**

O artefato Quadro de Avaliação permite a reflexão sobre problemas, questões, soluções e ideias em relação às partes interessadas oriundas da Análise de *Stakeholders*. O artefato está organizado de acordo com as mesmas camadas da Análise de *Stakeholders* e classifica seu conteúdo em duas colunas (*i.e.* Problemas/Questões e Soluções/Idéias). A

maneira para realizar inclusão (Figura C.15), alteração (Figura C.16) e remoção de conteúdo é a mesma da Análise de *Stakeholders*.


**Figura C.14. Quadro de Avaliação.**

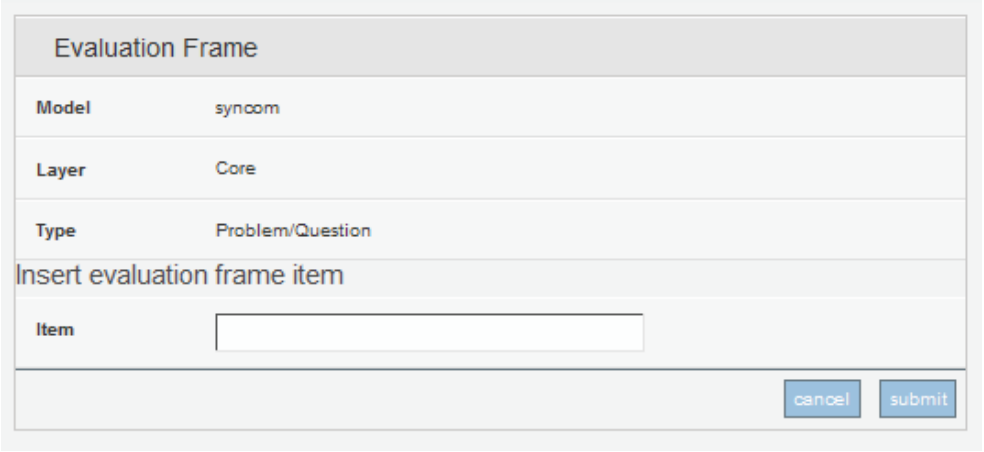


**Figura C.15. Quadro de Avaliação: cadastro de item.**

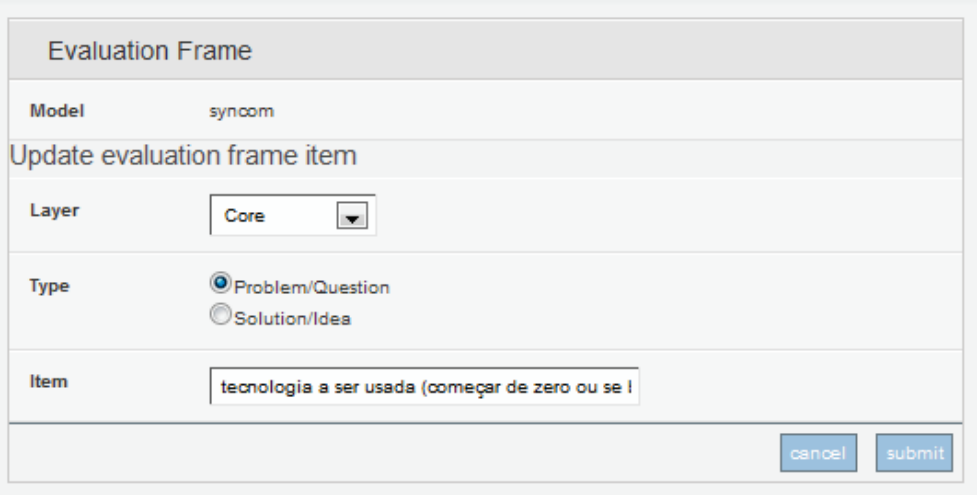


**Figura C.16. Quadro de Avaliação: alteração de item.**

O artefato Escada Semiótica permite a elicitação de requisitos de sistemas de informação distribuídos em seis degraus que refletem as categorizações de signos em contextos organizacionais (Figura C.17). As operações de inclusão, alteração e remoção são semelhantes às existentes nos artefatos Análise de *Stakeholders* e Quadro de Avaliação. Na inclusão (Figura C.18), usuários tanto incluir novos requisitos (Figura C.19) ou utilizar recomendações de requisitos relacionados à *awareness* em SCI na *Web* (Figura C.20)

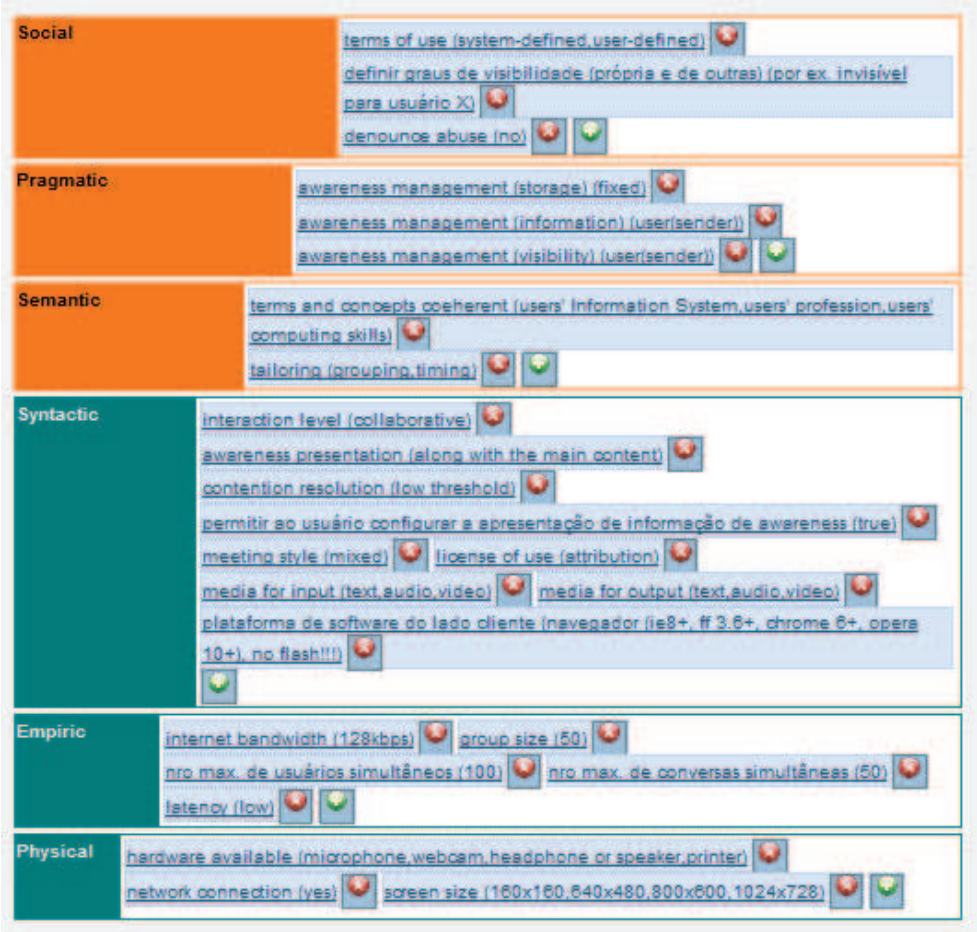


**Figura C.17. Escada Semiótica.**

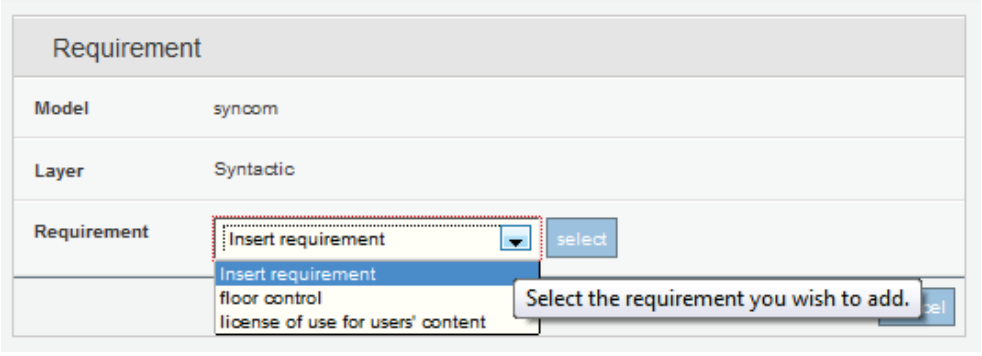


**Figura C.18. Escada Semiótica: cadastro de requisito.**

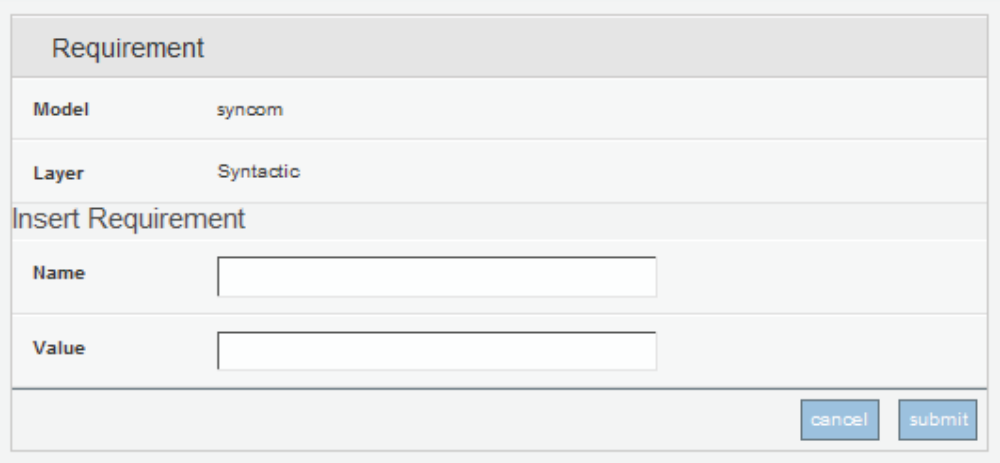


**Figura C.19. Escada Semiótica: novo requisito.**

Quando utilizando requisitos sugeridos pelo FAware, o usuário é provido com um conjunto de valores possíveis, e a descrição do requisito. O conjunto de valores possíveis de cada requisito sugerido pelo FAware tem um dentre três comportamentos: exclusivo (somente um valor pode se selecionado), cumulativo (somente um valor pode se selecionado, mas selecionando um valor subtende-se a seleção dos valores anteriores *e.g.* uma escala "até 5, até 10, até 100") e múltiplo (vários valores podem ser selecionados).

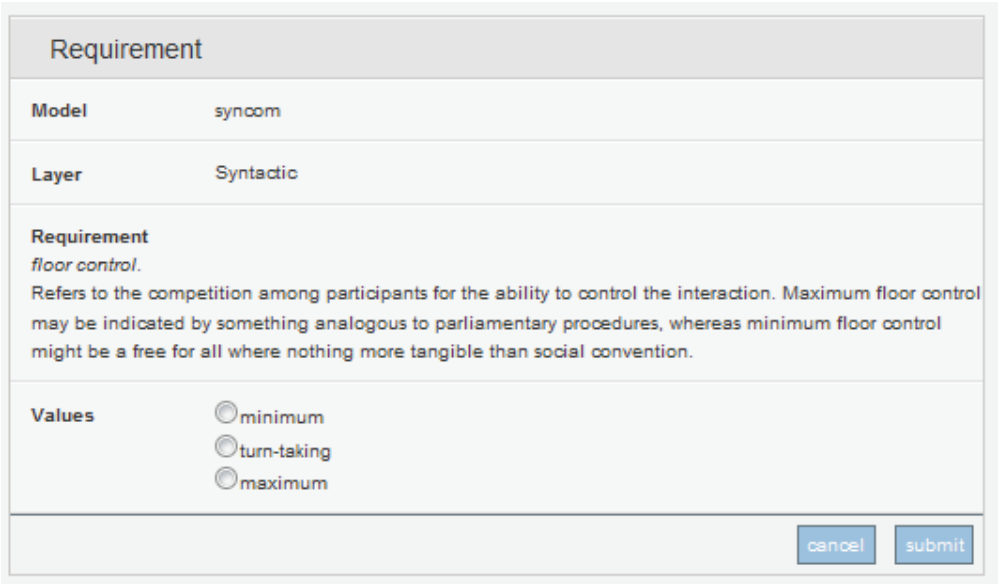


**Figura C.20. Escada semiótica: requisito do sistema.**

## *C.3 Acessibilidade Universal*

O módulo Acessibilidade Universal disponibiliza a funcionalidade para avaliação de *websites* (Figura C.22) e a visualização sintética do mapeamento entre diretrizes do DU e diretrizes técnicas de acessibilidade na *Web*, apresentado no Capítulo 5 (Figura C.24).

A funcionalidade de avaliação de acessibilidade universal apresenta inicialmente a lista de avaliações já realizadas no FAware (Figura C.21). A partir da lista é possível imprimir as avaliações, alterá-las, apagá-las ou, ainda, realizar novas avaliações. A funcionalidade para avaliação possui um cabeçalho onde é possível informar a URL que será avaliada, a ferramenta de avaliação semiautomática de acessibilidade que será utilizada em conjunto com o mapeamento e a descrição da avaliação (Figura C.22). As unidades de mapeamento são dispostas logo abaixo do cabeçalho e estão agrupadas por princípio e diretriz do DU.

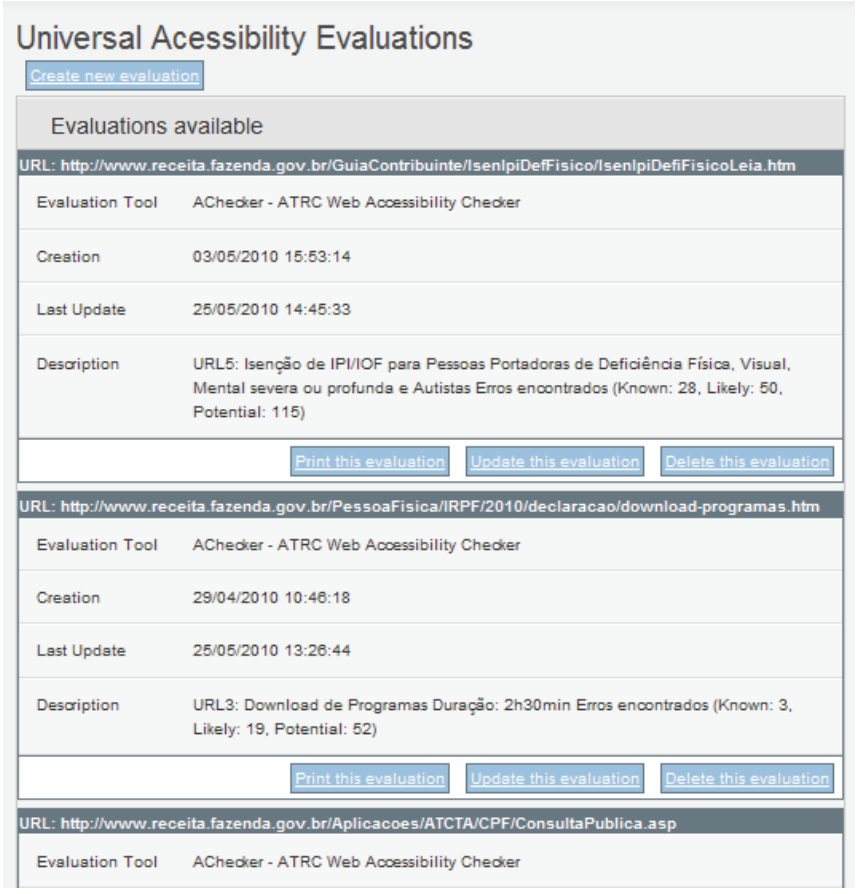


**Figura C.21. Lista de avaliações de acessibilidade universal já cadastradas.**

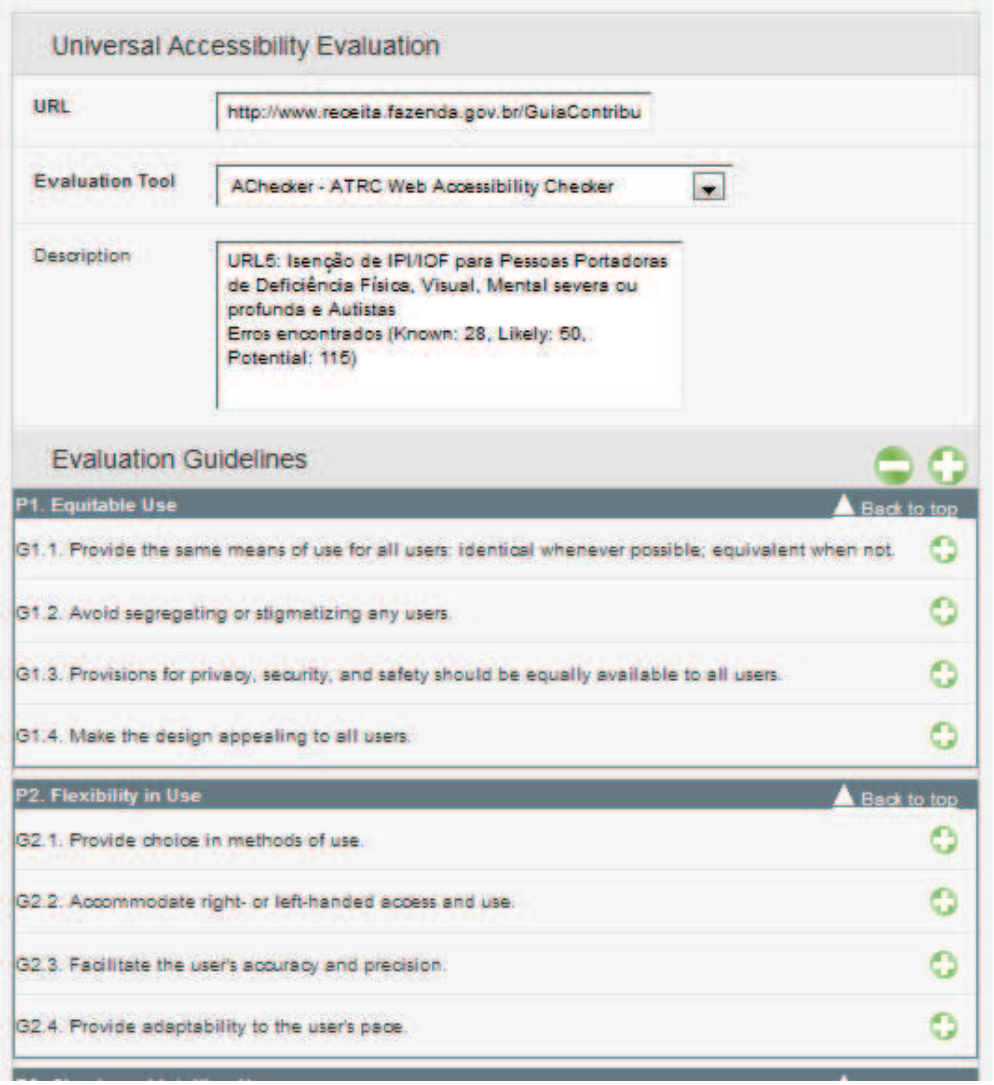


**Figura C.22. Avaliação de acessibilidade universal.**

Inicialmente as unidades de mapeamento não estão visíveis, para tanto o usuário pode clicar nos botões "+" presentes em cada diretriz do DU (Figura C.23). Cada unidade de mapeamento pode envolver um critério de sucesso do WCAG, uma recomendação da ISO 9241 ou um comentário. Para cada unidade de mapeamento há a possibilidade de informar o nível de concordância com a avaliação proveniente da ferramenta semiautomática e um espaço para registrar o *rationale* utilizado na avaliação da unidade.

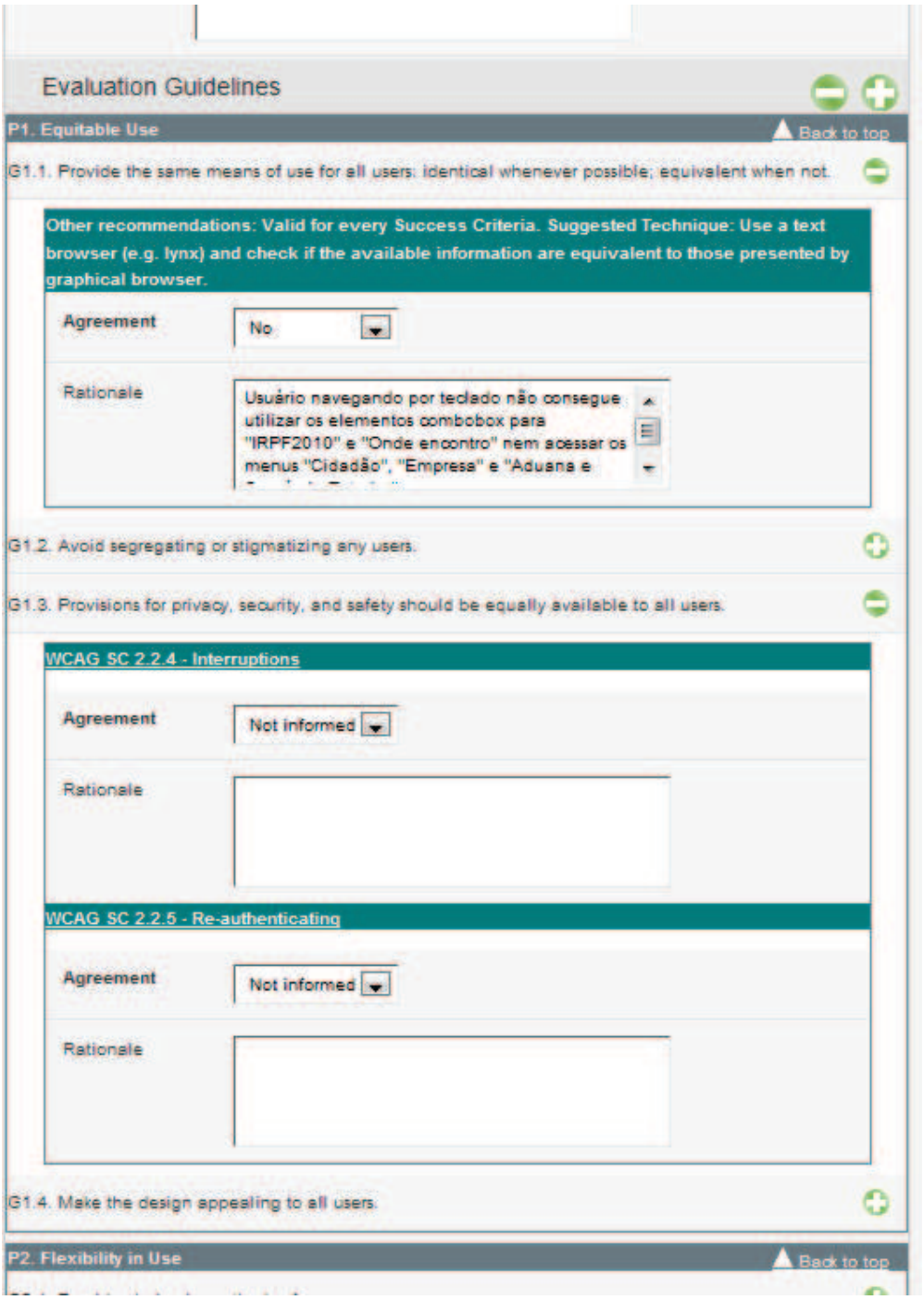


**Figura C.23. Avaliação de acessibilidade universal: unidades de mapeamento expandidas.**

A lista de unidades de mapeamento (Figura C.24) tem a finalidade de prover um acesso rápido as unidades de mapeamento, além de *links* para informações adicionais, algumas delas externas ao FAware (*e.g. website* da W3C). Ao final da lista há um quadro-resumo para apresentar a distribuições dos mapeamentos entre os princípios do DU e do WCAG (Figura C.25).

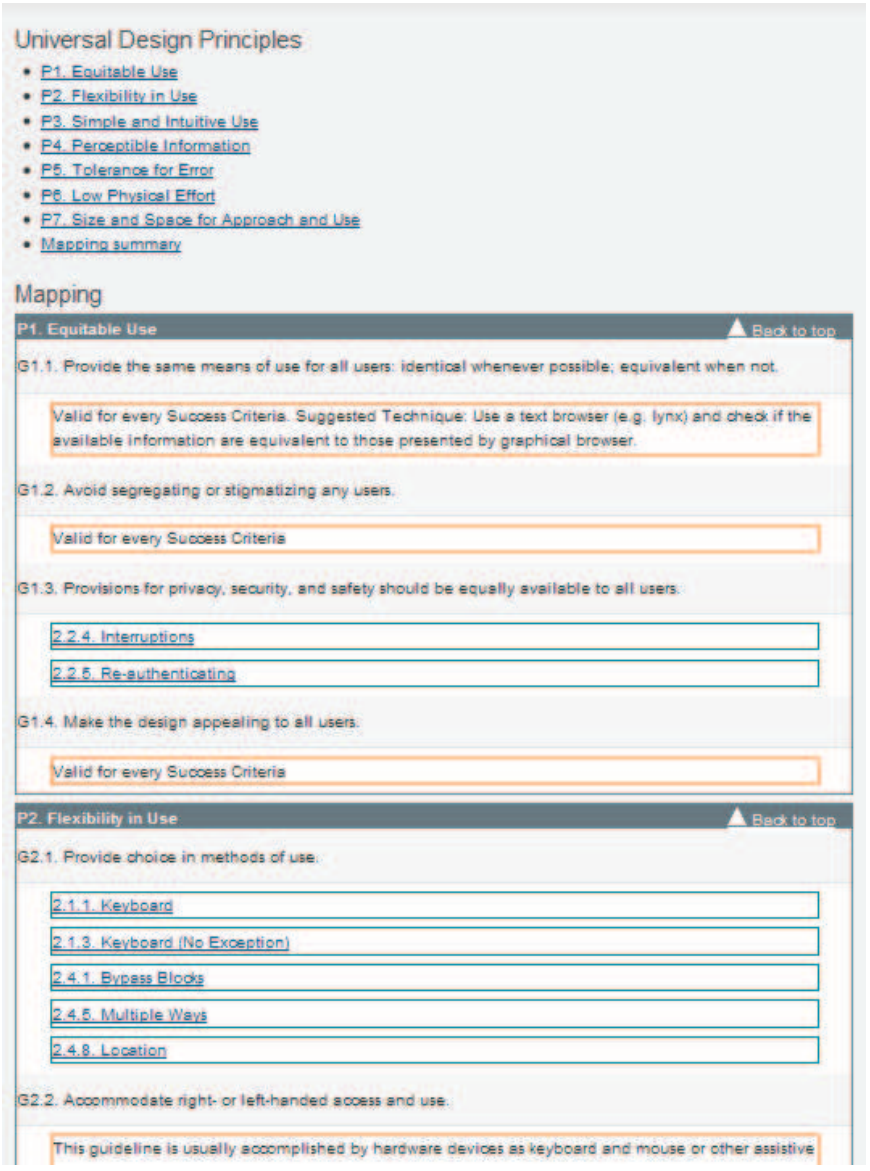


**Figura C.24. Consulta das unidades de mapeamento para acessibilidade universal.**

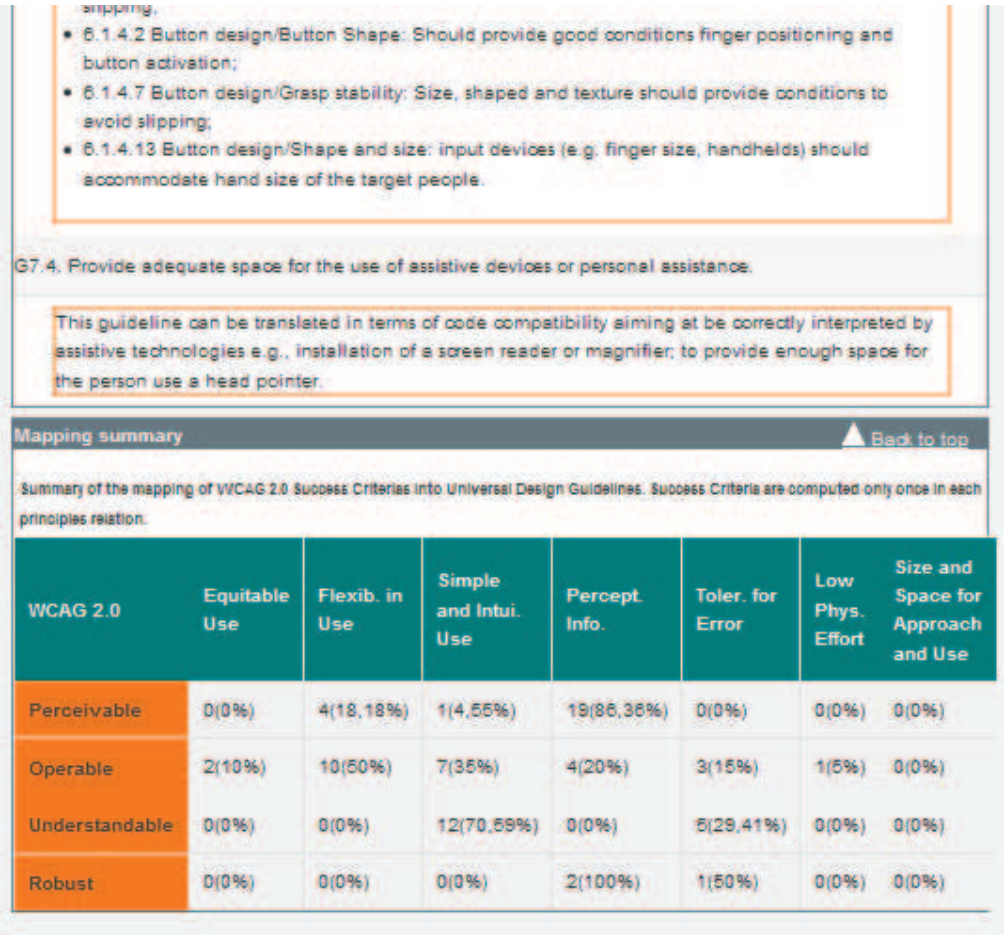


**Figura C.25. Consulta das unidades de mapeamento para acessibilidade universal: resumo da distribuição.**

## *C.4 Relatório de Recomendações*

O módulo Relatório de Recomendações tem o objetivo de prover recomendações de mecanismos para suporte a *awareness* com base nas informações fornecidas pelo usuário no módulo Especificação de Sistemas de Informação e no componente Base de Conhecimento, processadas pelo componente Processador de *Awareness*. Para gerar o relatório, o usuário pode realizar customizações no que diz respeito aos tipos de *awareness* com que deseja trabalhar (espaço de trabalho, contextual e conversacional), o tempo que as informações providas pelos mecanismos se referem (presente e passado) e, ainda, se deseja que o relatório traga informações somente relacionadas diretamente com a categoria de ferramenta colaborativa informada no artefato Modelo do *Designer* (Figura C.26).

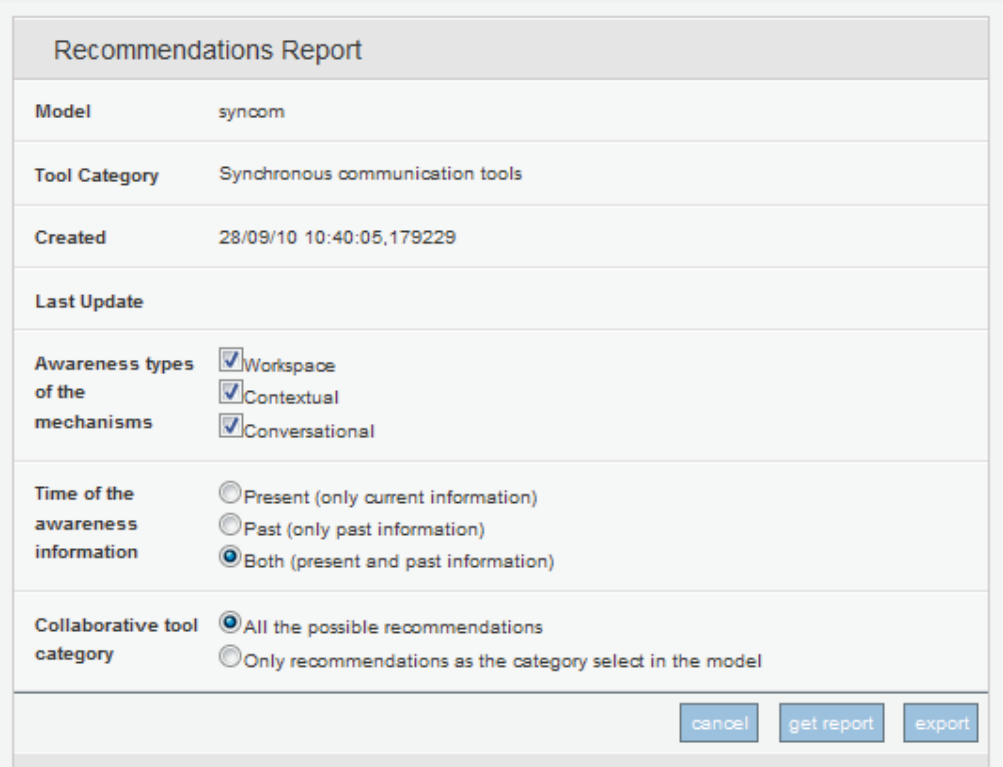


**Figura C.26. Relatório de Recomendações: configuração do relatório.**

Os resultados do processamento do relatório solicitado pelo usuário são apresentados abaixo da configuração do relatório (Figura C.27). As recomendações são apresentadas agrupadas por tipo de *awareness*, tempo, elemento e pergunta. Cada recomendação contém um texto explicado, a fonte da recomendação (que pode ser publicações acadêmicas, software livre ou ferramentas comerciais), imagens ilustrativas para apoiar a compreensão da recomendação e o nível de adequação da recomendação (0 a 100%) em relação ao sistema de informação especificado pelo usuário do FAware.

O Relatório de Recomendações é uma funcionalidade dinâmica e permite que usuários modifiquem o nível de adequação das recomendações inicialmente calculadas pelo FAware e, também, o descarte de recomendações. Recomendações descartadas não são removidas e podem ser acessadas a qualquer momento (Figura C.28).

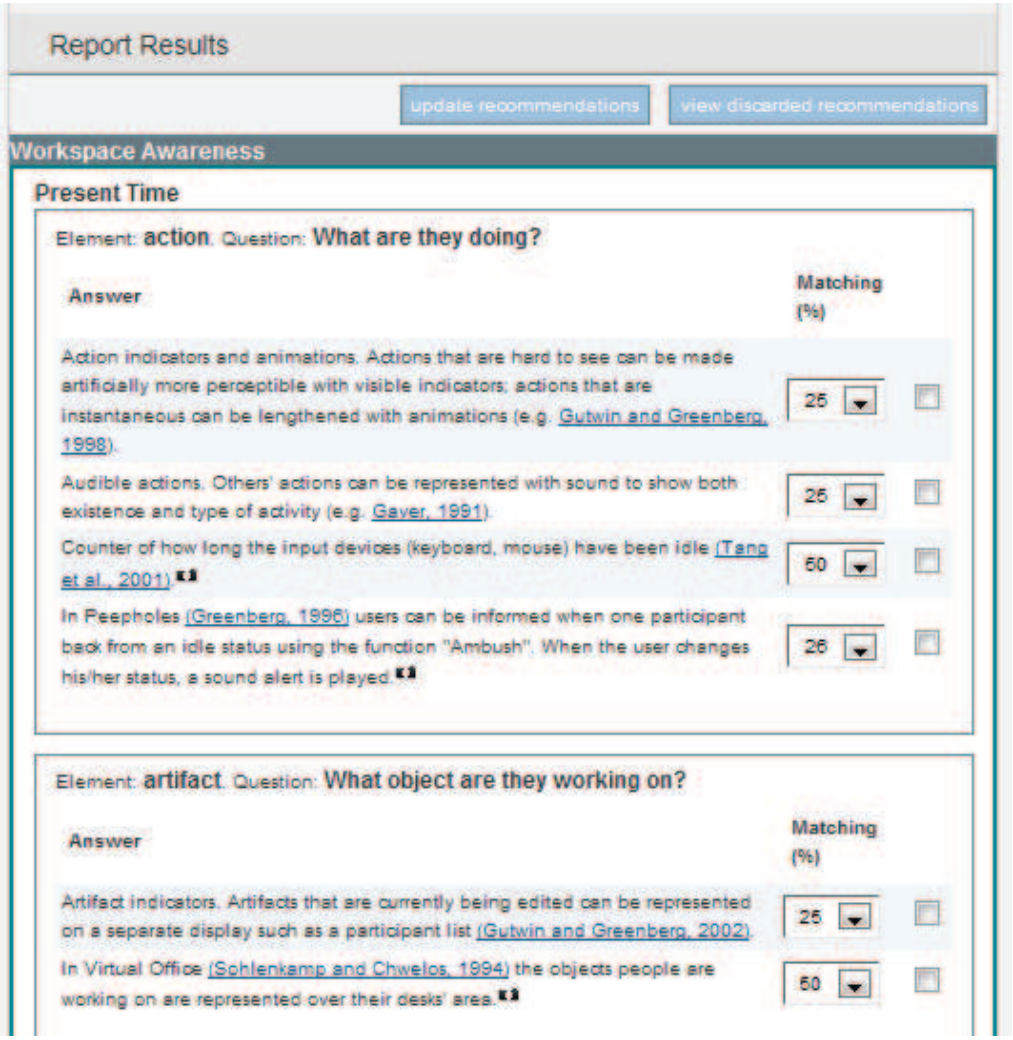


**Figura C.27. Relatório de Recomendações: corpo do relatório.**

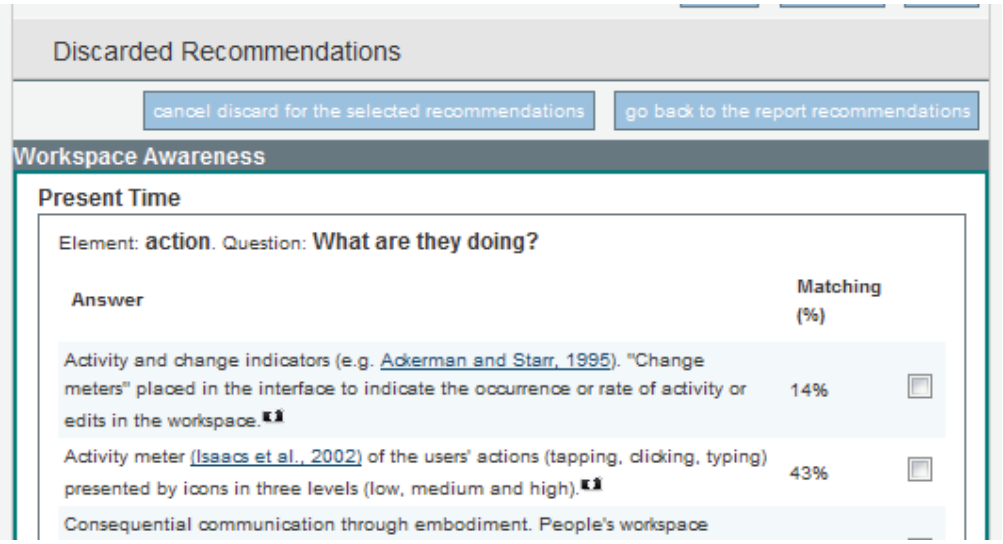


**Figura C.28. Relatório de Recomendações: recomendações descartadas.**

## *C.3 Referências Bibliográficas do FAware*

Toda referência utilizada no FAware e indexada na base de conhecimento, pode ser consultada nessa funcionalidade (Figura C.29). Além da referência bibliográfica completa, para as referências indexadas, é possível visualizar os dados detalhados da indexação. Os metadados utilizados na indexação são apresentados na representação da Escada Semiótica (Figura C.30). Imagens ilustrativas utilizadas no Relatório de Recomendações também são visíveis nessa funcionalidade.

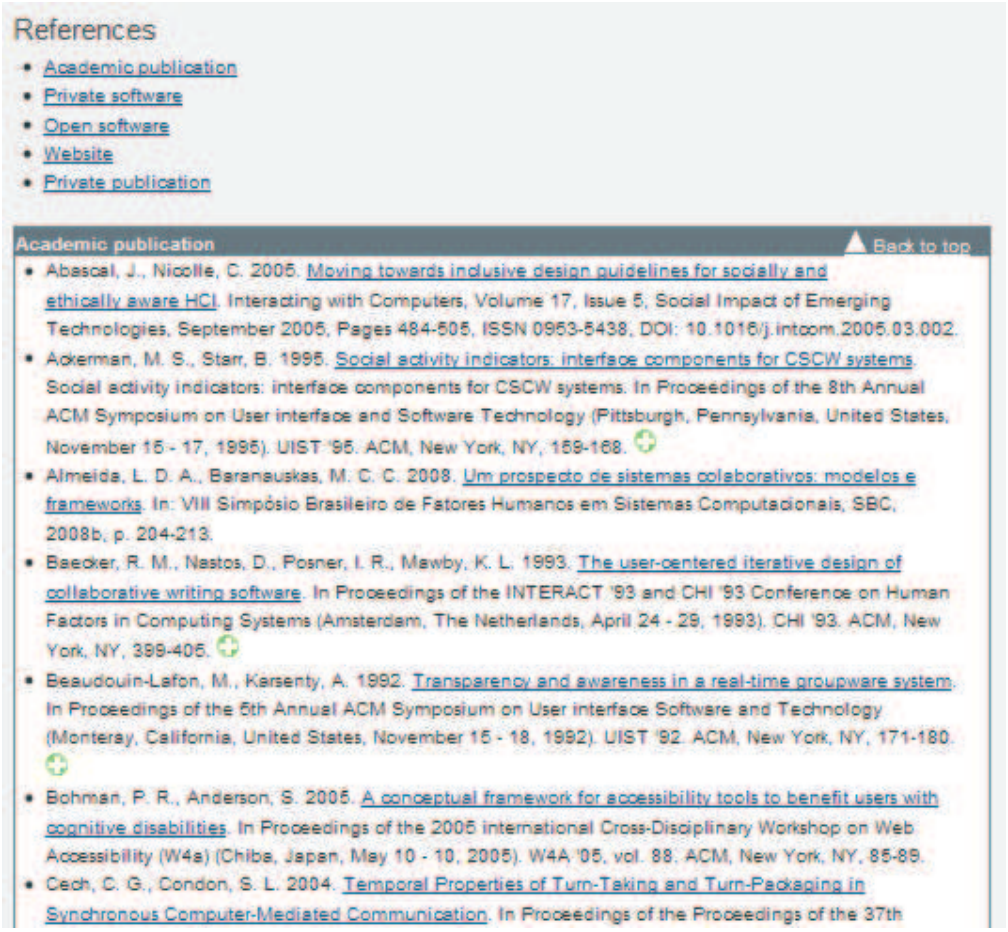


**Figura C.29. Referências bibliográficas.**

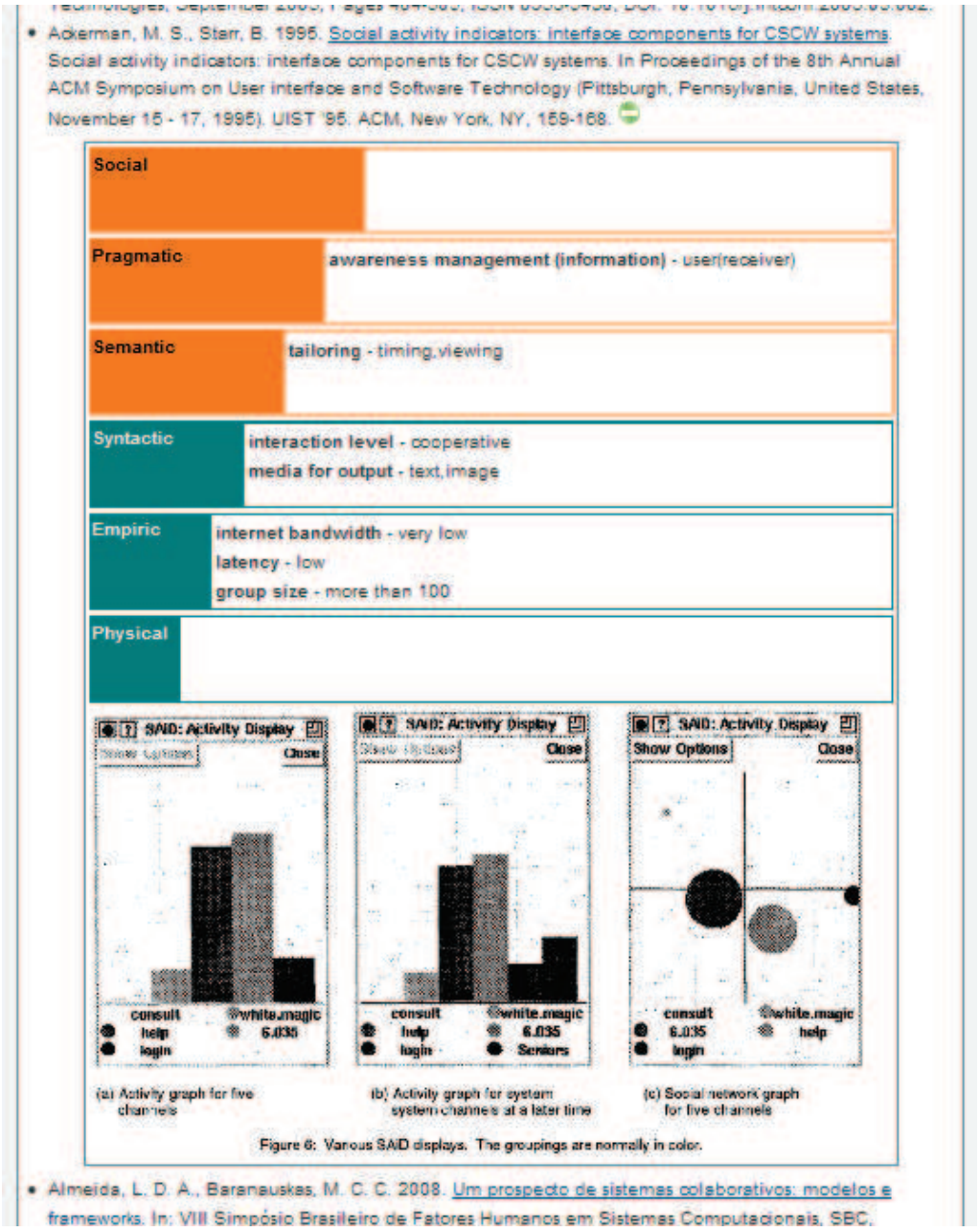


**Figura C.30. Referências bibliográficas: detalhes da indexação.**

# Apêndice D:

# Aspectos de Implementação do *Framework* FAware

Nesta seção estão descritos os aspectos de implementação do *framework* FAware, organizados em: Plataforma de *Software* e Dicionário de dados.

## *D.1. Plataforma de software*

A plataforma de *software* (Figura D.1. Plataforma de *software* do FAware.) é organizada em dois elementos principais: a Base de Dados e o Servidor *web*. A base de dados utiliza como sistema gerenciador de banco de dados, o Oracle Database 10g Express Edition Release 10.2.0.1.0. O *schema* criado para o *framework* envolve, além de tabelas e visões, dois *packages* que implementam o componente "Processador de *Awareness*". A realização do execução do "Processador de *Awareness*" por código nativo do Oracle traz como benefícios a redução significativa da troca de mensagens entre o servidor *web* e o bando de dados e, consequentemente, é capaz de processar as informações mais rapidamente e de maneira transparente.

O servidor *web* contém a interface de usuário e os respectivos procedimentos de validação e comunicação com a base de dados, organizados em uma estrutura MVC (Model-View-Controller). Como servidor *web,* foi utilizado o WAMPServer 2.0 (Apache 2.2.11). A interface de usuário, a validação e a comunicação com a base de dados utilizam PHP 5.3.0 para *server-side scripts*, XHTML 1.0 Strict, CSS 2 e Javascript para apresentação das informações.

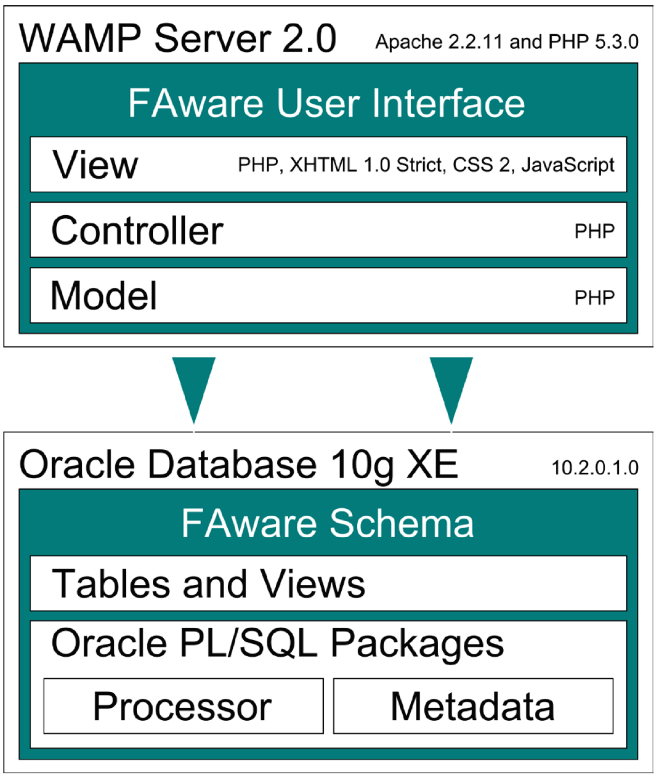


**Figura D.1. Plataforma de *software* do FAware.**

## *D.2. Dicionário de Dados*

Esta seção apresenta as tabelas componentes da base de dados do FAware. No diagrama IDEF1X apresentado na Figura D.2. Diagrama IDEF1X do Banco de Dados do *framework* FAware.
estão omitidas as tabelas relacionadas ao controle de histórico de alterações e as tabelas temporárias, para fins de simplificação.

A Tabela D.1 apresenta uma distribuição de uso das tabelas da base de dados de acordo com as funcionalidades do FAware. As funcionalidades indicadas são: taxonomia, referências, autenticação de usuários, módulo Relatório de Recomendações, módulo Acessibilidade Universal e módulo Especificação de Sistemas de Informação. A tabelXX apresenta os objetivos das tabelas contidas no diagrama IDEF1X.

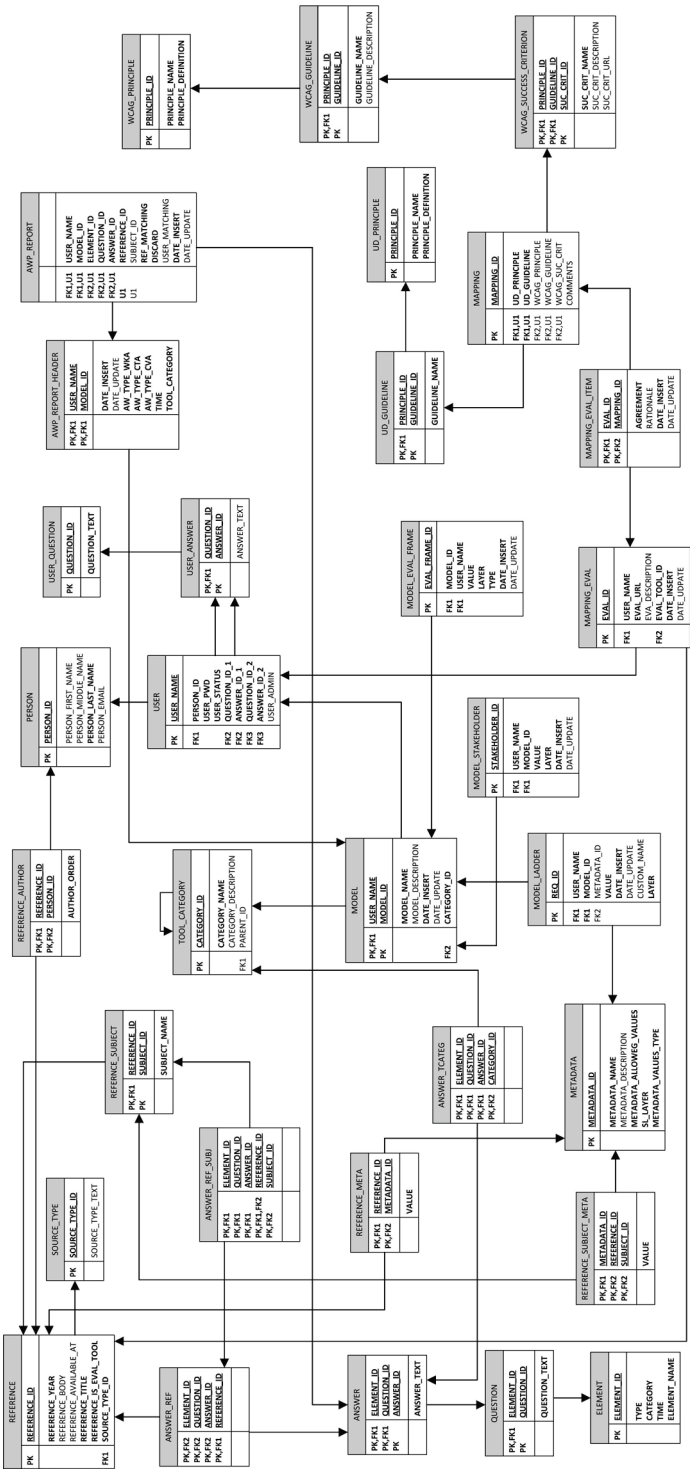

**Figura D.2. Diagrama IDEF1X do Banco de Dados do *framework* FAware.**

**Tabela D.1. Utilização da s tabelas da base de dados de acordo com as funcionalidades do FAware.**

| Tabela | Taxo. | Refs. | Usu. | Relat. Recomm. | Access. Universal | Espec. SI |
|---|---|---|---|---|---|---|
| answer | X | | | X | | |
| answer_ref | X | | | X | | |
| answer_ref_subj | X | | | X | | |
| answer_tcateg | X | | | X | | |
| awp_report | | | | X | | |
| awp_report_header | | | | X | | |
| element | X | | | X | | |
| metadata | X | | | X | | X |
| model | | | | X | | X |
| model_eval_frame | | | | | | X |
| model_ladder | | | | X | | X |
| model_stakeholder | | | | | | X |
| person | | X | X | | | X |
| question | X | | | X | | |
| reference | | X | | X | | |
| reference_author | | X | | X | | |
| reference_meta | X | X | | X | | |
| reference_subject | X | X | | X | | |
| reference_subject_meta | X | X | | X | | |
| source_type | | X | | | | |
| user | | | X | | | |
| user_answer | | | X | | | |
| user_question | | | X | | | |
| mapping | | | | | X | |
| mapping_eval | | | | | X | |
| mapping_eval_item | | | | | X | |
| tool_category | X | | | X | | X |
| ud_guideline | | | | | X | |
| ud_principle | | | | | X | |
| wcag_guideline | | | | | X | |
| wcag_principle | | | | | X | |
| wcag_success_criterion | | | | | X | |

**Tabela D.2. Objetivos das tabelas da base de dados do FAware.**

| Tabela | Objetivo |
|---|---|
| answer | Respostas para perguntas cadastradas em QUESTION |
| answer_ref | Referências envolvidas em uma resposta em ANSWER |
| answer_ref_subj | Assuntos utilizados em uma resposta em ANSWER_REF_SUBJ |
| answer_tcateg | Categorias de sistemas colaborativos relacionadas a uma resposta em ANSWER |
| awp_report | Itens de um relatório de recomendações |
| awp_report_header | Cabeçalho de um relatório de recomendações |
| element | Elementos de *awareness* |
| metadata | Metadados para indexar referências e requisitos |
| model | Modelos criador por usuários do FAware |
| model_eval_frame | Quadros de avaliação preenchidos por usuários do FAware |
| model_ladder | Escadas Semióticas preenchidas por usuários do FAware |
| model_stakeholder | Análise de *Stakeholders* preenchidas por usuários do FAware |
| person | Cadastro geral de pessoas (físicas ou jurídicas) |
| question | Questões sobre elementos de *awareness* em ELEMENT |
| reference | Referências usadas no FAware (podem ser acadêmicas, *websites*, *softwares* comerciais ou livres) |
| reference_author | Autores de uma referência (devem estar em PERSON) |
| reference_meta | Metadados usados para indexar uma referência |
| reference_subject | Assuntos específicos de uma referência |
| reference_subject_meta | Metadados relacionados a um assunto de uma referência em REFERENCE_SUBJECT |
| source_type | Tipos de referência |
| user | Usuários do FAware (devem estar em PERSON) |
| user_answer | Respostas para perguntas em USER_QUESTION |
| user_question | Perguntas aleatórias feitas para lembrete de senha de usuário. |
| mapping | Unidades de mapeamento de diretrizes do DU e do WCAG |
| mapping_eval | Cabeçalhos de avaliações universais de acessibilidade |
| mapping_eval_item | Itens considerados em avaliações em MAPPING_EVAL |
| tool_category | Categoria de sistemas colaborativos |
| ud_guideline | Diretrizes para princípios do DU em UD_PRINCIPLE |
| ud_principle | Princípios do DU |
| wcag_guideline | Diretrizes para princípios do WCAG em WCAG_PRINCIPLE |
| wcag_principle | Princípios do WCAG |
| wcag_success_criterion | Critérios de sucesso para diretrizes do WCAG em WCAG_GUIDELINE |

# Anexo A:

# Autorizações para Publicação

## *A.1 Sociedade Brasileira de Computação (SBC)*

E-mail de Solicitação:

Título: Solicitação para uso de artigos publicados em congressos da SBC

---

**Leonelo Almeida <ra069316@ic.unicamp.br>** **2 de dezembro de 2010 14:28**
Para: sbc@sbc.org.br

Sociedade Brasileira de Computação (SBC),
Nos próximos meses defenderei o Doutorado em Ciência da Computação no Instituto de Computação da Universidade Estadual de Campinas (IC/UNICAMP). Envio este e-mail com o intuito de solicitar autorização da SBC para incorporar artigos que foram publicados nos IHC 2008 e 2010 no corpo de minha Tese de Doutorado. Os artigos serão publicado na íntegra, sem alterações (com exceção da formatação do texto, numeração da figuras e tabelas, e formato de citações).

Os artigos são:
Título: "Um Prospecto de Sistemas Colaborativos: Modelos e Frameworks"
Autores: ALMEIDA, L. D. A., BARANAUSKAS, M. C. C.
Publicação: Anais do VIII Simpósio Brasileiro de Fatores Humanos em Sistemas Computacionais (IHC 2008);

Título: "Conversas Online: A Synchronous Communication Tool Integrated to Inclusive Social Networks"
Autores: ALMEIDA, L. D. A., HAYASHI, E. C. S., REIS, J. C., MARTINS, M. C., BARANAUSKAS, M. C. C.

Publicação: Anais do IX Simpósio Brasileiro de Fatores Humanos em Sistemas Computacionais (IHC 2010)

Título: “Universal Design Principles Combined with Web Accessibility Guidelines: A Case Study”
Autores: ALMEIDA, L. D. A., BARANAUSKAS, M. C. C.
Publicação: Anais do IX Simpósio Brasileiro de Fatores Humanos em Sistemas Computacionais (IHC 2010);

Conto com sua compreensão e agradeço a atenção,

Leonelo Dell Anhol Almeida
IC-Unicamp

Email de resposta:

---

**Supervisão Administrativa <supervisao@sbc.org.br>** **24 de janeiro de 2011 15:21**

Responder a: supervisao@sbc.org.br

Para: Leonelo Almeida <leonelodellanhol@gmail.com>

Caro Leonelo,

Segue retorno da diretoria referente tua solicitação.

Att,
Adriana

-------- Mensagem original --------

**Assunto:**Re: Solicitação para uso de artigos publicados em congressos da SBC

**Data:** Mon, 24 Jan 2011 09:15:30 -0800

**De:** Karin Breitman <Karin@inf.puc-rio.br>

**Para:** supervisao@sbc.org.br

Adriana

Acho que não, desculpe.

Em casos onde a publicação dos artigos tem objetivo de disseminação dos resultados sem finalidade comercial, basta que os autores comuniquem a SBC. O autor, Leonelo Almeida, está autorizado a republicar os artigos como parte de sua tese de doutorado.

[]s

karin

---

Dr. Karin K. Breitman
Professora - Depto. Informática PUC-Rio
Diretora de Publicações da SBC
Pontifícia Universidade Católica do Rio de Janeiro
R. Marques de Sao Vicente 225 - Prédio do RDC - Sala 416
Rio de Janeiro - RJ - Brasil 22453-900
tels: + 55 21 3527-1500 ext 4360 fax +55 21 3527 1530
www.inf.puc-rio.br/~karin
www.sbc.org.br

---

On Jan 24, 2011, at 4:59 AM, Supervisão Administrativa wrote:

Profa Karin,

Te encaminhei a solicitação abaixo em dezembro. recebeste?

Adriana

## *A.2 Springer*

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Mar 04, 2011

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