INTERNATIONAL SERIES ON INFORMATION SYSTEMS AND MANAGEMENT IN CREATIVE eMEDIA

NUMBER 2013/2

the series

The International Series on Information Systems and Management in Creative eMedia is advancing the knowledge of the use of informaiton systems and management in the wider field of creative eMedia industries. The series covers a wide range of media , such as television, publishing, digital games, radio, ubiquitous/ambient media, advertising, social media, motion pictures, online video, eHealth, eLearning, and other eMedia industries.

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Estefanía Serral Asensio, Artur Lugmayr, Bjoern Stockleben, Thomas Risse, and Bogdan Pogorelc (eds.)

Proceedings of the 6th International Workshop on Semantic Ambient Media Experience (SAME 2013)

Workshop Defining the Research Agenda for Information Management and Systems Supporting Sustainable Communities with Smart Media and Automated Systems - in Conjunction with C&T 2013

IS&M in Creative eMedia

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Preface

The Semantic Ambient Media Experience (SAME) workshop series attracts researchers and practitioners in the field of ubiquitous and pervasive computation to discuss and shape ambient media. Therefore, SAME workshop series becomes a perfect environment to meet creative thinkers for envisioning and creating the future of ambient media in team working. Since sustainability and sustainable urban environments are one of the current goals of different relevant agendas and initiatives, SAME 2013 has as a special challenge how ubiquitous and pervasive computation can be utilized to create sustainable communities – *sustainable cities, sustainable community, sustainable energy, sustainable culture –.*

This year, SAME received 10 submissions contributions, where 8 papers were accepted and published after a thorough double-blind review process. We would like to thank all the contributors, as only with their enthusiasm the workshop can become a success. Also, we would like to especially express our gratitude to our programme committee for helping in conducting the review process of the submissions – namely: Radu-Daniel Vatavu, Richard Chbeir, Zhiwen Yu, Shu-Ching Chen, M. Anwar Hossain, Moyen Mustaquim, Heiko Schuldt, Guillermo Talavera, Pablo Cesar, Sofia Tsekeridou, Mark Billinghurst, and Stephen Gilroy. Finally, we would like to thank the organizing team of C&T 2013 for its help in the organizational aspects of the workshop.

The success of SAME has led to celebrate it 5 consecutive years. The first SAME took place in 2008 in conjunction with ACM Multimedia 2008 in Vancouver, Canada; in 2009 in conjunction with AmI 2009 in Salzburg, Austria; in 2010 in conjunction with AmI 2010 in Malaga, Spain; in 2011 in conjunction with C&T 2011 in Brisbane, Australia; in 2012 in conjunction with Pervasive 2012 in Newcastle, UK; and this year's edition in conjunction with C&T 2013 in Munich, Germany.

In addition, the SAME workshop series led to the establishment of the Ambient Media Association (AMEA), where several workshop results and outcomes can be found online (www.ambientmediaassociation). In previous years, the workshop resulted in three special issues published by Springer-Verlag, Multimedia Tools and Appications.

In these proceedings, the workshop organizers present you 8 fascinating papers that investigate very interesting and innovative challenges with the focus on smart technologies, policies, and projects devoted to the issue of sustainable communities to create a better living experience.

Estefanía Serral Asensio
Artur Lugmayr
Bjoern Stockleben
Thomas Risse
Bogdan Pogorelc

Munich, Germany, 2013

Table of Contents

List of Contributors

Alexander Braun

Alexander Schatten

Andreas Thöni

Ansgar Scherp

Artur Lugmayr

Bogdan Pogorelc

Felix Köbler

Jože Guna

Jutta Meier

Lester Allan Lasrado

Lisa Madlberger

Matevž Pogačnik

Petromil Petkov

Sakthikannan Sakunthaladevi Ulaganathan

Subodh Agnihotri

Vidhya Govindan

ORGANIZATION

SAME 2013 was organized in conjunction with C&T 2013 with the special collaboration of the C&T workshop chairs Alessandra Agostini and Tom Gross.

Organization Committee

Workshop Chairs:

Artur Lugmayr, Tampere University of Technology (TUT) & lugYmedia Inc., FINLAND

Estefanía Serral Asensio, Technical University Wien (TUW), AUSTRIA

Bjoern Stockleben, Univ. of Applied Sciences Magdeburg, GERMANY

Thomas Risse, L3S Research Center, GERMANY

Bogdan Pogorelc, Jozef Stefan Institute, SLOVENIA

Program Committee

Radu-Daniel Vatavu, University Stefan cel Mare of Suceava, Suceava, ROMANIA

Richard Chbeir, Bourgogne University, FRANCE

Zhiwen Yu, Kyoto University Yoshida-Honmachi, JAPAN

Shu-Ching Chen, Florida International University, USA

Pablo Caesar, Centrum voor Wiskunde en Informatica, THE NETHERLANDS

Heiko Schuldt, Uni Basel, SWITZERLAND

Mark Billinghurst, Canterbury University, NEW ZEALAND

Sofia Tsekeridou, Athens Information Technology, GREECE

Moyen Mohammad Mustaquim, Uppsala University Uppsala, SWEDEN

M. Anwar Hossain, University of Ottawa, Ottawa, CANADA

Guillermo Talavera, CAIAC – UAB, SPAIN

CALL FOR POSITION PAPERS

SAME 2013
6th International Workshop on Semantic Ambient Media Experience (SAME 2013)

Defining the Research Agenda for
Information Management and Systems Supporting Sustainable
Communities with Smart Media and Automated Systems

29 June - 02 July 2013
in conjunction with C&T 2013
http://www.tut.fi/emmi/WWW/SAME2013

http://www.ct2013.cnss.de/

SAME 2013

Sustainability and sustainable urban environments are one of the goals of various research agendas and initiatives as e.g. the Regions of Climate Actions (R20). SAME 2013 devotes to the challenge, how information management and systems can support sustainable communities in their regional settings. This workshop focuses on the development of a research agenda around the wider topic of how smart media and automated systems can support the larger context of sustainability for communities with the help of information systems, smart media, and automated systems. The workshop defines a research agenda within this particular context, and especially devotes to the investigation of opened research issues how ubiquitous and pervasive computation can be utilized to create sustainable communities. Energy conservation and saving are one of the key-words SAME 2013 will devote its focus: *sustainable cities – sustainable community – sustainable energy – sustainable culture* supported by smart information systems, smart media, and fully automated systems. Smart electronics and infrastructure will be one major component in creating a green city environment. Within the scope of this workshop, the goal is to investigate smart technologies, policies, and projects that are devoting to the issue of sustainable communities to create a better living experience.

WORKSHOP CHALLENGES

The workshop aims at answering the following questions for applications, methods, techniques, and installations that follow the no-screen, no-keyboard, and no-mouse device idea:

- Community requirements to create sustainability
- Regional requirements (e.g. development world) for sustainability
- Information systems and management supporting sustainability
- Solutions and applications supporting sustainable developments
- Community and social aspects creating sustainable values
- Smart energy, smart grid, and smart consumer solutions
- Smart technologies and information systems supporting sustainable cities
- Sustainable presentation of information and learning experience
- Projects, policies, and regulations exist to support sustainability with smart media
- Which algorithms and methods exist to gain knowledge about energy and sustainability
- Collaborative or audience participatory content support sustainability

- Training communities to support sustainable smart media
- Storytelling and art that supporting sustainability
- Community projects creating sustainable smart environments
- Strategies for business value for smart sustainable environments
- Experience design, prototyping, and business models in the context of sustainable communities

TOPICS OF INTEREST

The following (and related) topics are within the scope of this workshop and shall act as examples:

- Creation of sustainable communities
- Ubiquitous computation for sustainable environments
- Methods and tools to develop smart sustainable environments
- Intelligent environments creating community value
- Business models, value-creation, and opportunities
- Semantics, and intelligence of ambient media creating sustainability
- Energy saving through smart electronics
- Innovations in finance, technologies, and policies
- Lower cost clean energy through smart technologies
- Sustainable community projects
- Smart media for sustainability

We are also aiming at multidisciplinary, highly future oriented submissions that help to develop the ambient media form for entertainment services, such as:

- Case-studies (successful, and especially unsuccessful ones)
- Oral presentation of fresh and innovative ideas
- Artistic installations and running system prototypes
- User-experience studies and evaluations
- Technological novelties, evaluations, and solutions

TARGET AUDIENCE

The target audience is researchers and practitioners in the field of ubiquitous and pervasive computation and in the field of sustainability or the creation of smart media for sustainable communities. These include pervasive computation, emotional computation, content creation, ubiquitous computation, human-computer-interaction and usability experts, mobile industry, service creators, etc. Workshop participants shall have previous experience in this or related fields to be able to contribute on a high scientific level. The workshop participants will actively contribute to the development of semantic ambient media, due to a different method of workshop organization. Participants shall ‘participate’ rather than passively contribute. The participants shall discuss and actively elaborate the topic and we plan to kick-off an international web-based informal forum for ambient media, which shall increase the effect of this workshop tremendously.

We strongly welcome multidisciplinary contributions coming from the media technology, community development, sustainability, artistic, business, and human experience side. Case studies (successful and especially unsuccessful), artistic installations, technologies, media studies, and user-experience evaluations are highly welcome, which are affecting the development of ambient media as new form of media. Especially visionary contributions shaping the future of ambient media are strongly welcome.

PAPER SOLICITATION, SUBMISSION AND SELECTION PROCESS

- 300 word Position papers are due by the 14th April 2013 and should be submitted as word document at: http://www.tut.fi/emmi/Submissions/2013SAME/
- In addition, each submission should contain: title, list of authors, abstract, list of 3 potential own research contributions and a brief description, list of 5 research questions including a brief description, and a brief literature review of the 5 most significant publications contributing to the thematic, and a free form body text describing the own view in 300 words
- Final submissions are expected to be 5-10 pages papers according the paper format of C&T available at http://www.ct2013.cnss.de/cfp/
- Please submit your paper at our paper submission system: http://www.tut.fi/emmi/Submissions/2013SAME/chair/
- Each contribution will be double blind reviewed and the top 10 paper will be selected depending on the review results
- Best contributions will be compiled to a special issue following up the workshop - we aim at Springer MTAP after reviewing the quality of contributions
- The workshop will be held according the method "Design Thinking", which has been traditionally applied in the SAME series context
- Paper solicitation is based on several marketing tools of the Ambient Media Association (AMEA): www.ambientmediaassociation.org, and we expect a submission rate of approx. 15-20 papers, where the top-10 will be selected for being accepted for the workshop

IMPORTANT DATES

Submission deadlines (deadlines for this workshop are strictly observed!):

- **14th April 2013:** Deadline for Position Paper Submissions
- **25th April 2013:** Notification of Accepted Workshop Position Papers
- **15th June 2013:** Camera Ready Accepted Workshop Papers Due
- **29th June 2013:** Workshop day

WORKSHOP SERIES CONTEXT

Pervious Workshops on Semantic Ambient Media Experience:

- 1st International Workshop on Semantic Ambient Media Experiences held in conjunction with ACM Multimedia 2008, (Vancouver, Canada), http://portal.acm.org/toc.cfm?id=1461912&type=proceeding&coll=ACM&dl=ACM&CFID=96753168&CFTOKEN=49706448
- 2nd International Workshop on Semantic Ambient Media Experiences held in conjunction with AmI-09, (Salzburg, Austria), http://webhotel2.tut.fi/emmi/forum/node/55
- 3rd International Workshop on Semantic Ambient Media Experiences held in conjunction with AmI-10, (Malaga, Spain), http://www.ambientmediaassociation.org/node/56

- 4rd International Workshop on Semantic Ambient Media Experiences held in conjunction with 5th International Conference on Communities and Technologies, Brisbane, Australia, http://www.ambientmediaassociation.org/node/60
- 5th International Workshop on Semantic Ambient Media Experience held in conjunction with Pervasive 2012

PREVIOUS SPECIAL ISSUES

For each held workshop, a special issue has been created with Springer-Verlag Multimedia Tools & Applications. The workshop shall gather people from industry and academia to develop the vision of ambient media as new form of smart media.

WORKSHOP CHAIRS

- Estefanía Serral Asensio, Universidad Politécnica de Valencia, SPAIN
- Artur Lugmayr, Tampere University of Technology (TUT) & lugYmedia Inc., FINLAND
- Thomas Risse, L3S Research Center, GERMANY
- Bjoern Stockleben, Univ. of Applied Sciences Magdeburg, GERMANY
- Bogdan Pogorelc, Jozef Stefan Institute & Spica International d.o.o., SLOVENIA

Artur Lugmayr, Tampere University of Technology (TUT) & lugYmedia Inc., FINLAND

Prof. Dr. Artur Lugmayr describes himself as a creative thinker and his scientific work is situated between art and science. Starting from 1st July 2009 he is full-professor for entertainment and media production management at the department for industrial management at the Tampere University of Technology (TUT). His vision can be expressed as to create media experiences on future emerging media technology platforms. He is the head and founder of the New AMbient MUltimedia (NAMU) research group at the Tampere University of Technology (Finland) which is part of the Finnish Academy Centre of Excellence of Signal Processing from 2006 to 2011 (http://namu.cs.tut.fi). He is holding a Dr.-Techn. degree from the Tampere University of Technology (TUT, Finland), and is currently engaged in Dr.-Arts studies at the School of Motion Pictures, TV and Production Design (UIAH, Helsinki). He chaired the ISO/IEC ad-hoc group "MPEG-21 in broadcasting"; won the NOKIA Award of 2003 with the text book "Digital interactive TV and Metadata" published by Springer-Verlag in 2004; representative of the Swan Lake Moving Image & Music Award (http://www.swan-lake-award.org/); board member of MindTrek (http://www.mindtrek.org), EU project proposal reviewer; invited key-note speaker for conferences; organizer and reviewer of several conferences; and has contributed one book chapter and written over 25 scientific publications. His passion in private life is to be a notorious digital film-maker. He is founder of the production company LugYmedia Inc. (http://www.lugy-media.tv). More about him on Google.

Thomas Risse, L3S Research Center, GERMANY

Thomas Risse works as a senior researcher at the L3S Research Center in Hannover. He received a PhD in Computer Science from the Darmstadt University of Technology, Germany in 2006. Before he joined the L3S Research Center in 2007 he lead a research group about intelligent information environments at Fraunhofer IPSI, Darmstadt. He worked in several European and industrial projects. He was the technical director of the European funded integrated project BRICKS, which aim was to build a

decentralized infrastructure for distributed digital libraries. Currently he his the deputy manager of the FP7 Living Web Archive (LiWA) project. Thomas Risse's research interests are semantic evolution, data management in distributed systems, federated search, and self-organizing systems. He serves regularly as program committee member or project reviewer. He published several papers at the relevant international conferences.

Bjorn Stockleben, RBB, GERMANY

Björn Stockleben was awarded his master's degree in Media Sciences, Media Technology and Computer Sciences from Technical University of Brunswick and Brunswick School of Arts in 2003. As a student research assistant he worked on MHP applications for the CONFLUENT and Multimedia Car Platform (MCP) project. He wrote his master thesis on ergonomic and content-specific constraints of video on mobile devices. Since April 2004 Björn Stockleben has been employed by Rundfunk Berlin-Brandenburg as project engineer for its Innovation Projects. Currently he is working on user generated content and citizen journalism for the news and youth radio departments of RBB.

Bogdan Pogorelc, Ljubljana University, SLOVENIA

Bogdan Pogorelc is a Ph.D. candidate and a Research Assisstant at Department of Intelligent Systems at Jožef Stefan Institute (JSI) in Ljubljana, Slovenia. Since 2008 he has been employed at Jožef Stefan Institute and Špica International d.o.o. for which he obtained the "*Young Researcher"* fellowship. Bogdan was visiting researcher at University "Rovira i Virgili" in Tarragona (Spain) in 2007, where he performed research on "Fuzzy Artmap neural network for assessment of metabolic syndrome". He received several awards for his research: e.g., 1st Prize at Slovenian forum of innovations for "*Intelligent security system for the surveillance of buildings"* in 2009 and awards of i) National Instruments and ii) University of Maribor for "*Mobile electrocardiograph*" in 2006.His publication list consists of 16 items, 3 of them in scientific journals. He is a reviewer for several scientific journals and conferences, a member of several scientific societies, e.g., ACM, IEEE and ECCAI, a Program committee- and Organizational comittee member of the *"2nd Jožef Stefan International Postgraduate School Student's Conference"* end editor of the proceedings for the *"2nd Jožef Stefan International Postgraduate School Student's Conference"*conference. Bogdan's research interests include artificial intelligence, machine learning, (temporal-/time series-) data mining as well as applications in these areas, especially medical informatics and ambient intelligence. His main research interest is "*Behavior recognition from motion capture systems using data mining*, such as "*Automatic recognition of gait-related health problems of elderly"* or "*Automatic management of (physical) rehabilitation process for (neurologically) impaired people"*.

Estefanía Serral Asensio, Technical University Wien (TUW), Wien, Austria.

Estefanía Serral is a postdoc researcher at the TUW, where her main topic is semantic integration of automation systems. Until 2011, she was working in the ProS Research Center in the Department of Information Systems and Computation at Universidad Politécnica de Valencia (Spain). Her research involves context-awareness, pervasive computing, task automation, conceptual modelling, model-driven development, executable models and model interpretation. She has published several contributions to well-known international conferences and scientific journals (AmI, CAiSE, PMC, UIC, SCICO, SOSYM, ER, MOBIQUITOUS, UCAmI, MOMPES, ERCIM, etc.).

PREVIOUS PROGRAM COMMITTEE OF THE SAME SERIES (NOT CONTACTED YET)

- Shu-Ching Chen, Florida International University, USA
- Heiko Schuldt, Uni Basel, SWITZERLAND
- Andreas Rauber, TU Vienna, AUSTRIA
- Mark Billinghurst, Canterbury University, NEW ZEALAND
- Carlos Ramos, Polytechnic of Porto, PORTUGAL
- Uwe Riss, SAP Research, GERMANY
- Carsten Magerkurth, SAP Research, GERMANY
- Ismo Rakolainen, FogScreen, FINLAND
- Bjoern Stockleben, RBB, GERMANY
- Jan Nesvadba, Philips, THE NETHERLANDS
- Gabriele Kotsis, University Linz, AUSTRIA
- Jussi Kangasharju, Helsinki University of Technology, FINLAND
- Pablo Caesar, Centrum voor Wiskunde en Informatica, THE NETHERLANDS
- Zhiwen Yu, Kyoto University Yoshida-Honmachi, JAPAN
- Tuula Leinonen, Fakegraphics, FINLAND
- Sofia Tsekeridou, Athens Information Technology, GREECE
- Richard Chbeir, Bourgogne University, FRANCE
- Bjorn Landfeldt, NICTA, AUSTRALIA
- Konstantinos Chorianopoulos, Ionian University, GREECE

Workshop Programme and Description

Schedule

- 09.00 - 09.30: Introduction
- 09.30 - 10.30: Quick Paper Presentations (5 minutes/paper)
- 10.30 - 11.00: Break
- 11.00 - 12.30: Design Thinking Session 1 + Roundup Group Presentation
- 12.30 - 14.00: Lunch
- 14.00 - 15.30: Design Thinking Session 2 + Roundup Group Presentation
- 15.30 - 16.00: Break
- 16.00 - 17.30: Workshop Roundup

Questions

- How to select, compose, and generate ambient content including a no-screen concept?
- How to present ambient content with no-screens?
- How to re-use ambient content and learning experiences without utilizing screens or traditional I/O devices?
- What are the characteristics of ambient media, its content, and technology when traditional I/O devices are not utilized?
- How can sensor data be interpreted and intelligently mined?
- How can collaborative or audience participatory content be supported?
- How can existing media such as TV, home entertainment, cinema extended by ambient media?
- What are ambient media in terms of story-telling and art that do not use screens?
- How do ambient media create business and value and how can ambient media be integrated into business processes and strategies?
- Which methods for experience design, prototyping, and business models exist?
- What is interactivity between the single consumers and consumer groups in the ambient context?

Workshop Introduction Presentation

(see next pages)

6th International Workshop on Semantic Ambient Media (SAME) 2013

Defining the Research Agenda for Information Management and Systems Supporting Sustainable Communities with Smart Media and Automated Systems

Artur Lugmayr, Tampere University of Technology (TUT) & lugYmedia Inc., FINLAND

Thomas Risse, L3S Research Center, GERMANY

Bjorn Stockleben, RBB, GERMANY

Bogdan Pogorelc, Ljubljana University, SLOVENIA

Estefanía Serral Asensio, Technical University Wien (TUW), AUSTRIA

This event is in cooperation with the Ambient Media Association (AMEA) (www.ambientmediaassociation.org)

Administrative Issues…

- Journal (Springer MTAP)…
- Publication: www.ambientmediaassociation.org
  SAME 2013 Proceedings + Journal

Accepted Papers

- 1: Companies as Drivers of Sustainability - Towards Requirements for an Integrative Sustainability Risk Management System
  - Andreas Thöni, Vienna University of Technology, Austria
  - Lisa Madlberger, Vienna University of Technology, Austria
  - Alexander Schatten, Sophisystems, Austria
- 2: Design as an inspiration for sustainable lifestyle
  - Vidhya Govindan, Tampere University of Technology, Finland
  - Sakthikannan Sakunthaladevi Ulaganathan, Fiat Chrysler India, India
- 3: Using Virtual Laboratories as Preparation to a Practical Laboratory Course: Empirical Investigation and Discussion of Potentials for Sustainability
  - Ansgar Scherp, University of Mannheim, Germany, Germany
  - Jutta Meier, University of Koblenz-Landau, Germany, Germany
- 4: Providing sustainable living through at-home early detection of metabolic syndrome
  - Bogdan Pogorelc, Jožef Stefan Institute, Dept. of Intelligent Systems, Slovenia
- 5: Applying Technology Management concepts in analyzing e Waste, sustainability and technology development in Mobile Industry: A conceptual perspective
  - Lester Allan Lasrado, eMMI lab,Tampere University of Technology, Finland
  - Subodh Agnihotri, eMMI lab,Tampere University of Technology, Finland
  - Artur R Lugmayr, eMMI lab,Tampere University of Technology, Finland
- 6: Interpersonal Persuasion on a Massive Urban Scale: Bringing the Future of the Cities Back to Their Citizens
  - Petromil Petkov, , Germany
  - Felix Köbler, , Germany
  - Alexander Braun, , Germany
- 7: Ambiental rendering of smartgrid data
  - Joze Guna, University of Ljubljana, Faculty of Electrical Engineering, Slovenia
  - Matevz Pogacnik, University of Ljubljana, Faculty of Electrical Engineering, Slovenia
- 8: An Overview of Smart Media and Sustainable Information Management and Systems
  - Artur Lugmayr, EMMi Lab., Tampere Univ. of Technology (TUT), Finland

The Goals of the Workshop

1. Analyze the Entries
2. Give Feedback
3. Cluster Topics
4. Group Work (one group)
5. Common Publication

Problem: sufficient water supply worldwide

Goals: affordable water for everyone with the sub-goals: good income, water treatment, new techniques

Objectives: no more people are dying due to water shortage leading to less diseases, …

- Defining the core problems that papers address
- Defining the effects and consequences of these
- Step 1: Defining the Problems and Goals that Research Works Address and by Which Means they Solve these Problems
- Step 2: Defining the Effects, Objectives, and Resulting Outcomes of the Available Means and Inputs

Workshop Schedule

- 10:30-10:45: introduction & participants
- 10:35-12:30: presentations I

LUNCH (12:30-13:30)

- 13:30-14:30: presentations II
- 14:30-15:00: design thinking I

COFFEE (15:00-15:30)

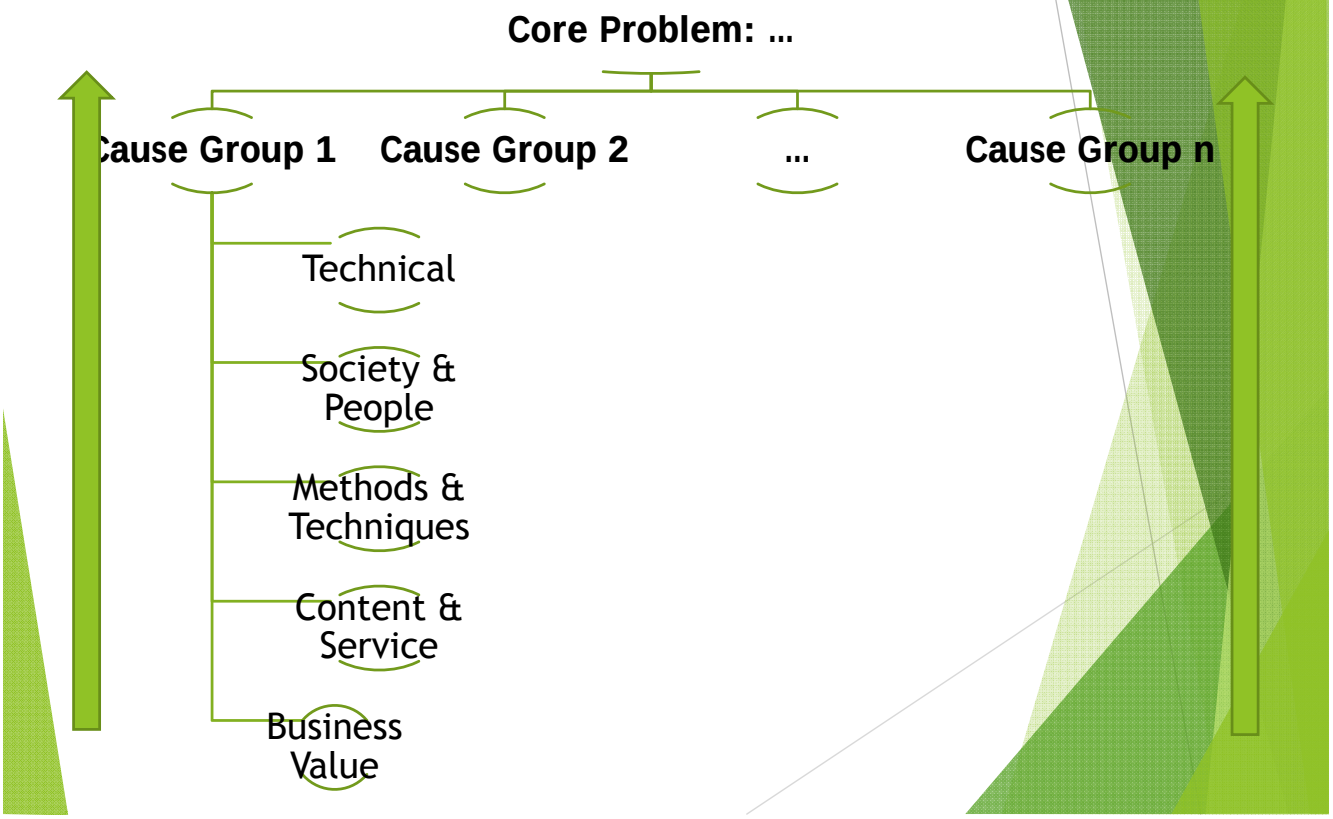
- 15:30-17:00: design thinking II

STEP 1: Defining the core problems that papers address

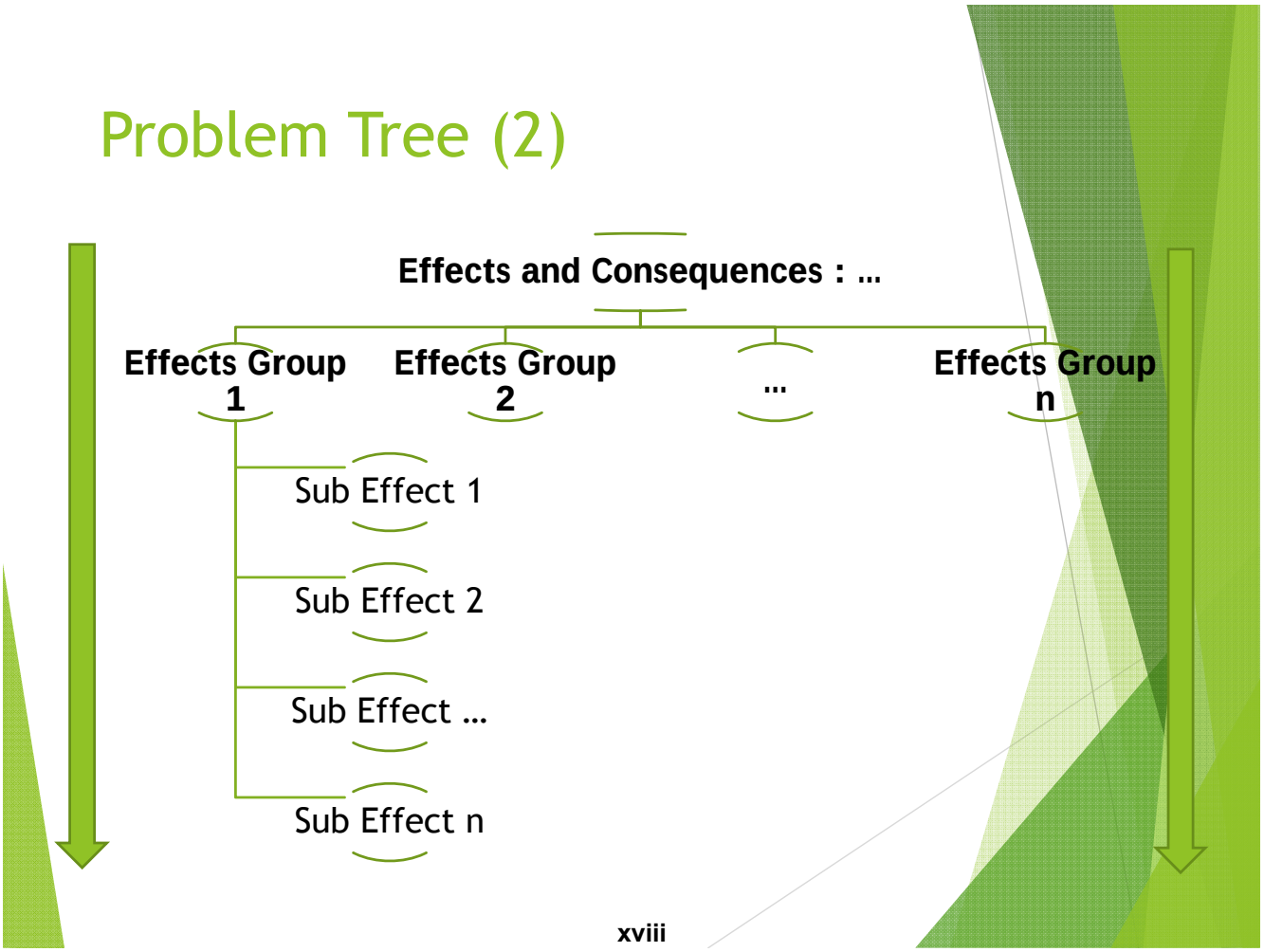
Open Research & Agenda

STEP 2: Defining the effects and consequences of these

Problems Addressed (1)

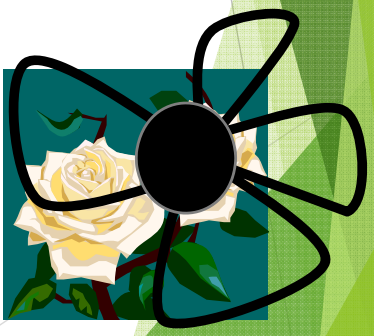


Problem Tree (2)



Reflection

- **THE Questions – Which Goals do Papers try to Achieve?**
  - Business
    - How can ambient media be applied in business processes?
    - How do ambient media create value and business?
    - Business opportunities and strategic issues of ambient media?
  - Content & the Media
    - What is ‘content’ and how can it be presented in the age of ‘ubiquitous’ and ‘pervasive’?
    - How to select, compose and generate ambient content?
    - How to manage and re-use ambient content in specific application scenarios (e.g. e-learning)?
  - Interactive Design & Experience
    - What is interactivity between the single consumers and consumer groups in the ambient context?
    - How can collaborative or audience participatory content be supported?
- **THE Method**
  - Objective Trees
- **THE Answers**
  - ☺



Companies as Drivers of Sustainability – Towards Requirements for an Integrative Sustainability Risk Management System

Andreas Thöni
Vienna University of Technology, Vienna, Austria.
andreas.thoeni@tuwien.ac.at

Lisa Madlberger
Vienna University of Technology, Vienna, Austria.
lisa.madlberger@tuwien.ac.at

Alexander Schatten
Sophisystems
Vienna, Austria.
alexander.schatten@sophisystems.com

ABSTRACT
With growing global population, economy and resource consumption we already have touched or even exceeded planetary boundaries. Sustainable development urges us to act in a socially and environmentally responsible way. Companies with resource and labour intensive production processes play an important role achieving a sustainable economy. As expectations of various stakeholder groups grow, sustainability becomes more and more important for company internal decision making. Managing sustainability is one of the key issues as they can have severe impacts on a company's performance and therefore are of interest for multiple stakeholders. Hence, a software system supporting sustainability risk management has to respect the information needs of these stakeholders. This paper follows the information subset model defined by Szyperski, who in principle suggests that in a "perfect world" objective and subjective information needs as well as information supply fully overlap. Following a literature-based approach, the information needs in the corporate sustainability domain are analyzed with management being the key stakeholder. Future research needs to examine how these information needs can be adressed by choosing the right input sources, analysis modules and output approaches.

Keywords
Sustainability Risk Management; Stakeholder requirements; Information Needs, Information Subset Model

SUSTAINABILITY IN THE BUSINESS CONTEXT

Current economic growth, production and consumption patterns are demonstrably not sustainable. The global population was growing just within the last century from about 2 billion in 1930 to about 7 billion in 2011. Not only global population was growing exponentially, so did the global economy and agriculture and parallel to the economic growth, resource, energy consumption and waste production. Today 4/5th of the ice-free surface is under direct human influence [2]. Research of Rockström et al. tries to derive planetary boundaries for the along 10 parameters/systems, most systems indicate an exponential curve towards assumed save planetary boundaries [20].

Furthermore, consumption of resources is extremely unevenly distributed. If the whole world today would show material consumption like the US or Europe, *"global consumption would rise elevenfold"* [22]. Sustainable development aims at achieving a more equal usage of natural resources while at the same time respecting planetary boundaries (environmental sustainability) and at a fair treatment of employees and communities globally (social sustainability).

Some activists focus on changing consumption patterns (bottom-up approach). While this is an important approach, recent analysis indicate, that top-down approaches (or combined approaches) can be more effective. For a start, all of the identified planetary boundaries: *climate change, biodiversity loss, nitrogen cycle, phosphorus cycle, stratospheric ozone depletion, ocean acidification, global freshwater use, change in land use, atmospheric aerosol loading and chemical pollution* are obviously strongly influenced by industrial and agricultural activity. Moreover, global economy (and thus ecology) is dominated by relatively few companies. Hence some Non-Governmental Organizations (NGOs; like WWF) are working closer with transnational corporations, arguing that the leverage is larger if it is possible to enhance business practices of a few dominating players in the market [30]. On the one hand, the direct influence is significant; on the other hand, the influence via supply chains and public perception is considerable. It seems reasonable to understand companies as main drivers for sustainability.

Companies' endeavors in the global quest for sustainability can be summarized under the caption "Corporate Sustainability". From a business perspective, derived from the general notion of sustainability, corporate sustainable development can be seen as the task to meet the needs of a company's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc.), without comprising its ability to meet the needs of future stakeholders. But sustainable development goes beyond Corporate Social Responsibility marketing activities, as many corporations eventually understand the obvious, namely that future business will not be possible under unsustainable conditions. Thus, the role of companies can be seen as two-fold (1) they have to ensure their own long-

term existence and (2) they contribute to the sustainability of the society as a whole [10].

The pressure of different stakeholder groups like the society, NGOs, media, as well as governmental regulatory requirements "push" companies to perform corporate sustainability initiatives in order to anticipate damage or further pressure to the company and its reputation. Differently, companies proactively increase corporate sustainability because of "pull" factors which represent opportunities to improve the position of the company e.g. cost savings as a result of energy reduction [21].

Regardless whether looking at push or pull factors, both the damage which can result from an incident caused by "unsustainable" corporate behavior and the missed opportunities connected to potential sustainability-related savings and improvements can be seen as risks related to specific stakeholder groups. This damage may in particular include public perception towards a company potentially resulting in economic losses.

This paper aims to identify important information needs posed by different stakeholders for a sustainability risk management system.

RELATED WORK - IT SYSTEMS FOR SUSTAINABILITY

One important thought in literature that addresses the scope for IT systems is the need to include the whole supply chain when discussing sustainability. Kogg and Mont [14] highlight the importance of life-cycle thinking across the supply chain when considering the sustainability of a product. They build on the global value chain and supply chain management theory: Sustainability management can be exercised directly or indirectly; directly through criteria setting. The indirect approach includes influencing, monitoring and testing other actors (e.g. through third parties or by implementing standardized certification schemes), and is important as global value chains can include hundreds of suppliers in multiple tiers.

Considering this scope of sustainability management, other authors highlight the importance of information technology. For example Piotrowicz and Cuthbertson [17] and Srivastava [23] note the usefulness of IT with regard to sustainability in supply chains on a general level. In the supply chain setting the need to exchange information has been underlined in the early 2000s and systems have been proposed (e.g. Carlson et al. [6]). Klassen and Vereecke [13] also stress the need to include the whole supply chain and underlined that a company can be accountable for their suppliers if it can influence their behavior. Social issues bear large operational risks. Based on 5 case studies they develop an integrative framework covering supply chain responsibility, risk and performance management as well as capabilities. For risk assessment and mitigation they highlight the importance of the dimensions *location*, *management system* and *certifications* as well as of *monitoring* in general. Describing multiple monitoring tools, Klassen and Vereecke [13] acknowledge the usefulness of IT, mainly in the domain of customer complaints monitoring. In their opinion, it is still unclear, if social and environmental management capabilities evolve dependently or not.

Traditionally the role of corporate IT Systems with regard to environmental impacts was often mentioned in the context of *Green IT*, focusing on the reduction of energy consumption of IT systems. In a more recent research field, *Green Information Systems*, the role of IT is seen in a broader context, focusing on transformation of business and information processes *through* IT [5,9].

Also Dao, Langella and Carbo [8] call for a bold new role of IT in sustainability beyond energy consumption reduction. Adapting a resource-based view, they argue that bundling HRM, SCM, and IT resources enable firms to develop sustainability capabilities. More specifically, they propose an integrated sustainability framework which sheds light on both internal and external drivers to improve current practices and develop long-term sustainability capabilities. They specifically highlight the need to include the whole supply chain.

Chen, Boudreau and Watson [7] suggest a conceptual model and propositions with regard to the roles of IS in the quest for ecological sustainability. They mainly deal with the potential of IS to increase eco-efficiency by automation and by providing information to stakeholders to facilitate learning processes. Both of these options ideally lead to transformations of business processes and accordingly, to increased ecologic sustainability.

Summing up, sustainability risks need to be managed across the supply chain. Literature suggests that IT plays an important role leveraging this process and furthermore supports inter-organizational learning.

UNDERSTANDING INFORMATION NEEDS IS THE KEY

Providing the right information sources is the key to manage sustainability risks appropriately. However, in many cases company information needs with regard to sustainability are not fulfilled. For example, managers often lack knowledge about second or later tier suppliers. Even if the information exists internally, it is often neither integrated nor structured as to be useful for sustainability analysis. Important data might be distributed over a large variety of different data silos and ERP systems. Scientifically this problem can be explained with the information subset model developed by Szyperski [24] and presented in Figure 1.

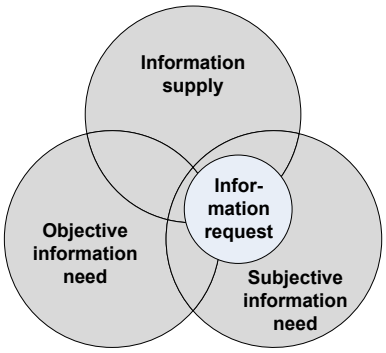


Figure 1: Information subset model based on Szyperski [24] in Becker et al. [3]

Skyperski defines four information sets: the information supply, the objective and the subjective information need as well as the information request. As depicted in Figure 1, the circles representing the different sets do not fully overlap in practice. In the ideal case, the information subsets should be as close as possible, meaning the supplied information should cover the information that users need and request.

As a consequence, developing an information system has to be footed on a profound understanding of information needs. Only then can the information system be designed to match the combined information need as closely as possible with a corresponding information supply [3].

APPROACH AND FRAMEWORK

This paper focuses on understanding the information needs of different stakeholders with regard to a sustainability risk management system. The resulting analysis serves as a starting point for the design of information resources necessary to fulfill the identified needs. The results of the analysis characterize the output of such a system. This focus is depicted in Figure 2.

In order to derive information needs for different stakeholder groups, a literature-based approach was used. The resulting compilation consists either of needs highlighted by literature for a specific stakeholder group or needs that were implicitly derived from literature. The list of information needs does not claim completeness, but attempts to highlight important elements that must be considered when designing a sustainability risk management system. Finally, the paper concludes with a characterizing overview of information needs, split into the different stakeholder groups.

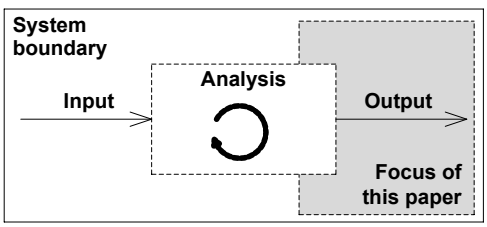


Figure 2: System boundaries and focus of discussion (author's compilation)

STAKEHOLDER INFORMATION NEEDS

Company internal stakeholder groups

Employees & labor unions

Generally, by transporting information from higher management levels downwards to employees, information systems can generate awareness on certain topics, which in turn can influence operational practices [7]. By making the information on environmental and social impacts of organizational activities accessible to employees, a sustainability risk management system can increase the salience of sustainability topics and foster the development of eco-friendly and social values in the organization, leading to more sustainable decisions and business practices [7].

Employees have different information needs when it comes to the visualization of sustainability risks. On the one hand, employees demand a confirmation that their employer is operating in an ethically responsible way. This is also important to attract talented future employees, who prefer to work in companies with high ethical standards [16]. A good overview about current sustainability issues and risks presented in a visually appealing way, can help to meet these information needs.

On the other hand, employees and moreover labor unions are interested in sustainability risks which relate to issues directly affecting themselves (e.g. worker protection, equality or health issues). Therefore it seems beneficial to provide an employee-specific view offering information about selected social aspects, which are directly related to their regions, organizational units and interest levels (detailed, general).

Management

For efficient risk management, management needs a comprehensive picture of the sustainability risks that endanger their company. However, an exhaustive list seems hardly possible and striving for completeness is a very time consuming task. Furthermore, the confidence that all risks have been covered will usually remain low [12]. Especially two dimensions, content and time, appear to affect completeness:

Content completeness is strongly influenced by the complexity that especially multinational companies face [29]. To achieve a comprehensive view, all steps of the production process need to be considered as sustainability starts with the product design and ends with the recycling activities [18,28]. This process does not stop company internally; also data from lower steps of the value and thus supply chain are needed. For example, the system for environmental monitoring along the value chain described by Carlson et al. allows for an exchange of data between supply chain partners [6]. Data exchange has to include a large number of different data items at each step to create a picture that is as complete as possible [25]. For suppliers also auditing, self assessments and supplier metadata regarding sustaina-

bility should be provided [13]. Furthermore, the content analysis should also include soft parameters [26].

Time completeness requires having the data from the past up to the present. This entails data availability in near real-time, which is fostered by the increasing availability of sensors or RFID systems deployed e.g. at production sites or logistics, (see Björk et al. or Verma, S. and Chaudhuri [4,27]). Moreover, it includes the ad-hoc visibility of incidents.

To achieve completeness, data might come from various sources, e.g. from suppliers, from NGOs, from company audits, from external organizations such as SEDEX, and all data needs to be finally integrated into a consistent view [14]. Furthermore, data needs to be linked to other functions of a company. For example risk management needs to be consistently integrated e.g. into procurement [29].

Besides, management has a general interest in respecting its data confidentiality standards. If, for example, sensitive data about supplier risk levels is handled, security concerns need to be respected. This claim gets even more critical, if information is exchanged between different organizations [2]. Another point highlighted by literature and definitely important for all consumers of a system, is the comprehensibility of the software. For management, comprehensible overviews and details are important. This can be realized in multiple ways. One can for example be a visually appealing map-based data presentation with a geographical information system (GIS; see [19]).

Company external stakeholder groups

Government

In general, governments are interested in the compliance of regulations and laws and therefore monitor companies' activities as well as their products. This assessment process can be leveraged by a near-real-time standardized information exchange between companies and regulatory bodies. An optimized information flow reduces the risk for companies (as problems are noticed early on) and generally increases the efficiency of the compliance framework. As governments aim for a complete picture, they need to link data from different supply chains to get a more complete picture [11]. This would be facilitated by an internationally standardized setting [29].

Public (incl. NGOs, investors, customers)

The public understanding of sustainability issues can be enhanced through information systems that distribute information more quickly, broadly and cheaply [7].

Media and NGOs use the web to publish information about environmental or social aspects in a fast and dynamic way. Furthermore, the public and foremost customers are strongly interested in any sustainability issues within the whole supply chain [29]. Companies need to respond to this development and provide information to various external stakeholders in an efficient and timely manner.

Significant information needs X..Fullly needed /..Partly needed		Information needs																					
		Scope			Sustainability		Content[1]			Temporal focus			Data attributes: Trigger		Granularity		Expected format		Confidentiality		
Area	Stakeholder group	Supply chain level	Company level	Sub-comp. level (reg., unit, …)	Environmental	Social	General risk data	Company's auditing approach	Product & part related risk data	Past data	Current data	(Near) real time data	On stakeholder request	Response to stakeholder input	Overview	Detailed	Standardized/Schema based	Unspecified	At company level	At supply chain level	Public
Internal	Employees & labor unions		X	X	/	X	X	/		/	X		X		X			X	X		
	Management	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X		
External	Governments	/	X	/	X	X	/	X	X	X	X	/	X			X	X		X		
	Public (incl. NGOs, investors, customers)	X	X	X	X	X	X	/	X	/	X		X		X	/		X			X
	Suppliers & partners	X	/		X	X	/	X	/	/	X	/	X	X		X	X			X	

Table 1: Overview of risk information needs by stakeholder group (authors' compilation; grey areas in content area indicate parts not addressed in the text)

Especially customers, but also other parties interested in a company like investors or media, have a need to be informed about sustainability-related performance and hence the risk level associated with a company in order to make more informed decisions. Sustainability performance is not only connected with the company, but also directly with the product [25]. Sustainability aware customers request information about the general sustainability related to a product or company. This information increasingly influences buying decisions. The system should provide a high-level overview for interested customers without revealing company internal details that might harm employees or company assets.

The increasing number of socially responsible investments indicates the rising importance of sustainability in the financial market [15]. With the introduction of the Dow Jones Sustainability Index, a global, rational index which measures the performance of investments into sustainably acting companies has been established [1]. This suggests that investors are interested into a transparent picture of important sustainability risks.

Another group to be considered are locals who are directly affected by the corporation's activities, like communities residing near production sites or in areas providing the resources (land, water, forest, …) to be used in production processes. To proactively sense possible conflicts or complaints, communication is an important matter. The system should therefore provide information to affected stakeholders specifically focused on a concrete regional area.

Supplier & partners

With regard to sustainability, an improved information flow including environmental and social aspects can result in a better understanding of inter-organizational sustainability matters and thereby lead to more sustainable decisions [8]. To enable this learning process it is important to establish data exchange in both ways along the supply chain. For an integrative sustainability risk management system, this calls for the requirement to provide individual views on the data for each supplier. Since a learning-process is an unstructured and rather unpredictable process, several layers, configuration and query options could help to adapt the information supply to the subjective information needs of suppliers.

Moreover, if focal companies require data from supplying companies, these suppliers will likely want to get feedback based on their data input. To ease this communication, data-models and communication protocols that facilitate the transaction will be important. For example Barrett, Strunjaš-Yoshikawa, and Bell proposed a data model to ease the exchange of life cycle data for emission calculations [2]. The same is likely to be true for cooperating partners. Furthermore, suppliers will be very much interested in the way they are monitored and thus have information needs about the rating process [29].

SUMMARY AND CONCLUSION

Although some companies already engage in stakeholder dialogues, stakeholder opinions, reactions and concerns are not integrated in a dynamic way into business considerations and especially into a risk management approach. Companies need tools and processes which support them to collect and visualize sustainability data in a fast and effective way, not only inside but also outside the company's borders.

Based on the outlines above, Table 1 summarizes the different risk information needs of multiple stakeholder groups. When not addressed in the text, elements of the table were estimated from the context. These are left for further discussion.

As highlighted, the different stakeholders and typically management have very broad and diverse information needs. A potential integrative sustainability risk system has to account for all of them as they define the scope of the system. Yet, given the amount of actors and needs, a prioritization of requirements seems necessary.

The information needs discussed here, specifically focus on the output side of a system. Research has to further explore requirements related to system internals, i.e. the analytics, and the data input required. Hence, Table 2 outlines the resulting research questions.

Research question	Description
Which data sources can be used to fulfill the information needs?	As information needs define the necessary information supply, different sources will be necessary to meet the needs posed by various stakeholders. These sources can be both, company-internal and external.
Which analytical modules are necessary to integrate and analyze the data to fulfill the information needs?	Data sources will not provide information that can be presented straight to stakeholders. Multiple sources need to be validated, disambiguated, conflicting data resolved, combined and aggregated in order to be convincing. For this purpose, sophisticated algorithms will be necessary that have to account for uncertainty.
How can sustainability risks be automatically assessed?	In order to automatically evaluate sustainability risks, a detailed understanding of completeness of environmental and social sustainability is necessary.
In which ways can the information be presented to meet the individual needs of various stakeholder groups?	In recent years various techniques for information presentation have been developed by multimedia scientists. Due to its special context and the possible large amount of information, advanced presentation techniques can help stakeholders to be able to use the information in an improved way.
How can the system be designed in order to ease integration into existing company software landscapes?	A sustainability risk system will be one element of a complete and integrated company IT landscape. It will exchange information with other systems using specific interfaces. Moreover, this landscape is constantly evolving and system design needs to take care of this in advance.

Table 2: Research questions

In this paper, the authors analyzed different information needs stated by stakeholders for an integrative sustainability risk management system. In subsequent research, these insights will be used as a starting point for the design of a prototypical implementation of a sustainability risk management system. In the future, the authors plan to contribute to the body of knowledge in the field of Enterprise Information Systems & Sustainability in essentially three areas: (1) Evaluation and development of different mechanisms for sustainability data collection (linked open data, crowdsourcing based approaches, sensing, text mining) (2) Advanced analytics for sustainability risk calculation (social focus) (3) Map-based data representation for improved stakeholder communication.

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REFERENCES

1. Balik, M. Nachhaltigkeitsmanagement: mit Sustainability Management durch Innovation und Verantwortung langfristig Werte schaffen. VDM, Verlag Dr. Müller, 2006.
2. Barrett, W.M., Strunjaš-Yoshikawa, S., and H Bell, J. Extension of computer-aided process engineering applications to environmental life cycle assessment and supply chain management. In Valentin Pleşu and Paul Şerban Agachi, ed., Computer Aided Chemical Engineering. Elsevier, 2007, 1187–1192.
3. Becker, J., Brelage, C., Dreiling, A., and Ribbert, M. Business process-driven information requirements engineering. Proceedings of the 2004 International Information Resource Management Association Conference (in Review), New Orleanse, LA, USA, (2004).
4. Björk, A., Erlandsson, M., Häkli, J., et al. Monitoring environmental performance of the forestry supply chain using RFID. Computers in Industry 62, 8–9 (2011), 830–841.
5. Boudreau, M.-C., Chen, A., and Huber, M. Green IS: Building sustainable business practices. Information Systems: A Global Text, (2008).
6. Carlson, R., Erixon, M., Forsberg, P., and Pålsson, A.-C. System for integrated business environmental information management. Advances in Environmental Research 5, 4 (2001), 369–375.
7. Chen, A.J.W., Boudreau, M.-C., and Watson, R.T. Information systems and ecological sustainability. Journal of Systems and Information Technology 10, 3 (2008), 186–201.
8. Dao, V., Langella, I., and Carbo, J. From green to sustainability: Information Technology and an integrated sustainability framework. The Journal of Strategic Information Systems 20, 1 (2011), 63–79.
9. Dedrick, J. Green IS: concepts and issues for information systems research. Communications of the Association for Information Systems 27, 1 (2010), 11.
10. Dyllick, T. and Hockerts, K. Beyond the business case for corporate sustainability. Business strategy and the environment 11, 2 (2002), 130–141.
11. Hofman, W. Supply Chain Visibility with Linked Open Data for Supply Chain Risk Analysis. Workshop on IT Innovations Enabling Seamless and Secure Supply Chains, (2011), 20–31.
12. Huang, L.G., Port, D., Wang, L., Xie, T., and Menzies, T. Text mining in supporting software systems risk assurance. Proceedings of the IEEE/ACM international conference on Automated software engineering, (2010), 163–166.
13. Klassen, R.D. and Vereecke, A. Social issues in supply chains: Capabilities link responsibility, risk (opportunity), and performance. International Journal of Production Economics 140, 1 (2012), 103–115.
14. Kogg, B. and Mont, O. Environmental and social responsibility in supply chains: The practise of choice and inter-organisational management. Ecological Economics 83, , 154–163.
15. Kraus, P. Die Auswirkung von Corporate Governance und Nachhaltigkeit auf den Unternehmenserfolg. BoD–Books on Demand, 2011.
16. Münstermann, M. Corporate Social Responsibility: Ausgestaltung und Steuerung von CSR-Aktivitäten. Springer DE, 2007.
17. Piotrowicz, W. and Cuthbertson, R. Sustainability - a new dimension in information systems evaluation. Journal of Enterprise Information Management 22, 5 (2009), 492–503.
18. Ramani, K., Ramanujan, D., Bernstein, W.Z., et al. Integrated Sustainable Life Cycle Design: A Review. Journal of Mechanical Design 132, 9 (2010), 091004.
19. Rao, N.H. A framework for implementing information and communication technologies in agricultural development in India. Technological Forecasting and Social Change 74, 4 (2007), 491–518.
20. Rockström, J., Steffen, W., Noone, K., et al. A safe operating space for humanity. Nature 461, 7263 (2009), 472–475.
21. Schaltegger, S., Windolph, S., and Harms, D. Corporate Sustainability Barometer–wie nachhaltig agieren Unternehmen in Deutschland? Centre for Sustainability Management der Leuphana Universität Lüne-

burg/PricewaterhouseCoopers, Lüneburg/Frankfurt aM. 2010.

22. Smith, L. The New North. Profile Books, 2012.
23. Srivastava, S.K. Green supply-chain management: A state-of-the-art literature review. International Journal of Management Reviews 9, 1 (2007), 53–80.
24. Szyperski, N. Informationsbedarf. Handwörterbuch der Organisation 2, (1980), 904–913.
25. Trienekens, J.H., Wognum, P.M., Beulens, A.J.M., and van der Vorst, J.G.A.J. Transparency in complex dynamic food supply chains. Advanced Engineering Informatics 26, 1 (2012), 55–65.
26. Vannieuwenhuyse, B., Gelders, L., and Pintelon, L. An online decision support system for transportation mode choice. Logistics Information Management 16, 2 (2003), 125–133.
27. Verma, S. and Chaudhuri, R. Creating Customer Satisfaction And Profitable Value Chain With E-commerce In Rural India: A case based approach. International Journal of Business Insights & Transformation 2, 1 (2009), 51–63.
28. Wang, H.-F. and Gupta, S.M. Green Supply Chain Management: Product Life Cycle Approach. McGraw-Hill Professional, 2011.
29. World Economic Forum. New Models for Addressing Supply Chain and Transport Risk. World Economic Forum, Cologny/Geneva, 2012.
30. How We Work with Business. WWF Canada. http://www.wwf.ca/about_us/business/index.cfm.

Design as an inspiration for sustainable lifestyle

Vidhya Govindan
Tampere University of Technology
unicvidhya@gmail.com

Sakthikannan Sakunthaladevi Ulaganathan
Fiat Chrysler, India
sakthikannan.u@gmail.com

ABSTRACT
To envision a sustainable society, it is not enough to have sustainable products and services; radical change has to happen in every individual's lifestyles and ways they interact with society. Design has the power to make the radical change happen and motivates people to embrace sustainable lifestyle. The paper discusses the concept of design as an inspirational tool towards sustainable lifestyle briefly and proposes a website based community model based on the concept. The model proposed in this paper can be validated and the effectiveness can be understood through a workshop and pilot study. The paper provides the steps to deploy the model as a pilot study and challenges involved in implementing this model.

Keywords
Sustainable Lifestyle, Design, Motivation, Communities

General Terms
Design, Human Factors

INTRODUCTION

"'We should go about in the manner of a bee collecting nectar from a flower: The bee harms neither the fragrance nor the beauty of the flower, but gathers nectar and turns it into sweet honey.'" This is the vision about human activity in this world from a Buddhist saint Arahnt. This vision could be achieved when each human being ensures that his actions are not producing any damage to our earth's ecosystem. In today's complex consumption value chain, it is quite not easy for a person to ensure if his consumption does not disturb the ecosystem and leave any damage. Leaving aside the damage created by consumption, the pattern of increased consumption itself is noted as a big issue for sustainable lifestyle. The words minimize, zero impact, reduce are often associated with sustainable lifestyle and therefore irks people as consumers. In order to take the concept of sustainable lifestyle to masses, it is important to communicate through messages that catches attention from them and not irks them. This is especially important for causes like sustainability because there is no immediate or more financial benefits associated with these activities. Therefore participation in this sustainability oriented activities requires more intrinsic motivation from people as consumers. Take this example, "A middle aged lady purchased her groceries and near the billing counter she realized that she forgot her shopping bag and added a plastic shopping bag to her purchase". Most of our everyday purchases and consumption happen in similar manner where people are either completely unaware of the consequences of their consumption or then have good knowledge about issues like climate change, environment conservation but could not translate into action. Therefore it could be seen that there is a significant reason to create systems which inspires consumers to lead a sustainable lifestyle. This paper takes the definition of sustainable living from "The Natural Step" [1] which conceived it as "The practice of sustainability is about creating new ways to live and prosper while ensuring an equitable, healthy future for all people and the planet". It has to be acknowledged here that lifestyle in developed countries varies greatly from developing countries. There is a surge in consumption of resources in everyday life in developed countries, for example packaged foods, increased gadgets and appliances, power demand and car travel. On the other hand, majority of consumers in developing countries do not consume in abundance but a segment of consumers termed as "new consumers" do enjoy affluent lifestyle. In order to channelize people towards sustainable lifestyle, it is important in the first place to provide necessary infrastructure which enables people to embrace sustainability in their everyday lives. For example, if the government does not provide separate waste bins to collect bio-waste and mixed waste, citizens do not have possibility for waste management in a sustainable manner. While this is true, there are many service organizations like DailyDump [2], a compost provider, which promotes bio-waste compost in a region where waste segregation infrastructure is not provided by government. Therefore, this discussion funnels down to a point which emphasize that when people are inspired towards sustainable lifestyle, there is always a way to achieve it. This paper proposes an approach on how to inspire people towards sustainable lifestyle and get it reflected on their everyday actions.

WHAT IS SUSTAINABLE LIFESTYLE?

Lifestyles refer to the ways we live our everyday lives to fulfill our needs and how we interact with the society and ecosystem [3]. They are closely associated to people's disposition of their status and interest. Along the same lines, sustainable lifestyles correspond to action and consumption patterns that people do to meet their basic needs, provide better quality of life while at the same time minimize natural resources usage, reduce waste and do not jeopardize needs of future generations. In simpler terms, a sustainable lifestyle is one which incorporates conscious

efforts towards preserving earth's ecosystem for our next generation. These definitions of sustainable lifestyle are from a broader perspective and in order to understand how it could be perceived in everyday lives, the framework shown in Figure 1 could be used.

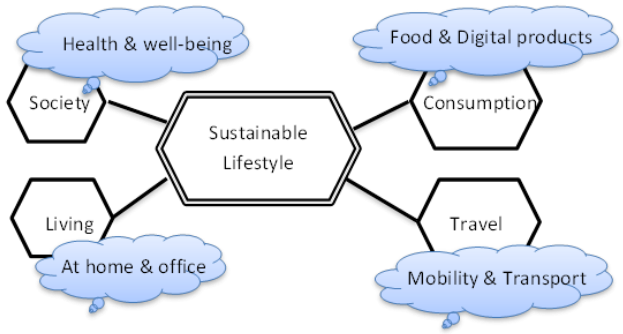

Figure 1. Sustainable lifestyle framework (Adopted from [3])

Before proceeding to define the activities that constitute these four categories of lifestyle which makes them call sustainable, it is equally important to ascertain those activities which are unsustainable and why? Marten [4] has pointed that main sources of unsustainable human ecosystem interaction is expanding human population along with expanding economy posing excessive demands on ecosystems. Marten [4] has put forth the main social forces that cause these unsustainable interactions which is shown in Table 1 below.

Before proceeding to define the activities that constitute these four categories of lifestyle which makes them call sustainable, it is equally important to ascertain those activities which are unsustainable and why? Marten [4] has pointed that main sources of unsustainable human ecosystem interaction is expanding human population along with expanding economy posing excessive demands on ecosystems. Marten [4] has put forth the main social forces that cause these unsustainable interactions which are shown in Table 1.

Table 1 highlights the sources of unsustainable interactions, and in order to understand how they are related to our everyday activities, concrete examples from everyday context has to be analyzed with respect to these five sources. For example, a European Union project reported that meat and dairy consumption accounts to one quarter (24%) of all final consumption impacts in Europe [5]. The per capita meat consumption of a European is 86kgs on the year 2007. This increased demand means that more cattle is reared and fed with water and crop, resulting in overexploitation of ecosystem resources. There are similar such examples of activities which when analyzed from a life cycle perspective could be linked to one or more of the sources of unsustainable ecosystem interactions. Though it may appear that most of our activities are directly or indirectly linked with these unsustainable sources, the people of current generation have a choice to reduce their impact on the ecosystem.

Social force	How?
1. Human migrations	When people move in masses from one place to another (say from rural to urban), their interactions with ecosystem varies greatly and creates imbalance (increased resource usage).
2. New technologies	New technologies though brings in great productivity and efficiency they do have repercussions. People do not have lifecycle assessment of technology use and their impact to ecosystem which demands long term vision of using these technologies.
3. Tragedy of the commons	What is best for each individual is not best for all resource users together (say, traveling by car is easier for a person but adds pollution to the atmosphere).
4. Portable capital in market economy	Sustainable interactions promise long term returns, on the other hand, unsustainable ways attract huge returns lasting only for short term.
5. Alienation from nature	Increased urbanization has distanced away humans from nature and thereby slowly cutting down the emotional links man has for nature.

Table 1: Social forces for unsustainable interactions [4]

Marten [4] has emphasized that resilience (ability of ecosystems to function despite severe stress) and adaptive development (ability of social systems to cope with change) are the two important aspects to be taken care of whenever we undertake any activity. Based on these aspects a list of everyday activities pertaining to sustainable lifestyle could be prepared. However, as mentioned in the previous section, embracing sustainable lifestyle calls for actions from various levels. Figure 2 below captures the different levels involved in making sustainable lifestyle possible.

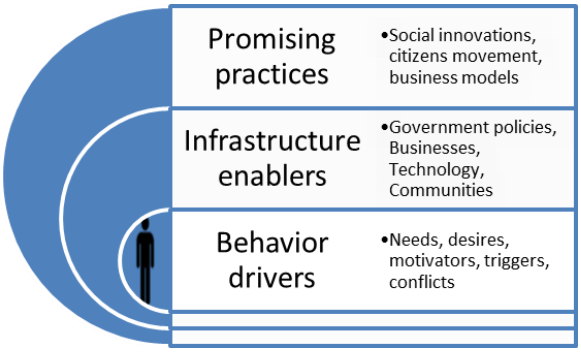

Figure 2. Different levels involved in sustainable lifestyle

As shown in Figure 2, practicing sustainable lifestyle can be achieved by individual commitment fuelled by internal motivation. Even with the presence of infrastructure, if an individual lacks motivation to use the resources effectively and lead sustainable lifestyle, the efforts and investment goes futile. For example, if a municipality provides collection points for electronic waste and the citizens are not motivated to drop their electronic waste there, the investment made by the municipality does not reap benefit. Therefore motivating people to make use of infrastructure towards sustainable lifestyle is as important as the investment for the infrastructure itself. In lifestyle concepts, behaviour is not described by social position; instead behaviour is understood as guided by motivation [6]. This discussion has established the need of individual motivation resulting in behaviour change towards sustainable lifestyle.

BEHAVIOR CHANGE

Behaviour change and motivation

Research on psychology revolves around the concepts of behaviorism and cognitivism. Behaviorism corresponds to analyzing behaviors by looking externally at what people do and cognitivism mostly focuses on mental states and analyzes what makes people to do something. Behaviorism discusses more on influencing behaviors through the use of a stimulus. The stimulus could be for example a sticker placed on your working table to remind you taking a break in every 20 minutes. The two different approaches towards behaviorism is classical conditioning (where the responses are altered based on the stimulus) and operant conditioning (where the consequences of a behavior alters the behavior itself). From the discussion of behaviorism two main views could be used to bring in behavior change. Firstly, learning how people respond to different stimulus and secondly, the circular process of action, feedback and response is powerful to motivate a behavior. According to Weiner [7], motivation corresponds to the set of determinants of a human activity. The study of motivation does not stop with analyzing what makes some people do some things, but also includes host of other things like, what action a person doing (choice of behavior), how much effort an individual puts (intensity of behavior), how long does a person is involved in the activity (persistence of behavior) and how an individual feel before, during and after the activity (emotional attachment to behavior). Motivation and behavior change are closely interlinked and are significant factors in embracing sustainable lifestyle. Several theories of motivation exist and each of them is used in specific context. Community based social marketing (CBSM) is a concept and tool which discusses in detail about motivation and design of programs to foster sustainable behavior. Next section of the paper will discuss CBSM concept and how it could be used to bring in behavior change.

Behaviour change in sustainable lifestyle

Community Based Social Marketing (CBSM) is based upon research in the social sciences that demonstrates behavior change is often most effectively achieved through initiatives delivered at the community level that focus on removing barriers to an activity while simultaneously enhancing the activity's benefits [8]. It complements the concept of social marketing along with social sciences and establishes that in order to influence behaviors that benefit society (public health, environment etc), it can be achieved best when targeted at a community level. The CBSM tool inherits different behavior change tools that can be utilized to foster behavior change and compiles it to a five step approach as mentioned below.

1. Selecting behaviors
2. Identify barriers and benefits
3. Developing strategy that reduces barriers and enhances behavior's perceived benefits
4. Piloting the strategy
5. Evaluate broad scale implementation and evaluation

CBSM has been used widely in various programs targeting behavior change towards social issues and environmental problems like persuading anglers to release rather than consume contaminated fish, encouraging employees to turn off their computers and monitors during weekend. The core of CBSM concept is attributed to aim at reducing barriers and augmenting the benefits. Figure 3 shows how the strategy could be developed based on the magnitude of barriers and level of benefits.

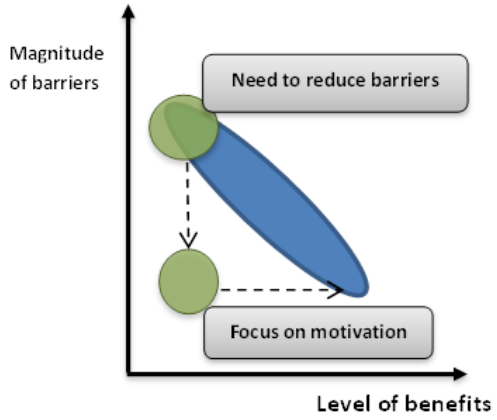

Figure 3. Strategy based on magnitude of barriers and benefits

As shown in Figure 3, when the magnitude of barriers is high (for example absence of bicycle lanes) for a particular behavior (foster eco-friendly transportation), it is pointless to put efforts in increasing motivation. Therefore in that case, the strategy should be to reduce the barrier. On the other hand, when the magnitude of barrier is low, the behavior can be fostered by enhancing motivation and make people realize the perceived benefits (for example health benefits of cycling). There are various forms of behaviour

change tools that can be used to motivate people towards making sustainable lifestyle choices. They are commitments, social diffusion, goal setting, social norms, prompts, incentives, feedback and convenience. This paper uses the CBSM concept and focuses on identifying ways to foster behavior change by enhancing motivation.

Influence of design in sustainable lifestyle

The word 'design' can be used either as a noun or verb. As a noun, 'design' refers to an object or entity created with intent and as a verb it refers to a process. In the context of sustainability, design is commonly used in both noun and verb forms. When used as a verb it is referred as 'Design for Environment (DfE) or sustainable product design' which lays emphasize on the process of design considering the aspects of environmental footprint, life cycle analysis and resource usage. On the other hand, design as a noun in sustainability context refers to an entity which is the product of a design process and can be [9],

- physical in the form of objects (house we live in, furniture etc)
- temporal as an event that occurs in time (a party or a gathering)
- conceptual referring to some idea (an activity to conserve water)
- relational such as interaction between two entities (proper usage of appliances to increase its lifetime)

When design is used as a noun in the above cases, it is mostly an experience and not intended to be an inspiration. While the primary focus is to make the product design sustainable, emphasis is not laid to instill the thought about sustainability in user's mind. For example, if an individual commute to office by bicycle daily, but does not maintain the bicycle properly, it may be worn out soon therefore leading to buy new one. With the advent of increased gadgets and appliances, comes the increased appliance garbage. This relational thinking of sustainability can be applied to most of our everyday interactions. Figure 4 portrays the essence of this discussion.

Figure 4. Role of design in sustainable lifestyle

As shown in Figure 4, design plays the role of creating awareness (like sticker designs pasted in waste bins), creation of sustainable products (like low energy CFL bulbs) and sustainability thinking (like proper usage of a computer). In order for an individual or a community to embrace sustainable lifestyle holistically, these three aspects need to be considered and for these to be effective, techniques like Gamification as discussed in the next section could be deployed.

Gamification and behavior change

Gamification refers to applying game elements and structures to other business and programs with an intention to augment user participation. Gamification is a tool for motivation and is very effective to bring in behavior change. Gamification can be used as a tool for motivation to form certain habits and behaviors which are good for person, community and world. For example, we do know that running is a good exercise, but mostly people lack motivation to do it daily. Nike + is a Gamified system which motivates its customers to run and be part of the game. The game elements include points, rewards, leader boards, progression, resources, challenges, badges, collections, quests, social graph, virtual goods and the list grows on. However, not all the game elements can be used for instilling sustainable lifestyle behaviors. Take for example rewards which is the core of certain games; but when rewards are used to motivate towards sustainable behaviors it creates the danger of losing the interest when rewards are removed. Therefore it is important to choose certain game elements which would augment motivation and do not have repercussions. A Gamified system has to take care of two main aspects for it to be effective in the long run as shown in Figure 5.

1. Engagement loops
2. Progression loops

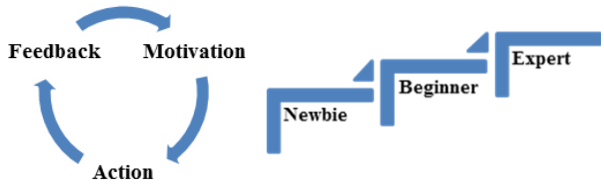

Figure 5. Engagement and progression loop in Gamification

PROPOSED MODEL

Design as an inspiration for sustainable lifestyle

Design could play a powerful role in inspiring human beings to lead a sustainable lifestyle. The core of the proposed model relies on using visual design in art forms and objects which would act as an inspiration for people to embracing sustainable lifestyle every day. The model inherits concepts from Community Based Social Marketing and is targeted to build a community of individuals interested in sharing their journey towards sustainable lifestyle. The model is primarily designed to be a web based platform to harness a sustainable lifestyle community and the concept is built based on three main themes namely,

- Co-creation
- Crowd sourcing
- Join me in Journey

Each of these themes is explained in detail below.

Co-creation:

The everyday activities an individual interacts at home, at work place, on travel have the potential to have an impact of sustainable lifestyle. However, not all people are inspired to protect the ecosystem and worried about the deterioration of earth's resources from an environmentalist perspective. A report by Unilever [10] refers to a statistic that only less than 10% of people are interested in caring and protecting environment, while the vast majority of 70% remain indifferent to these environmental issues. The paper therefore asserts if sustainable lifestyle has to be taken to mainstream it has to be communicated in other ways that would draw attention from the vast majority. On the other hand, people in general have some interests of their own, for example in sports, music, art, cooking, exercise, gardening etc. Therefore in order to take the concept of sustainable lifestyle to mass people, it is important to tailor the concept according to their interests. For example, sustainable lifestyle concept can be introduced to a cooking enthusiast as,

"*If you host a party full of delicious recipes, take time to consider providing reusable dishes! Those paper and plastic cutlery of your guests fill up the landfill resulting in soil pollution. Enrich the soil which enriches your party with its energetic food materials."*

The above example accompanied with an apt visual poster design would be more sensible to the cooking enthusiast than a general statement of "*Use reusable dishes and protect soil pollution"*. This idea of tailoring the concept to varied interests cannot be carried out by a single source, say an NGO organization. In that case, it will become a unidirectional approach with people in the receiving end. The effectiveness of this concept can be augmented only when the users or targeted people participate in this concept. This can be achieved by providing a co-creation platform where people from varied interests can create visual designs accompanied with messages related to their interest towards sustainable lifestyle. This has the potential to create viral effect and produces ripples among people from related interests. Co-creation gives a user, pride of being part of creation and getting recognized by others from the community. Co-creation of visual designs in art and object forms can be used to influence three main aspects of sustainable lifestyle namely awareness about a certain activity or behavior towards sustainable lifestyle, using sustainable products or services and sustainability thinking. The co-creation concept is pictorially illustrated below in Figure 6.

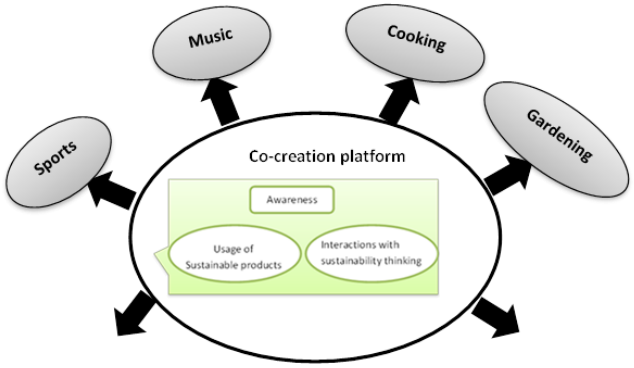

Figure 6. Co-creation in visual designs from varied interests.

The visual design refers to any art forms whose basic design could be shared in website and can be replicated by all users. It could be a poster, sticker, wall picture, a Do-It-Yourself (DIY) object or even a computer desktop background. Web technology provides excellent tagging opportunities to categorize these different design forms and therefore could facilitate users to choose the form which would suit them best. To illustrate these co-creation visual designs from varied interests, an example is given below.

"Sustainable lifestyle oriented activity: Shopping with Reusable bags

Theme: Sports

Aspects

1. *Awareness: Car sticker picture with a cloth shopping bag running longer than a plastic bag and a message 'This car always carries a shopping bag that lasts longer'*
2. *Usage: Making a DIY shopping bag keychain that reminds to take a shopping bag when going out.*
3. *Sustainability thinking: Wanted to say 'No' to the bags given for your purchase of clothes? But still wanted to show off that you bought from Nike? Save those initial trendy bags you got and remember to use them on your next visit; Reuse & Showoff"*

The example shown above could be just one version of the many more that each sport enthusiast could come up with and also inspire others in sports community. This concept could set a trend and make people think that embracing sustainable lifestyle is not only good but also trendy.

Crowdsourcing:

Few decades back, it is very common for tourists to rent a taxi when they visit a new place. The reason behind it could be a perceived hindrance of not knowing about the transport facilities available at that place. Thanks to crowdsourcing websites like Wikipedia, which helps tourists to understand the transportation possibilities and plan their travel well ahead. According to Merriam-Webster dictionary,

crowdsourcing is the practice of obtaining needed services, ideas or content by soliciting contributions from a large group of people. Crowdsourcing is an effective concept to engage users of a community to share their knowledge and provide a platform to help each other. To promote sustainable lifestyle and to give users a sense of knowledge sharing, crowdsourcing is used by this proposed model of "Design as an inspiration of sustainable lifestyle". Crowdsourcing from a knowledge discovery and management perspective is used to collect rich information from various sources and manage information facilitating the retrieval process. Therefore crowdsourcing could be used effectively to collect and maintain locally relevant information about activities pertaining to sustainable lifestyle. A study [11] of why Americans don't recycle highlights that more than 80% knew that recycling would reduce landfills, but still many of them do not recycle. The reason attributed to that is lack of correct knowledge hinders recycling efforts. In addition to that, people living in urban places do not have enough space to store unwanted stuff to recycle. This means that people do not know where to recycle, what to recycle and how to reduce their garbage. Especially each city council has different recycling rules to be followed. Crowdsourcing could be the apt solution for this caveat. Those people who already experts in taking their own steps towards sustainable lifestyle can provide information about recycling points, provide easily understandable recycling info graphics, possible ways to reduce garbage in their region (by buying cartons instead of cans, energy efficient stuff). A crowdsourcing platform provided in the website could help & guide the expert providers in sharing their knowledge and newbies to easily access local relevant experience. In order to understand the target audience and context of the crowdsourcing intended to be used, Erickson's [12] four quadrant crowdsourcing model can be referred as shown in Figure 7 below.

	Same place	**Different place**
Same time	Audience-centric crowdsourcing	Event-centric crowdsourcing
Different time	Geocentric crowdsourcing	Global crowdsourcing

Figure 7. Four quadrant crowdsourcing model [12]

As seen in Figure 7, crowdsourcing has been widely used in contexts involving same and different places at same and different times. The crowdsourcing context referred here focusses more on people helping each other and reducing barriers in taking steps towards sustainable lifestyle and could be effective at regional level. Therefore it could belong to 'Geocentric crowdsourcing'.

Though this crowdsourcing idea may look promising, the question arises on what makes an individual be it an expert or a newbie to share their knowledge in this website platform? The answer lies in deploying Gamification linked with this crowdsourcing concept. There are some more commonly and popularly used Gamification elements like badges, rewards and quests. However most of them are related towards attaining a goal or an action and may not be suitable for recurring situations like leading sustainable lifestyle. The main aim of Gamification is to encourage participation of users in the crowdsourcing platform and that would mean regular visit to the website. Virtual goods aspect of Gamification could suit well for this intention and is utilized in this model to encourage user participation. Virtual goods should be closely linked with user activity and purpose behind the activity. Therefore, thematic virtual goods namely "Build your garden" or "Color your house" could be used. For example, the idea behind "Build your garden" is that the when an user contributes to crowdsourcing platform, a small plant is placed on user home profile and when many other users are getting benefit of it, the plant turns to a tree and starts blossoming. This idea closely interlinks the user activity to a Gamified system.

Join in Journey:

The third theme in this proposed model is termed as "Join in Journey". Embracing sustainable lifestyle is like a journey, where an individual could face hindrances and rewards on the way. In an interview by earth911.com website, the reasons gave by all respondents for not recycling their used cans and bottles were lack of convenience. This response asserts that sustainable lifestyle does count on an individual's commitment and taking an extra mile for that purpose. Being a community, an individual can raise interest on his fellow members to join his journey group in adapting a particular behavior or activity towards sustainable lifestyle. For example, if a group's journey is to avoid food waste (during meals, unused rotten food in fridge etc), they could share their inspirations, experiences, hindrances faced, planning skills acquired, comment on others and can make their journey interesting. A report by Unilever [10] suggests, in order to translate sustainability into meaning for our everyday lives, it is important to demonstrate examples of what more sustainable living looks like. This concept could be seen as an online collaborative community effort towards knowing different ways to lead sustainable lifestyle. This differs from the crowdsourcing theme mainly because it is more towards sharing experiences and inspiring each other; while on the other hand, crowdsourcing is more towards sharing information alone.

Thus the proposed model uses these three main themes to disseminate design as an inspirational tool for embracing sustainable lifestyle. With this understanding of the proposed model, it is important to evaluate at what level (individual, community, policy makers etc) this model operates and how effective it is. This evaluation could be performed by utilizing the framework developed by the European Union project for sustainable lifestyles known as

SPREAD 2050 to establish four sustainable lifestyle scenarios for Europe in 2050 and is shown in Figure 8 below [13].

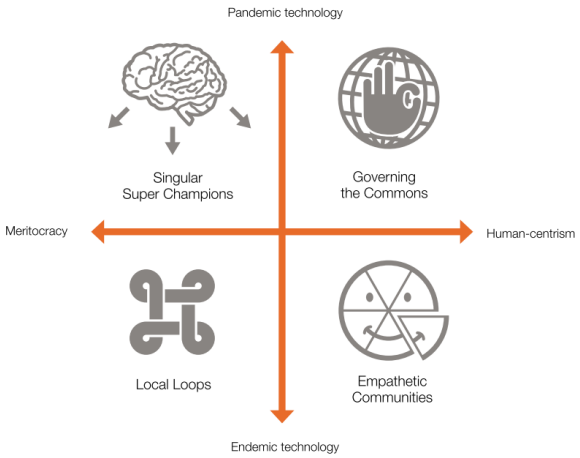

Figure 8. Four scenarios for sustainable lifestyles 2050: From global champions to local loops [13]

As seen in Figure 8, the scenarios are developed based on the factors namely, pandemic technology (global dominant technology), endemic technology (technology tailored to local needs), human centered (value human capital in all forms), meritocracy (emphasize more on professional skills). The proposed model based on the factors and its context, naturally falls under 'empathetic communities' scenario. The report highlights some aspects which are identified as base elements for 'empathetic communities' scenario and foresee possible lifestyles in 2050 which are mentioned below,

- Collaborative consumption
- Community oriented activities
- Knowledge sharing with more inclination towards Do-It-Yourself (DIY) concepts
- Public, private and people (PPP) welfare model
- New ways of living (interior designs, house grown vegies, flexible space)

These base elements are closely associated with the proposed model and indicate that the target audience for this model is 'empathetic communities'. Therefore it could be asserted that, for this model to be effective, it has to use technologies that are relevant to local communities and also human centered (encompass human capital in all forms).

PILOT STUDY AND CHALLENGES INVOLVED

This concept could be deployed in a region where the internet penetration and participation in online activity is high. As the aim of the entire model is to understand how visual design in various forms like art, objects could inspire people and motivate them towards sustainable lifestyle, the magnitude of barriers towards sustainable lifestyle, in the selected region should be low. This would imply that the region is provided with recycling facilities, public transport infrastructure (may not be not widely used though) and if possible few city council programs for sustainable lifestyle. The pilot study could be performed by taking forward this model with the steps mentioned below.

- Choose a region that satisfies the criteria mentioned above.
- Design a minimal website for community participation with the three main themes as the core. Identify the sustainable lifestyle actions and behaviors applicable in that region and choose a list to focus. Ensure that the website has the options for sharing the discussions and user participation to social media. Prepare an initial resource base to trigger the discussion in the community.
- Identify a handful of local pioneers in the field of sustainability who could take up the role of experts. People from varied background like student organizations (ESTIEM-SERI for example), designers, academicians, businesses executives, artists, social and environmental activists could comprise the initial experts.
- Introduce the website and concept to general public during fairs, workshops, exhibitions and city days. Possible collaborations with local city councils programs for sustainable development could yield good results.
- Define a pilot study period and targeted user base number. Brief the user base about the pilot study, its aims and outcomes that would be shared at the end.

During concepting this model, certain challenges associated with piloting are also identified and mentioned below.

- Some ways to measure the impact – how far the information proposed have fulfilled individual's needs; how far old behaviors unlearned (perhaps with some voting buttons on the website discussion platform?); consistency of the new lifestyle patterns.
- How to provide positive reinforcement which is critical in behavior change?
- What aspects could be considered to keep up the participation of newbies, beginners and experts while at the same time providing a sense of satisfaction?
- How to build and harness the interested community? There are several examples of successful online communities and also communities that could not sustain for longer time and slowly wither down. Threadless.com is an

example of a successful online community which has certain key features like giving users the power to mobilize their design that makes it standout. Therefore in order to ensure longer withstanding of community participation, the model should be designed with some key features like more community contribution gives power to represent on behalf of the community.

CONCLUSION

The paper discusses briefly about sustainable lifestyles and the significance of focusing on instilling behaviors towards sustainable lifestyle as important as introducing new technologies, products and services towards sustainable development. A website model based on design as an inspirational tool to motivate and harness a community towards sustainable lifestyle is proposed. The proposed model has the potential to be deployed as a pilot project and could provide feedback and insights on the effectiveness of this concept. The paper briefly presents the steps and challenges involved in carrying out the pilot project.

REFERENCES

1. Step, The Natural. Sustainability Primer. 2009.
2. www.dailydump.org. [Online]
3. SPREAD 2050. SUSTAINABLE LIFESTYLES: Today's facts & tomorrow's trends. 2012.
4. Marten, Gerald G. Human Ecology - Basic concepts for sustainable development. s.l. : Earthscan publications, 2001.
5. Weidema, Wesnaes, Hermansen, Kristensen, Halberg. Environmental improvement potentials of meat and dairy products. s.l. : http://ftp.jrc.es/EURdoc/JRC46650.pdf, 2008.
6. Claudia Empacher, Konrad Götz. Lifestyle approaches as a sustianable consumption policy - a German example. The ecological economics of consumption. s.l. : Edward Elgar Publishing Limited, 2004, s. 251.
7. Weiner, Bernard. Human Motivation: Metaphors, Theories and Research. s.l. : SAGE publications, 1992.
8. Doug McKenzie-Mohr, Nancy R. Lee, P. Wesley Schultz, Philip Kotler. Fostering sustainable behavior. Social marketing to protect the environment. s.l. : SAGE publications, 2012, s. 256.
9. R, Miller William. Definition of Design. [Online] 2005. [Accessed: 27. May 2013.] http://static.userland.com/rack4/gems/wrmdesign/DefinitionOfDesign1.doc.
10. Unilever. Inspire sustainable living. [Online] [Viitattu: 5. June 2013.] http://www.unilever.com/images/slp_5-Levers-for-Change_tcm13-276807_tcm13-284877.pdf.
11. Worthington, David. Infographic: Reasons why Americans don't recycle. [Online] Smartplanet, April 2012. [Accessed: 5. June 2013.] http://www.smartplanet.com/blog/intelligent-energy/infographic-reasons-why-americans-dont-recycle/14937.
12. Erickson, Thomas. Some thoughts on a framework for crowdsourcing . [Online] 2011. [Accessed: 5. June 2013.] http://crowdresearch.org/chi2011-workshop/papers/erickson.pdf.
13. SPREAD 2050. Scenarios for sustainable lifestyles 2050: From global champions to local loops. s.l. : http://www.sustainable-lifestyles.eu, 2012.

Using Virtual Laboratories as Preparation to a Practical Laboratory Course: Preliminary Empirical Investigation

Ansgar Scherp
Institute of Computer Science and Business Informatics
Research Group on Data and Web Science
University of Mannheim, Germany
ansgar@informatik.uni-mannheim.de

Jutta Meier
Institute for Integrated Natural Sciences
Research Group on Microbiology
University of Koblenz-Landau, Germany
jmeier@uni-koblenz.de

ABSTRACT

Virtual laboratories are a specific kind of e-learning application. They allow students of natural sciences to conduct experiments in a highly-interactive almost photo-realistic virtual environment built into the computer as simulation engine. Goal of virtual laboratories is to train the student's procedural knowledge that is needed for conducting experiments in a real laboratory environment. Students can train themselves comfortably in a secure environment using the computer and without wasting precious resources such as substances and devices. Despite the existence of virtual laboratories for a while now, there exist to the best of our knowledge so far no empirical study that investigates the actual impact of using virtual laboratories as preparation to a practical laboratory course.

In this paper, we present the design and results of a preliminary study conducted using the virtual laboratory GenLab for genetics and genetic engineering. While one group of students (n=18) did receive a training using GenLab prior to real laboratory experimentation, the others did not (n=14). We have measured the task performance for two typical experiments in genetics of different complexity. In addition, we have recorded the students' own assessment of the experiment complexity and comprehensibility. The results show that there is a statistically significant difference for the more complex experiment task, while it has not been observed for the less complex one.

Keywords

Virtual Laboratories, Summative Evaluation, E-learning, Genetics, Genetic Engineering

INTRODUCTION

A virtual laboratory is an almost photo-realistic depiction of a real laboratory in a computer for the purpose of conducting experiments in virtual reality. A concrete example of a virtual laboratory is GenLab [OFF03] for genetics and genetic engineering. GenLab consists of two central components [Sch02]: The seminar room allows the students to gain knowledge about the theoretical foundations of genetic tools just like a traditional computer-based training application. In addition, it provides small, interactive e-learning units that allow for training individual skills such as using specific laboratory devices. The virtual lab room allows for a highly-interactive and exploratory learning of procedural knowledge in the domain of genetics and genetic engineering. While the students are conducting the experiment, a tutor constantly tracks the experiment progress and provides feedback when the learner makes a mistake. Advantages of virtual laboratories are that the students can train the procedural knowledge arbitrary often. As the experiments are conducted in virtual reality, precious resources like reagents and samples are saved and experimental devices can be explored without risks. In addition, the students are not exposed to any hazards while being in the virtual training phase.

In this paper, we present the design and results of a preliminary study investigating if students using GenLab are actually better prepared for the practical course in a real lab. First, we present the related work in the field. Subsequently, we describe in more detail the seminar room and experimentation room of GenLab. We provide a brief introduction into the two experiments considered in this study, namely the agarose gel electrophoresis (AGE) and the polymerase chain reaction (PCR) [SR01]. Subsequently, the design of the study and its results are presented, before we conclude the paper with a discussion.

RELATED WORK

E-learning has been an important and highly interesting research field over the last decades. Initially called computer-based training, its popularity tremendously increased since e-learning has reached the web. For example, significant media attention is currently drawn to so-called Massive Open Online Courses (MOOC) [Wal13]. An interesting area of research in e-learning are so-called virtual laboratories [NAA12, OFF03, Sch02], which allow for training procedural knowledge safely and without wasting resources in a computer environment before going into a real world lab. In contrast, remote laboratories are real laboratories that are controlled over the Internet and often make use of a web cam for providing immediate feedback to the learner [RML+09, RAM+08].

An example of a virtual laboratory is GenLab [OFF03]. It allows for executing different genetic experiments in a computer-based simulation (see also Section "Overview of GenLab"). While GenLab is delivered on CD-ROM, virtual

laboratories are also available online and can be used for MOOC such as the web-based version of GenLab[1]. Furthermore, virtual laboratories are specifically designed as being part of a physical curriculum (*blended learning*) and being used as preparation for a real-world (laboratory) training and experience phase, respectively.

A tool to test the effectiveness of virtual labs on the overall learning performance would be the method of summative experiments [LFH10]. An example of a summative experiment is given by Franz et al. who studied the usability of a standard desktop PC in comparison to a semantic desktop, where relations between e-mails, contacts, appointments, files, and others are explicitly stored and used for typical tasks of personal information management [FSS09]. To this end, the participants in the experiment were randomly assigned to two different groups, one working with the standard desktop and the other group using the semantic extensions. Measurements such as task completion time, number of clicks, and error rate were measured and compared to determine which group performed better. Overall, the results show that the users of the semantic desktop performed statistically significant better when conducting complex tasks of personal information management. While such evaluations aim at comparing two different software systems, our work is somewhat different from this scenario: In our experiment, the participants are also split into two groups. However, while one group has received preparation using a virtual laboratory prior to the real laboratory course, the other group did not use any software at all and thus served as control group.

In another study, Lucca et al. [LRS+04] have investigated if telecommunication technologies can support e-learning. They have compared remote groups working together via teleconference, face-to-face groups (groups at disparate locations but that meet in person), and groups that are at the same location. The results are to some extend not surprising and show that the groups at the same location perform best. Investigating the influence of using e-learning tools as preparation to some subsequent laboratory work has not been investigated.

Dagger et al. [DWC04] have investigated the process of developing adaptive e-learning content. They argue that production of adaptive content requires an interdisciplinary team and is of high effort [DWC04]. Although not specifically considered by Dagger et al., virtual laboratories are necessarily adaptive e-learning applications as they need to provide individual feedback to the learner. The authors conducted a preliminary evaluation in form of a case study with the aim to investigate the user-friendliness and comprehensibility of their approach. To this end, the authors have asked the participants to create a short adaptive e-learning course. However, a comparative evaluation of using a virtual laboratory as preparation to a real laboratory course like it is done here has not been conducted.

[1] Example experiments are available online at: http://www.virtual-labs.org/

OVERVIEW OF GENLAB

The virtual laboratory GenLab has been developed at the research institute OFFIS in Oldenburg, Germany [OFF03]. It is commercially available and can be used by students to prepare themselves to a various selection of different genetic experiments. Besides the commercial GenLab application, there exists also the non-commercial variant called ViPGen that has been distributed and used at universities for educational purposes. However, ViPGen is not available for general public use.

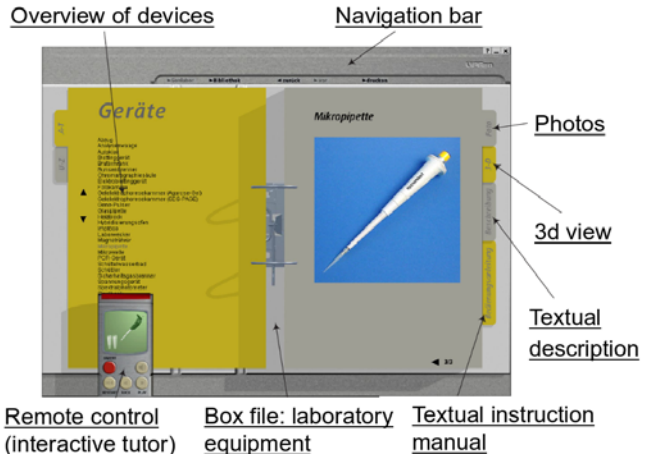

Figure 1. Screenshot of the seminar room in GenLab (captured from [OFF03]).

Thus, instead we have used in this study the commercially available GenLab. It consists of two central components, the seminar room and the experimentation room [Sch02]. A binder found in the bookshelf of the seminar room is depicted in Figure 1 and is very similar to traditional computer-based training applications. It allows students to study the theoretical foundations of genetic laboratory work (see the folder depicted in the figure). However, it also provides 3D views and photos of laboratory devices. Finally, unlike other traditional computer-based training applications, the seminar room of GenLab offers small, interactive e-learning units to train individual skills such as using specific laboratory devices (which can be seen at the bottom left part of the screenshot in Figure 1, leading to Figure 2).

Figure 2. Screenshot of the interactive tutoring component for training the skill of using the micropipette (captured from [OFF03]).

The experimentation room depicted in Figures 3 – 5 is the actual core of GenLab. It provides a virtual lab room that allows for conducting virtual genetic experiments in a highly-interactive and exploratory simulation engine. Thus, the theoretical knowledge gained in the seminar room is put into practice. Students can learn essential procedural knowledge needed for conducting experiments in a real laboratory environment. In the top left of Figure 3, a tutoring window is shown. It constantly tracks the progress of the experimentation and is coupled with the simulation engine. While the students are conducting the single steps of the experiment, it instantly provides feedback when the student makes a mistake such as waiting too long and letting solidify the gel before pouring it into the gel tray during the AGE experiment (see also experiment description below).

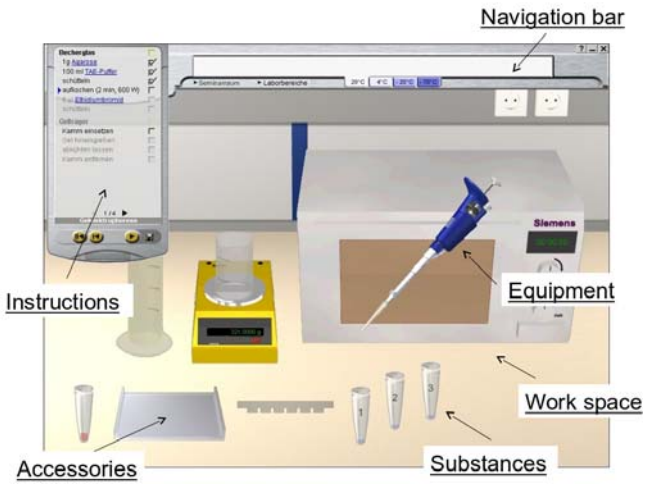

Figure 3. Screenshot of the laboratory bench in GenLab (captured from [OFF03]).

GENETIC EXPERIMENTATION

As example experiments in our study, we have selected the agarose gel electrophoresis (AGE) and the polymerase chain reaction (PCR) [SR01].

Agarose gel electrophoresis (AGE)

The procedure of AGE consists of several steps which are very closely reenacted in the virtual lab. First the students had to make their gels, including the weighing and mixing of components, the melting of the gel solution in the microwave, as well as the preparation of the gel trays prior to the pouring of the gel. Once the gel had solidified, it was transferred to the electrophoresis chamber and covered with the electrophoresis buffer. Now, the samples could be loaded on the gel. For this purpose, the samples were mixed with the loading buffer and each sample was carefully applied with a micropipette to the gel slots. The chamber was closed with the lid putting the electrodes in place. Current and voltage were adjusted and electrophoresis was started. Finally, the gels were placed on a UV-transilluminator and imaged for documentation purposes and subsequent analysis. A screenshot of the virtual AGE experiment in GenLab is shown in Figures 3 and 4.

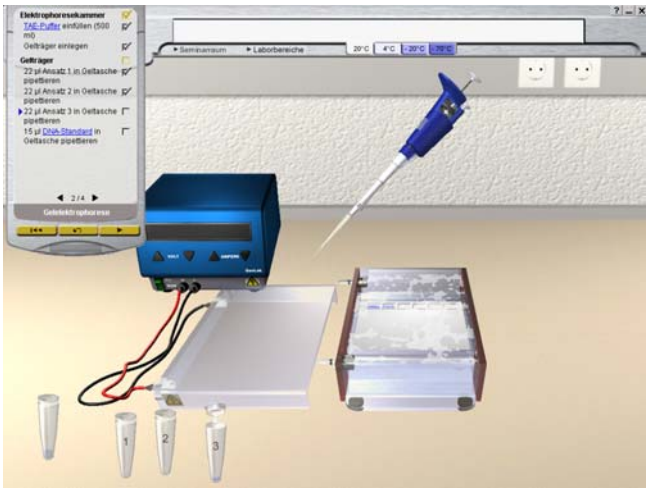

Figure 4. Screenshot of the agarose gel electrophoresis in GenLab showing the electrophoresis chamber (captured from [OFF03]).

Polymerase chain reaction (PCR)

The preparative steps for PCR are less numerous than for AGE, which was also the case for the virtual version. The students first had to calculate – depending on the numbers of samples – the volume of each component of the so called ‘mastermix’. The appropriate volumes of each component were then pipetted into a reaction tube and mixed. The mastermix was distributed into new reaction tubes according to the number of samples and the samples were added. After brief mixing, the reaction tubes were placed into the thermocycler and the program was started to conduct the PCR. A screenshot of the virtual PCR in GenLab is shown in Figure 5.

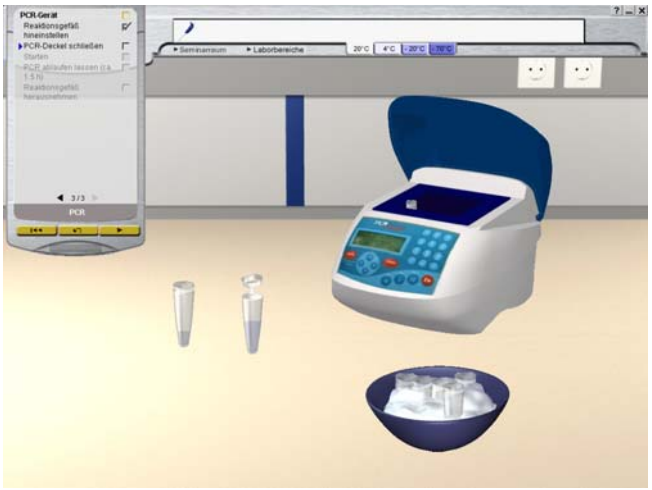

Figure 5. Screenshot of the polymerase chain reaction in GenLab (captured from [OFF03]).

EXPERIMENT DESIGN

Participants

32 students (19 female) of biology from the University of Koblenz-Landau in Germany took part in our experiment. The average age of the students was 24.5 years (SD=3.63). Participation was voluntary. No compensation for the effort in participating in the experiment was given.

Procedure

We have conducted a summative evaluation, where we have split the students in two groups. One group has been trained using GenLab prior to the practical course (n=18, 10 female). The other group has served as control condition and was not trained (n=14, 9 female). As example experiments, we have selected the agarose gel electrophoresis (AGE) and the polymerase chain reaction (PCR) [SR01] described above.

The first group, i. e., the GenLab group received a two hour training in the procedures of genetic engineering using the virtual laboratory. The students were allowed to the use software as they like. However, it was mandatory to read the theory on PCR and AGE in GenLab, to learn the use of the micropipette with the software, and to conduct the virtual experiments AGE and PCR using the software. Subsequently, the students participated in a real laboratory course where they have conducted experiments in pairs of two. Among the experiments conducted in this course were AGE and PCR. The students were asked to measure the time and among others provide a subjective rating of the difficulty and comprehensibility of conducting the individual experiments. The latter were captured using a questionnaire.

The second group, i. e., the control group did not receive training a priori to the real laboratory course. Except from this difference, both treatments were the same. The control group conducted the same set of experiments in the same laboratory and equal conditions like the GenLab group. In order to allow also the students of the control group to investigate the usefulness of the virtual laboratory GenLab, the students were invited after the laboratory course to work with the software as well.

RESULTS AND DISCUSSION

In summary, the results of our study show that the GenLab group needed on average less time conducting the experiments. However, applying a Mann-Whitney U test did not find the differences significant ($U=137.0$, ns, $z=0.71$). We have also asked the participants how well they felt prepared for conducting the experiments in the real laboratory. Here, again the difference was not significant ($U=122.5$, ns, $z=0.22$). This basically meant that the students were not more self-confident while conducting the experiments when having received treatment in using GenLab as preparation.

Among further questions, we have asked the participants to rate the experiments regarding their comprehensiveness. Here, we made a very interesting observation that the participants in the GenLab group did understand the procedure of the AGE and PCR experiments much better, based on their subjective judgment. The differences in the ratings of the comprehensiveness of the AGE experiment were statistically significant between the groups ($U=172$, $p<.05$, $z=1.75$), while the results for the PCR experiment were not ($U=155.5$, ns, $z = 1.12$).

Surprisingly, this result was not reflected in the participants' subjective rating of the experiments' complexity. The participants in the treatment group using GenLab rated the complexity of the AGE and PCR experiment higher than the control group. While the difference in the ratings of the AGE experiment were pronounced and statistically significant ($U=172.0$, $p<.05$, $z=1.75$), the differences in rating the complexity of PCR were minor and not significant ($U=126$, ns, $z=0$).

We explain the different outcome for the AGE experiment by the fact that the AGE experiment is more complex than the PCR. As the AGE experiment includes more steps to conduct and the virtual version depicts the real procedure much closer than it does for the PCR, we assume that the students have gained much more from the AGE preparation using the virtual laboratory than for the simpler experiment. However, this results need to be investigated in more detail in the future.

CONCLUSION

In this paper, we have conducted an early experiment measuring the influence of the use of a virtual laboratory like GenLab on the performance when conducting experiments in a real laboratory course. Overall, we can state that virtual laboratories may play a significant role in better preparing students in real laboratory work and thus have the potential to safe precious resources when conducting experiments in the real world.

However, more extensive user studies are needed in the future. These user studies need to particularly investigate the usefulness of virtual laboratories as preparation for real laboratory courses. In addition, it will be interesting to investigate if knowledge acquired additionally through the virtual laboratories is more sustainable than traditional learning methods.

ACKNOWLEDGMENTS

We thank all the students participating in the experiment.

REFERENCES

[DWC04] Declan Dagger, Vincent P. Wade, Owen Conlan: Developing Active Learning Experiences for Adaptive Personalised eLearning. Adaptive Hypermedia 2004: 55-64

[FSS09] Thomas Franz, Ansgar Scherp, Steffen Staab: Are semantic desktops better? Summative evaluation comparing a semantic against a conventional desktop. Knowledge Capture 2009:1-8

[LFH10] Jonathan Lazar, Jinjuan Heidi Feng and Harry Hochheiser: Research Methods in Human-Computer Interaction, Wiley Publishing, 2010.

[LRS+04] Joyce Lucca, Nicholas C. Romano Jr., Ramesh Sharda, Mark Weiser: An Assessment of Elearning Technologies to Support Telecommunications Laboratory Learning Objectives. HICSS 2004

[NAA12] Adel S. Nada, Fahad A. Alzahrani, Ossama B. Abouelatta: Interactive Web-Based Virtual Electrical Lab, The Journal of American Science 2012; 8:475-484

[OFF03] OFFIS Institute for Information Technology (Ed.): GenLab: virtual practical courses in genetic engineering (in German: GenLab: das virtuelle gentechnische Praktikum), Spektrum, 2003. ISBN 3-8274-1461-X

[RAM+08] R. Restrepo, D. Aristizábal, A. Montoya, J. P. Jiménez H., Pedro Torres: Web Laboratory Experiences for Elearning: The Michelson Interferometer. Innovative Techniques in Instruction Technology, E-learning, E-assessment, and Education 2008:19-23

[RML+09] Maria Teresa Restivo, Joaquim Gabriel Mendes, António Mendes Lopes, Carlos M. Silva, Maria de Fátima Chouzal: A Remote Laboratory in Engineering Measurement. IEEE Transactions on Industrial Electronics 2009; 56:4836-4843

[Sch02] A. Scherp: Software Development Process Model and Methodology for Virtual Laboratories, Proc. of the 20th IASTED Int. Multi-Conf. Applied Informatics, S.47-52, Innsbruck, Austria, IASTED, February, 2002. ISBN 0-88986-322-9

[SR01] Joseph Sambrook, David William Russell: Molecular Cloning: A Laboratory Manual, CSHL Press, 2001.

[Wal13] M. M. Waldrop: Online learning: Campus 2.0. Nature 2013; 495:160-163

Providing sustainable living through early detection of metabolic syndrome

Bogdan Pogorelc
Jožef Stefan Institute,
Department of Intelligent
Systems
Slovenia
bogdan.pogorelc@ijs.si

ABSTRACT
The non-healthy lifestyle of the people in developed countries is one of the reasons for higher amounts of atherosclerosis and diabetes type 2, which are related to a metabolic syndrome. This paper proposes an intelligent system for the early, unobtrusive detection of metabolic syndrome in order to support sustainable environments for today's and tomorrow's generations. An implementation of Fuzzy ARTMAP Neural Network for diagnosis of Metabolic Syndrome is presented. It allows classifying ^{1}H NMR serum spectra into five classes, from healthy person to person with Metabolic Syndrome. Using "Voting strategy" it gains an ability to classify samples with a confidence value.

Keywords
Sustainable living; early detection; metabolic syndrome; neural network; Fuzzy Artmap.

INTRODUCTION

The main purpose of this paper was to implement the Fuzzy ARTMAP neural networks in ANSI C to have a tool for classifying individuals into five classes, from healthy individuals to patients with metabolic syndrome (MetS).

MetS is a combination of medical disorders that increase one's risk for *diabetes (type 2)* or *cardiovascular disease*, such as *atherosclerosis*. Because of unhealthy way of living it affects a large number of people in industrially developed countries. In some studies, the prevalence in the USA is calculated as being up to 25% of the population. The presence of a metabolic syndrome relates to particular changes in the lipoprotein subclass profile, but the current clinical assessment methodology cannot take this properly into account [1, 2].

The solution may be ^{1}H NMR (Proton Nuclear Magnetic Resonance) spectroscopy, which allows fast measurement of lipoprotein profile directly from blood or urine serum. The literature review has revealed measurement methods, however none of them uses probability approach to show the confidence value of the classification for each sample.

Probability approach is performed with Fuzzy ARTMAP neural networks (FAM) using Voting strategy. FAMs are classification neural networks, which use supervised learning. In comparison to other types of neural networks (NN) FAMs have an ability of quick learning with reduced set of measurements, they need less computational power and have an ability of quick learning of rare events [3].

Using Fuzzy Artmap neural networks we have classified a large dataset of simulated ^{1}H NMR spectra of serum. Dataset was built on the basis of experimental data of lipoprotein subclasses. It contains the typical spectra of 5 classes, from normolipidemic (healthy) individuals through middle classes to MetS individuals [4].

THEORETICAL BACKGROUND

The problem of Metabolic Syndrome

Metabolic syndrome (MetS) is combination of medical disorders, which lead to increased risk for diabetes (type 2) or cardiovascular disease, such as atherosclerosis. These are the related facts:

- around one quarter of adults have MetS;
- people with MetS have twice bigger risk of heart attack and three times bigger risk of death by heart attack in comparison to people without MetS;
- 80% of 200 millions of people with diabetes will die from cardiovascular disease [1, 5].

By the current clinical diagnostics an individual has MetS, if he/she has:

- central obesity (defined as waist circumference):
  - larger than 88 cm for women and 102 cm for men in USA [2],
  - larger than 80 cm for women and 90 cm for men for the rest of the world;
- raised plasma fasting glucose:
  - 100 mg/dl or more;
- increased level of triglycerids:
  - 150 mg/dl or more;

- decreased level of HDL:
    - less than 40 mg/dl for men and 50 mg/dl for women;
- raised blood pressure:
    - systolic – more than 130 mm Hg,
    - diastolic – more than 85 mm Hg .

Atherosclerosis is a diffuse systemic disease that is characterized by the local build-up of lipid-rich plaques within the walls of large arteries (Fig. 1).

Figure 1: Atherosclerotic vessel [6]

If the plaque is eroded or ruptured and thrombus is created, event is denominated *atherothrombosis*. If a thrombus gets to coronary artery, blood flow to the heart is suddenly decreased and event is called *Acute Coronary Syndrome (ACS)*. The symptoms are:

- pain in the chest,
- sweating,
- nausea,
- vomiting.

However, in rare cases there is no symptom [8].

A common practice for assessing the risk of an individual for atherosclerosis is to measure the lipoprotein lipids in blood plasma or serum:

- high levels of low-density lipoprotein (LDL), known as "bad cholesterol",
- low levels of high-density lipoprotein (HDL), known as "good cholesterol" [7].

Recent researches show that all 11 lipoprotein subclasses are characteristically connected with MetS and risk of atherosclerosis, thus we have to measure all of them. This is possible using ^{1}H NMR and Fuzzy ARTMAP neural networks, implementation of which was the goal of this paper.

METHODS

The Fuzzy ARTMAP algorithm

In this study the FAM is implemented. As any other neural network, it starts with learning/training, where the neural network adapts its weights, and continues with testing, where classification is done based on previous learning. If we compare predicted classes with real ones, the procedure is called evaluation.

ARTMAP is a class of neural networks, which allows supervised learning of categories (classes) and making of multidimensional maps as a response to input vectors (measurements) in an arbitrary order [3, 9]. Supervised learning means that we provide the real class with each measurement for learning. However, for testing a neural network must predict classes by itself.

The original ARTMAP [10] is built on the basis of *Adaptive Resonance Theory (ART)* and is limited to classification of binary vectors. As an ARTMAP's improvement, *Fuzzy ARTMAP* includes fuzzy logic and the input vectors have components between 0 and 1.

Basic ARTMAP (Fig. 2) includes two *ART1 neural networks* [11], which use the rules of *fuzzy-set theory*. Between them there is a *map field*, which is a map of connections between inputs and targets. It is made during training and used for testing.

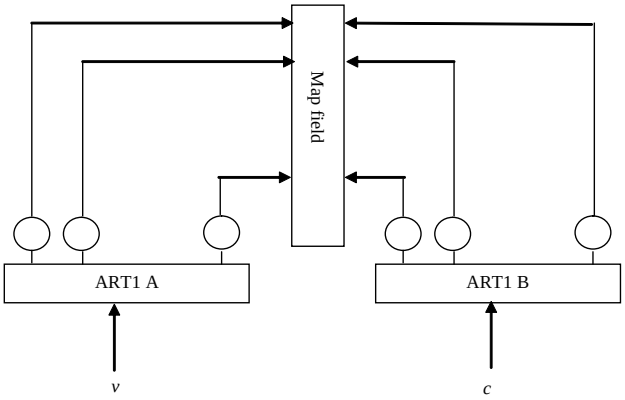

Figure 2: ARTMAP

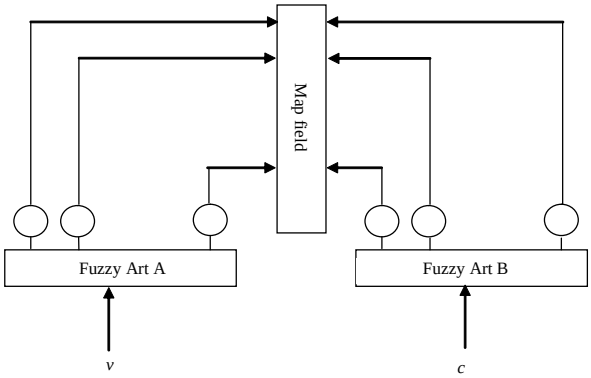

Figure 3: Fuzzy ARTMAP (FAM)

Fuzzy ARTMAP (Fig. 3) as an improvement of ARTMAP consists of two Fuzzy ART [12] networks instead of ART1 networks.

EXPERIMENTS

Testing of the application was done using the following steps:

- from the database of simulated inputs we took the desired type of inputs and number of inputs
- half of the inputs were used for training and the other half for testing
- testing was performed using different inputs than training in order to test the robustness of the classification.

Components of input vector were coefficients, which describe the contribution of individual lipoprotein subclasses for the construction of the lipoplasma. An example is the input vector V_{train}, which was built from components of the second and third column of Table 1.

Table 1: Relative contributions of lipoprotein subclasses spectra to the spectrum of lipoplasma [4]

Lipoprotein subclass	H (%)	MetS (%)
VLDL1	6.0	15.0
VLDL2	6.0	15.0
IDL	3.0	10.0
LDL1	20.0	5.0
LDL2	13.3	16.7
LDL3	6.7	8.3
HDL_{2b}	17.5	5.0
HDL_{2a}	17.5	5.0
HDL_{3a}	2.0	4.0
HDL_{3b}	4.0	8.0
HDL_{3c}	4.0	8.0

Classes from H to MetS are numerated from 1 to 5, so for the second column we get C_{train}=1 and for the third column we get C_{train}=5. The dimensions of the vector are 11.

RESULTS

Table 2 shows typical results of the classification of 100 measurements and 50 repetitions of the voting strategy. We show only 10 measurements as part of it.

Classification was very successful, because the smallest percentage was 94%. Label "Row" denotes the number of the measurement and "Pr. C1" to "Pr. C5" denote predicted classes from H to Mets.

Table 2: Results of classification of each measurement (row) in percent for 10 measurements:

	Pr.C1:	Pr.C2:	Pr.C3:	Pr.C4:	Pr.C5:
Row 1:	100.0%	0.0%	0.0%	0.0%	0.0%
Row 2:	0.0%	0.0%	**100.0%**	0.0%	0.0%
Row 3:	98.0%	2.0%	0.0%	0.0%	0.0%
Row 4:	0.0%	0.0%	0.0%	100.0%	0.0%
Row 5:	0.0%	0.0%	0.0%	0.0%	100.0%
Row 6:	98.0%	2.0%	0.0%	0.0%	0.0%
Row 7:	0.0%	0.0%	100.0	0.0%	0.0%
Row 8:	0.0%	0.0%	0.0%	100.0%	0.0%
Row 9:	0.0%	0.0%	0.0%	0.0%	100.0%
Row 10:	100.0%	0.0%	0.0%	0.0%	0.0%

Table 3 shows the content of the output file for 1250 measurements and 50 repetitions of the voting strategy. Input parameters are:

- vigbase – ρBASE
- vigb – ρb
- lra – βA
- lrb – βB
- alfa – α
- new parameter:
  - viga – ρa

The result is the classification accuracy of 94% which is a high accuracy.

Table 3: Results in output file

```
Input parameters:
vigbase     0.000000
vigb   0.999900
lra    0.100000
lrb    1.000000
alfa   0.001000

New parameter:
viga   0.937952

Results:
```

```
Correctly classified measurements:
94.0%
```

Table 4 shows the confusion matrix for the described example, from which we can observe the percentage rate of classification of real classes (Real C1 – Real C5) into predicted classes (Pr. C1 – Pr. C5). Note that the largest numbers should be on the diagonal.

In the described example this is true. Confusions occur only for neighbour classes, and that is interpreted as if classification is very good.

Table 4: Confusion matrix

	Pr. C1	Pr. C2	Pr. C3	Pr. C4	Pr. C5
Real C1	98,3%	1,7%	0,0%	0,0%	0,0%
Real C2	7,3%	91,9%	0,8%	0,0%	0,0%
Real C3	0,0%	0,0%	99,1%	0,9%	0,0%
Real C4	0,0%	0,0%	0,0%	92,1%	7,9%
Real C5	0,0%	0,0%	0,0%	0,0%	90,0%

Figure 4 shows a confusion matrix visualized by a 3D graph, where one axis represent real classes, another represent predicted classes and the altitude of 3D blocks represent percentage of each classification.

Figure 5 shows confusion matrix, represented with projection of altitude of blocks. Different altitudes are marked with different colours.

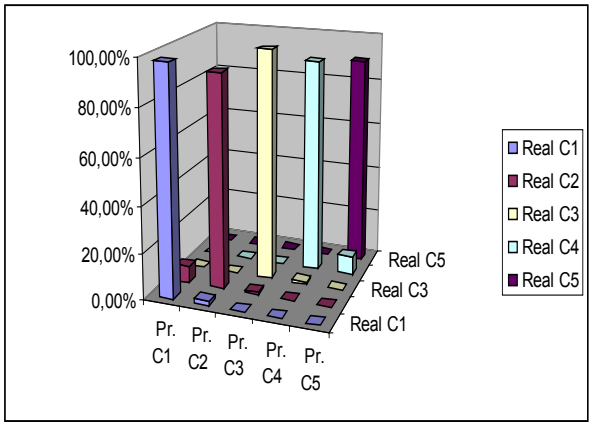

Figure 4: Confusion matrix, represented with 3D blocks

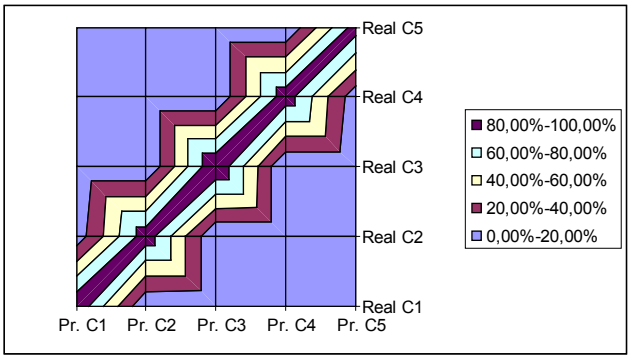

Figure 5: Confusion matrix, represented with projection of altitude of blocks

CONCLUSION

The study of this paper offers a great advantage in comparison with current clinical diagnostics for MetS. Current clinical diagnostics measures levels of HDL as a »good cholesterol carrier« and LDL as a »bad cholesterol carrier«. Our work deals with all 11 lipoprotein subclasses, which is much more precise according to the latest research in the field of metabonomics. This is possible with ^{1}H NMR spectroscopy with help of our programming tool, which will classify ^{1}H NMR serum spectra into 5 classes, from H to MetS. Our project is the first stage of complete NMR procedures for diagnostics of MetS and its progressions.

All the goals of this paper were achieved or even exceeded. As a goal we had the implementation of Fuzzy ARTMAP neural networks in the C/C++ programming language. However at the end we chose the standard ANSI C language. The advantage of such choice is that we can compile program code with any compiler for any operating system on any personal or even embedded computer, such as a DSP.

Our implementation in ANSI C has many advantages in comparison to the implementation in Matlab such as modularity, options of including into different programs, and in price, because some good development tools for C programming language are for free.

We improved our algorithm in comparison to basic Fuzzy ARTMAP, and now it can automatically choose the highest vigilance parameter, which makes sure that every measurement is classified into a known class.

Very important is the unique ability of the algorithm to tell the confidence value of the classified example. For this purpose the “Voting strategy” is used.

Results show that the developed programming tools are appropriate for this assignment. Proofs for this are the high values of classification accuracy and good confusion matrices.

The presented algorithm can be used for various domains.

For future work the real ^{1}H NMR spectra could be classified, which was not possible in the time of this study.

ACKNOWLEDGMENTS

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REFERENCES

1. MedicineNet, »Metabolic syndrome«, http://www.medicinenet.com/metabolic_syndrome/article.htm
2. American Heart Association, »Metabolic syndrome«, http://www.americanheart.org/presenter.jhtml?identifier=4756
3. Carpenter et al., » Fuzzy ARTMAP: A neural network architecture for incremental supervised learning of analog multidimensional maps«, IEEE Transactions on neural networks. 1992, 3, 698–713.
4. Brezmes et al., »A probabilistic approach to the assessment of metabolic syndrome using 1H NMR spectroscopy and Fuzzy ARTMAP neural network«, Euromar 2007.
5. International Diabetes Federation (IDF), »Worldwide Definition of the Metabolic Syndrome«, http://www.idf.org/webdata/docs/IDF_Meta_def_final.pdf
6. Golub et al., »Metabolni sindrom«, Medicinska fakulteta, Univerza v Mariboru, www.mf.uni-mb.si/slike/Gradivo/Fiziologija07/Metabolni%20sindrom.doc
7. Ala-Korpela et al., "Characterization and molecular detection of atherothrombosis by magnetic resonance—potential tools for individual risk assessment and diagnostics", Annals of Medicine, 2006; 38: 322-336.
8. Viles-Gonzalez et al., "Atherothrombosis: A widespread disease with unpredictable and life-threatening consequences", European Heart Journal 2004 25(14):1197-1207; doi:10.1016/j.ehj.2004.03.011.
9. Brezmes, J., »Doctoral disertation (span.): Diseño de una nariz electrónica para monitorizar el grado de maduración de la fruta«, Universitat Politecnica de Catalunya, Barcelona, 2001. Chap. 4, 69-120.
10. Carpenter et al., "ARTMAP: Supervised Real-Time Learning and Classification of Nonstationary Data by a Self-Organizing", Neural Networks, Vol. 4, pp. 565-588, 1991.
11. Carpenter et al., »A massively parallel architecture for a self-organizing neural pattern recognition machine«. Computer Vision, Graphics, and Image Processing, 37, 54-115. Reprinted in G. A. Carpenter & S. Grossberg (Eds.) (1991). Pattern recognition by self-organizing neural networks (Chap. 10). Cambridge, MA: MIT Press.
12. Carpenter et al., »Fuzzy ART: Fast Stable Learning and Categorization of Analog Patterns by an Adaptive Resonance System«, Neural Networks, Vol. 4, pp. 759-771, 1991.

Applying Technology Management concepts in analyzing e Waste, sustainability and technology development in Mobile Industry: A conceptual perspective

Lester Allan Lasrado
EMMi Lab.
Tampere Univ. of Technology (TUT)
www.tut.fi/emmi
+358 417016463
lester.lasrado@tut.fi

Subodh Agnihothri
EMMi Lab.
Tampere Univ. of Technology (TUT)
www.tut.fi/emmi
+358 447510012
Subodh.agnihothri@tut.fi

Artur Lugmayr
EMMi Lab.
Tampere Univ. of Technology (TUT)
www.tut.fi/emmi
+358 40 821 0558
lartur@acm.org

ABSTRACT
In the highly globalized, competitive and technocrat world, mobile industry is heavily focused on making itself sustainable. In order to achieve this focus should be on improving the e waste management in the industry. Currently the industry is advanced beyond market demand in delivery services to customers in terms of ICT and smart phones. This research paper is trying to conceptualize the aspect of technology management by comparing technology advancement of mobile phone technology and the lagging e WASTE management in the same industry. The paper further explores the importance of sustainability and its acceptance by the customers of the mobile technology. The reasons for this adoption lag among customers of mobile technology might be lack of awareness or just slow response. The paper reviews current literature and the author tries to conceptualize his thoughts in this paper.

Keywords
Adopters, reverse salient, ecosystem, e waste.

1. Introduction

Consumer electronics especially mobile phones have become increasingly popular and culturally important over the past several decades. The recent trends and pattern of updating hardware due to advancement of technology and customer demand thus creating large scale electronic waste is alarming. E-waste in mobile industry is a direct offshoot of neglect of both industry and consumer towards sustainability. E waste management is currently the largest growing waste stream that has been ignored for more than a decade as compared to rapid growth of technological evolution in the mobile phone technology. Neglect of e Waste management as contrary to huge advancement in smart phone technology are two contrasting aspects that have been explored in this paper.

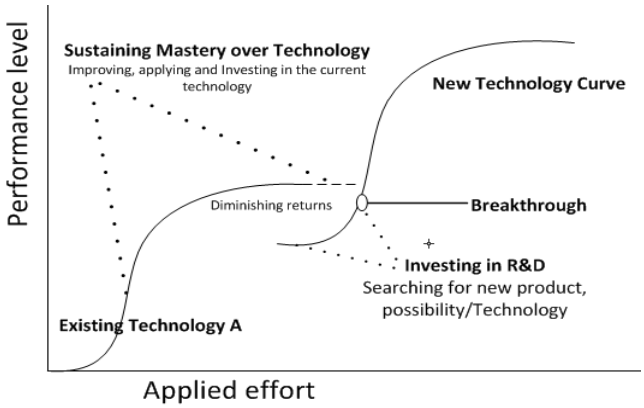

Figure.1. New technology evolution. [5].

2. E waste in Mobile Industry

The definition given in the Directive 2002/96/EC of the European Parliament and Council on waste electrical and electronic equipment (WEEE) [2] seems to be the most comprehensive and used. It states e-waste as "electrical or electronic equipment which is waste within the meaning of Article 1(a) of Directive 75/442/EEC, including all components, subassemblies and consumables which are part of the product at the time of discarding.

Used and old mobile phones are the most rapidly growing problem in the waste stream due to their quantity and toxicity. Mobile Phones have fast become one of life's most important communications tools. With new technological advances encouraging regular upgrades, mobile phones are rapidly becoming a major waste problem. The average useful design life of a mobile handset is around seven years, yet users in developed countries typically replace their phones about every 18 months driven by both the evolution of technology and the tendency of consumers to want a device with more applications [1]. The life cycle of mobile electronics products includes following steps: (i) Raw materials acquisition (ii) Manufacturing, (iii) Purchase and use, (iv) storage, and (v) End-of-life management.

The subsequent management and processing of e Waste involves procedures that have been adopted by only few nations across the

globe. Some developed nation shows their concern to look into that segment up to some extent. According to [3], e-waste from developed countries that is sent for recycling, 80 per cent ends up being shipped (often illegally) to developing countries such as China, India, Ghana and Nigeria for recycling. The waste destined for recycling is either burned, dumped or recycled using processes which involves polluting operations without taking concern for environment and sustainability [4]. Most of the recycling is done informally by poor and small social groups who involved into waste picking for income generation and survival, impact of which till date was ignored by the mobile industry.

But the recent developments in the industry has shifted the focus to the topic of sustainability, thus highlighting e Waste as one the major issue to be tackled within the industry. Sustainability is balancing environmental, social, and economic outcomes in order to endure, is being recast as a way to unleash innovation [6]. Mobile industry in the last couple of years has been improving their sustainability practices by changing products and processes with the help of their stakeholders and concerning elements. The correlation of this has been explained further using accepted management theories.

3. Technology management and S curve

Innovation is driven by need for performance improvement and the customer's willingness to pay (WTP) for this extra performance [7]. The advent of mobile phones can be one such example; Motorola was the largest manufacturer of cordless phones in the 90's, but the customer demand for communication tools surpassed the maturity of Cordless phones, which enabled the communications industry to come out with mobile phone technology. On the contrary technologies are not always given the opportunity to reach their limits—they may be rendered obsolete by new technologies [8].

Technologies often exhibit S-curve in their performance over a period of time. The S-curve is seen when the performance parameters like speed, capacity, accuracy, cost and many others are plotted against effort or time. The shape typically shows initial growth followed by steep accelerated increase and then diminishing improvement [8]. Thus, it is very important to evaluate the Technology S-curve along with the demand curve so as to know if the customer is willing to pay for the added extra performance. There is also a need to know the demand Curve so to predict when the technology might mature in the minds of customer and be ready with a new technology or product to suit the growing demand needs.

When an existing technology gets disrupted by adopting a new technology, there arises a concept of diffusion of technology with its ambient and this will be discussed in this Section. As shown in Figure 1 disruptions occur when the new technology achieves the performance level greater than that of the existing technology; then there is a breakthrough. Now this breakthrough technology will either cause disruption in other technologies in its ambient or has to diffuse with the existing setup; in most cases it will have to diffuse in the existing set up or process [5].

This similar pattern is seen with mobile technology wherein the pace of technology evolution is rapid and so is the diffusion of technology. The diffusion can also be shown as an S-shaped; the shape shows few adopters or accepters of technology initially, but adoption level increases slowly and approaches maximum [9]. Furthermore diffusion is the gradual adoption of an innovation, concept or new technology in a market segment or society. The same concept will be used further to explore the correlation sustainability adoption, e waste and mobile technology evolution.

4. Evolution of Mobile Phone as technology

The cell phone is one of the most rapidly growing new technologies in the world. In 2001, cell phone subscriptions were less than a billion worldwide with the majority of the cell Phone user were from the developed countries. At the end of 2010, however, cell phone number had reached five billion worldwide with subscriptions from developing countries out numbering that of the developed countries [11]. Mobile devices have become the most ubiquitous consumer electronic devices ever invented. The rate of Technological growth surpassed any other growth in this decade. Every year hundreds of new models with new and advanced features are launched by different companies. Even in the poorest of the nations, mobile phones have evolved from being a luxury to an in dispensable necessity. Figure 2 shows the evolution of mobile phone with respect to time. The rapid growth shows the technological advancement in mobile phone sector.

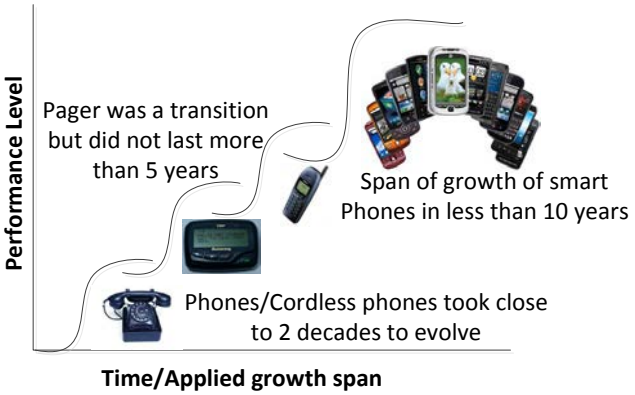

Figure.2. Evolution of Mobile phone with time.

Mobile phones, especially smartphones have become our inseparable companions today. New companies are bringing new set of technology to attract people around them. The recent trends show that the life cycle of mobile phones are decreasing at alarming rate and there arises the question of sustainability of this industry.

5. Process Sustainability in Mobile Industry

Using the theory explained in previous chapter and with help of other concepts of "reverse salient" and "era of dominant design", the concept of sustainability in mobile phone industry has been probed and conceptualized in the paper. According to [12] the mobile phone industry is facing a huge challenge with respect to achieving sustainability and e waste management. The main challenges are implementing e waste management as a company responsibility and educating the customer on sustainability. There is also a need for efficiently using existing ICT and smart phone technology to promote sustainability among users [12]. The report states that the EU has regulations in place to ensure take back and recycling of mobiles and companies are working on developing a sustainable supply chain to ensure collection of these mobiles.

Mobile industry has grown with respect to technology and features, but the waste management technology development

currently in place is lagging behind the requirement of the society. This has been illustrated in Figure 3, wherein core aspects of management and technical aspects with recycling has reached threshold limit and there is demand for new technology to replace the current scenario.

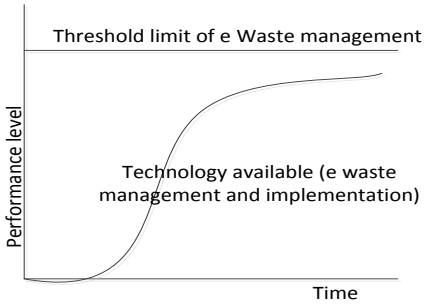

Figure 3. Technology limit with e waste management.

Furthermore compared to e waste technology and management, the mobile technology has surpassed customer demand. The ICT application and mobile technology has successfully satisfied customer needs. As illustrated in Figure 4, the customer's willingness to pay is much smaller than the value provided by the smart phone technology itself. Hence sophisticated features of smart phone should be used to promote sustainability among users.

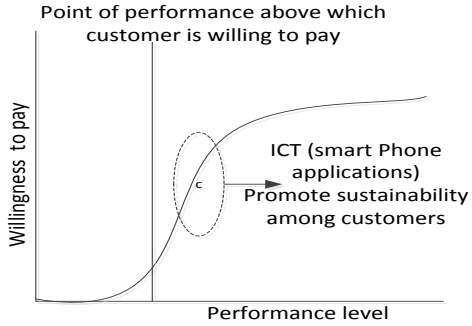

Figure 4. Willingness to pay for sustainable solution.

The above discussion reiterates the fact that "ICT and mobile phone technology has surpassed market demand, but the recycling and sustainability aspect among users and companies is lagging behind by a huge margin".

6. Impact of Society on sustainable approach

The last chapter discussed on comparison between mobile phone technology and recycling aspect in the industry. Continuing this discussion, we look into societies and cultural aspect in this chapter. In Figure 5, the left hand side illustrates customer/user of the mobile phones. The willingness of the customer to pay and the technology demand is different in Africa and in Europe. There are number of reasons of this difference, few being (i) money (ii) education (iii) mindset to sustainability and priorities in life. The cost incurred for a sustainable product and increased features on a smart phone/ICT will cost the customer more. The customer in different societies will react differently to these aspects. Furthermore the level of education about pollution caused and acceptable norms would vary, hence creating a huge challenge for companies to satisfy the criteria.

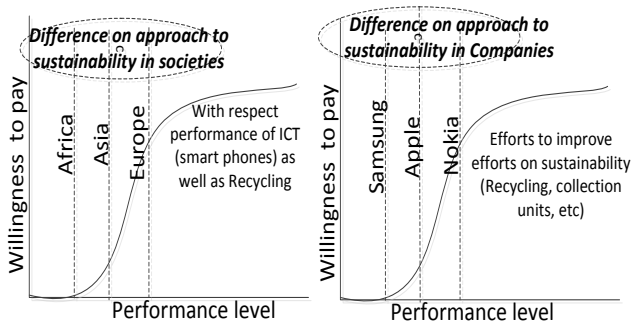

Figure 5. Adoption across companies, customers and societies.

The right side of Figure 5 illustrates approach of companies and their policy towards profit and sustainability. According to [11], Nokia leads the Telecom sector in sustainability approach, especially with respect to product design, green supply chain and efforts to recycle and re use. The approach varies between companies, if they adopt stockholder or stakeholder ethics in management. European companies are ahead in sustainability as compared to their American or Asian counterparts and the comparison has been clearly illustrated.

7. Ecosystem Analysis & reverse salience

According to Institute of Manufacturing at Cambride (2010) , disruption happens when a new product or innovation arrives in the market that offers better perofmance on know measured parameters or along a new dimension. Furthermore we try to analyze sustainability of mobile industry as shown in Figure 6. The mobile industry grew and smart phones are dominating over regular mobile and pager industry in today's world. The different eras of growth and development are shown in the figure. What would be the next technical marvel that would replace current smart phones and ICT would be a question to answer. The purpose of Figure 6 was to explain how mobile technology has grown and smart phone/ICT has dominated the current market as a technology.

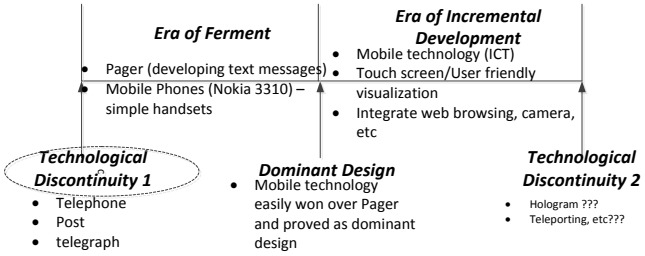

Figure 6. Mobile phone industry growth cycle.

Now using the similar approach we try to understand the sustainability in the mobile industry. As illustrated in Figure 7, the technology and management related to recycling are still in era ferment and being developed. The adopters among the companies are increasing and even societies are accepting sustainable approach to recycling. Web 2.0 and ICT touch screen has proved itself to be the dominant technology currently and should be used to promote sustainable lifestyle among users.

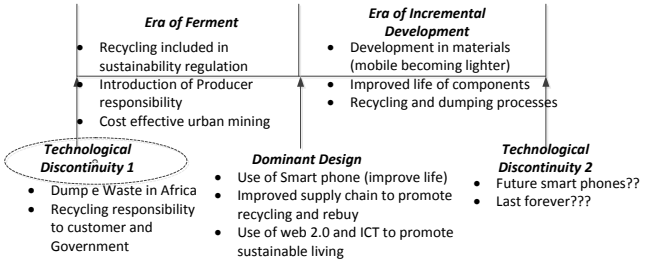

Figure 7. Sustainability and mobile phone growth cycle.

The smart phone applications and ICT combined with crowdsourcing is dominating the effort of promoting sustainability among users. The development of lighter phones, less toxic materials and dumping processes are in the era of incremental development. The next technological discontinuity would be cell phones that last forever and superior management methods of collecting e Waste and disposal mechanisms.

From the discussions in the paper there is a consensus that mobile industry has a goal of sustainability for themselves and the users. To achieve this goal, the concept has been visualized a system in itself and an effort is made to identify the reverse salient features as illustrated in Figure 8. The combination of existing ICT, mobile technology, materials, management, supply chain, policy and customer knowledge is necessary to achieve the system goal of a sustainable mobile industry.

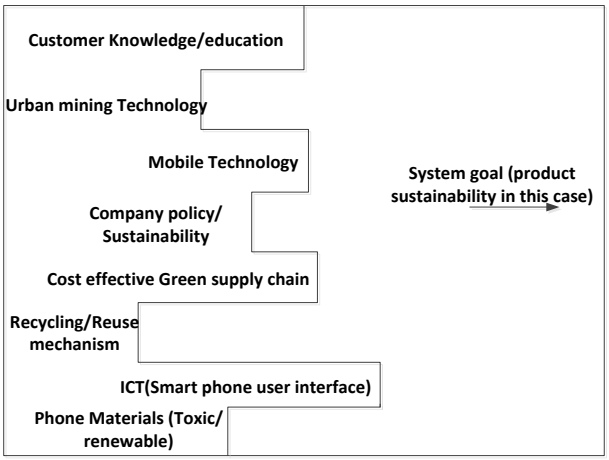

Figure 8. Reverse salient analysis to achieve sustainability.

As shown in the figure, ICT (smart phone interface) and mobile technology is leading the system. The supply chain and distribution has been optimized to a higher degree as compared to recycling and reuse/take back mechanism. The education of users to be sustainable has been improved steadily using the smart phone interface and mobile technology. To achieve complete sustainability a lot of work has been done to push producer responsibility in policy making and investments in urban mining and toxic material disposal. This combines the discussion of sustainability, mobile technology and concepts of technology management.

8. CONCLUSIONS

In the recent years of globalization high end technology evolved rapidly which gave end user lots of choices and selection options in terms of mobile phones and electronics devices. In mobile sector there is huge transformation from low end phones to high end advanced phones, these rapid transformations created a serious and unnoticed threat, which is expanding at same rate as technology.

Furthermore, from all the above discussion on sustainability promotion and adoption, it can be deduced that the customer has adopted the technology of mobile phone and ICT very well. There is a large base of adopters for smart phones and its applications. But the adoption of sustainability is still in its initial phase among customers and this idea has been illustrated in Figure 9 below. The adoption of the concept of sustainability and efforts for promotion among customers is gaining momentum among companies and this phase has crossed the chasm phase, thus ensuring that this would be the trend going forward. Figure 9 gives a clear illustration of the idea presented in this paper.

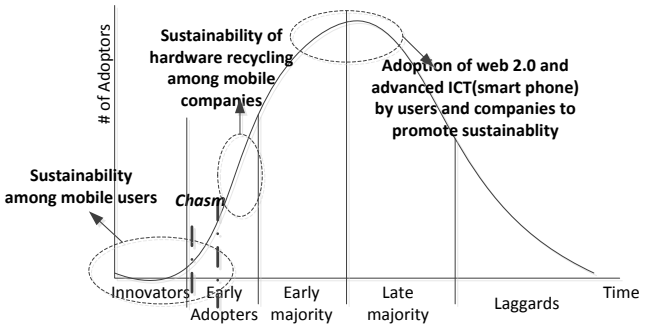

Figure 9. Adoption of sustainability- customers, companies and technology.

Therefore in order to achieve the ultimate goal of sustainability and achieve high adoption rate, a lot of improvement needs to be done with respect to green supply chain and urban mining/recycling technology. The management and ethics of sustainability needs to be also worked upon and strong efforts are to be made to improve promotion of sustainable living among the customers as well.

REFERENCES

[1] GSM Association. 2006. Mobile Phone Lifecycles Use, Take-back, Reuse and Recycle. http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/environmobilelifecycles.pdf (Retrieved on 11th May 2013)

[2] Official Journal of the European Union. 2003. EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 January 2003 on waste electrical and electronic equipment (WEEE). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:037:0024:0038:en:PDF (retrieved on 11th May 2013)

[3] Lundgren. K. 2012. The global impact of e-waste: Addressing the challenge. International Labour Organization, Geneva Publication.

[4] Wilson, D.C.; Velis, C.; Cheeseman, C. 2006. “Role of informal sector recycling in waste management in developing countries”, in Habitat International, Vol. 30, No. 4, pp. 797–808.

[5] Christensen, C M .1997. the Innovator's Dilemma-When New Technologies Cause Great Firms to Fail, Harvard Business School Press, pp.3-22, http://www.businessweek.com/Section/christensen.htm (Retrieved 15th March 2012)

[6] Nidumolu, R., Prahalad, C.K. and Rangaswami, M.R. 2009. “Why sustainability is now the key driver of innovation”, Harvard Business Review, September.

[7] Ron Adner. 2004. a demand-based perspective on technology life cycles, in Joel A.C. Baum and Anita M. McGahan (ed.) Business strategy over the Industry Lifecycle (Advances in Strategic Management, Volume 21), Emerald Group Publishing Limited, pp.25-43.

[8] Schilling. M A & Esmundo, M .2009. Technology S-curves in renewable energy alternatives: Analysis and implications for indust and government, Energy Policy 37,pp.1767–1781 http://pages.stern. nyu.edu /~mschilli/JEPO%20Technology%20S%20Curves%20Final. (Retrieved on 13th March 2012)

[9] Ortt, J &. Schoormans, P L. 2004. The pattern of development And diffusion of breakthrough communication technologies, Volume 7, pp. 292- 298.

[10] Press Release, 2010. International Telecommunication Union. Barcelona. http://www.itu.int/newsroom/press_releases/2010/06.html (retrieved on 11th may 2013)

[11] Greenpeace (2013), Guide to green electronics, http://www.greenpeace.org/international/ en/campaigns/climate-change/cool-it/Campaign analysis/Guide-to-Greener-Electronics/

[12] Tanskanen, P (2012). Electronics Waste: Recycling of Mobile Phones, Post-Consumer Waste Recycling and Optimal Production, Prof. Enri Damanhuri (Ed.), ISBN: 978-953-51-0632-6, InTech, Available from: http://www.intechopen.com/books/post-consumer-waste-recycling-and-optimal-production/electronics-asterecycling-of-mobile-phones

Designing for Interpersonal Persuasion on a Massive Urban Scale: Bringing the Future of the Cities Back to Their Citizens

Felix Köbler
BahnScout
Raiffeisenstr. 6, 85567 Grafing
f.koebler@bahnscout.de

Petromil Petkov
Technische Universität München
Boltzmannstr. 3 85748 Garching
petromil.petkov@gmail.com

Alexander Braun
BahnScout
Raiffeisenstr. 6, 85567 Grafing
a.braun@bahnscout.de

Suparna Goswami
Technische Universität München
Boltzmannstr. 3 85748 Garching
suparna.goswami@in.tum.de

ABSTRACT
On May, 9th 2013, the concentration of CO_2 particles in the atmosphere reached 400 parts per million for the first time since its measurements began [1]. Reaching this psychological threshold marks the latest alarming trend of the negative human impact on the environment.

Climate change is only one of several major challenges that humanity faces. Policy makers and social entrepreneurs aware of these challenges and opportunities have gradually increased their efforts to address these problems, unfortunately without a measurable impact on a global scale. Policies attempting to address the challenges predominantly focus on institutions and organizations. However, many of these problems are a direct result of human actions, and therefore call for human behavioral change to overcome such challenges.

Previous research in the area of persuasive design indicates that a certain behavior is usually a result of the corresponding attitude towards the behavior. Therefore, there is a need to promote the right attitudes towards "proper" behaviors among people. Such attitudes can be influenced by providing people with the relevant information that enhances their awareness regarding the consequences of their actions, and ways of overcoming or reducing such consequences.

Interaction designers and human-computer interaction (HCI) researchers adopted this bottom-up approach of designing interfaces and intervention mechanisms that focus on bringing about individual behavior changes. Through carefully designed persuasive applications and products they attempted to motivate users and consumers to change their behavior in various aspects (energy consumption, transportation choices, purchasing decisions to name a few). In this regard, users are mere "consumers" of the design, which helps them make personal choices.

This position paper builds on the described bottom-up approach, but does not see the users only as consumers but also as activists, who can help the designers in their effort to induce wide-scale behavior change to more sustainable lifestyle. The goal of this research proposal is to empower users with the means to persuade their peers. Furthermore, the research proposes that persuasion on a massive scale requires specific efforts to design persuasive feedback that caters to various motivations and makes efficient use of the communication channels as well as novel ubiquitous and mobile technologies, to which users have access now.

The paper first provides a look on authors' previous research in the area of persuasive design. In particular, we present a persuasive energy monitor application – *EnergyWiz*, a system for civic engagement – *BahnScout*, and a theoretical framework for designing persuasive feedback for differently motivated individuals.

Thereafter, we review a body of existing research on persuasion on a massive scale and, based on the research gaps, suggest approaches that would lead to rapid and persistent behavior change among people. Finally, we critically analyze the described approaches and outline several research gaps and directions that can advance future research in the area.

PREVIOUS WORK
In the following section, we report on our findings and experiences in three research projects that rely on basic principles of persuasive design for changing individual behaviors. In our research, we focused on the use of various persuasion and influence mechanisms such as providing users with the relevant information that can result in behavior change (informational influence), providing users with information regarding the behaviors and activities of their social peers (social influence).

EnergyWiz: Personalized Eco-Feedback as a Design Technique for Motivating Energy Saving Behavior at Home

While the energy monitors available on the market deliver real-time energy usage feedback to the consumer, the format of this data is usually unengaging and mundane. Moreover, it fails to address consumers with different motivations and needs to save and compare energy. Our research presents a study that seeks to provide initial indications for motivation-specific design of energy-related feedback [9, 10]. We thereby focused on *comparative feedback* supported by a community of energy consumers. In particular, we examined eco-visualizations, temporal self-comparison, norm comparison, one-on-one comparison and ranking, whereby the last three allow us to explore the potential of socializing energy-related feedback. These feedback types were integrated in *EnergyWiz* – a mobile application that enables users to compare with their past performance, neighbors, social peers on social networking sites and other *EnergyWiz* users. The application was evaluated in personal, semi-structured interviews, which provided first insights on how to design persuasive comparative feedback.

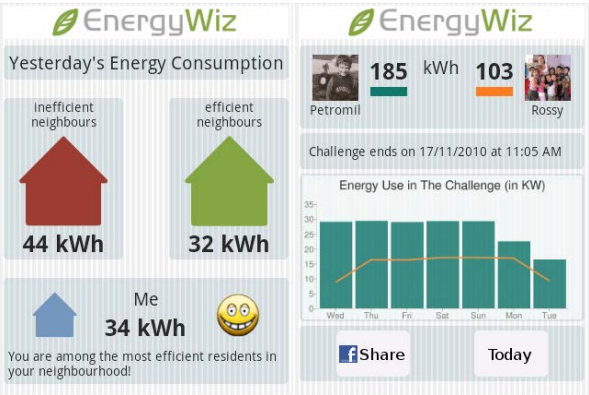

Figure 1: *EnergyWiz* social comparison features

During the interviews, we noticed several recurring ideas and preferences from users.

First, choosing relevant people for comparison mattered most to the *EnergyWiz* users. More specifically, people preferred comparing to their friends than to anonymous neighbors. However, they expressed doubt that comparison between friends is always "fair" having in mind the various lifestyles and contexts, in which they consume energy. This statement has been described in psychology as the Proxy Model. It states that relative attributes gain importance for the user's anticipation of success when the effort on the previous tasks is ambiguous or unknown [14]. Since energy saving is not wide-spread yet, users probably find it challenging to seek friends who share common past achievements. Therefore, they would turn to comparing with similar others to evaluate their abilities. Due to the various factors, which influence energy consumption, persuasive applications should at best provide benchmarking with similar friends to combine both similar past experience and relevant attributes. When this is impossible, the similarity of the comparison subjects should be effectively communicated.

Second, we found that *EnergyWiz* does not support peer learning very well. In interviews with experts, it became clear that "the last mile" to energy saving, i.e., personalized hints on how to conserve energy is missing. Therefore, in order to support the users in learning from each other, persuasive applications should better facilitate communication between them.

Third, the tight integration with Facebook prevented people, who do not use the social network, to benefit from all of the application's features. To avoid this phenomenon, a multi-platform support should be provided.

BahnScout: Persuasive Techniques for Crowdsourcing Civic Engagement – Nuisance Reporting in Public Transportation

In this study, we attempted to examine whether a mobile application can be utilized to crowdsource nuisance reporting in public transportation infrastructures and therefore focused on studying effects of *persuasive techniques* and *gamification* on users' behavior and long-term motivation to use the application. Following a design science research approach, we developed and evaluated a mobile application (*BahnScout*) in a longitudinal closed field test conducted in a large German metropolitan area focusing on nuisance reporting in train stations with approximately 60 active users over a period of 13 months.

Figure 2: *BahnScout* gamification elements: ranking (left) and badges (right)

We applied an iterative participatory and user-centered design approach to not only optimize for usability and user interface aspects of the application, e.g., in order to minimize the average time to create a report, but also to adjust applied gamification concepts such as a points-based system, levels, rankings and logic of badges.

In parallel, we executed a rigor requirements elicitation that included document analysis as well as shadowing of, and interviews with experts and employees of the transportation authorities. Our findings suggest that persuasive techniques and gamification elements such as badges and rankings positively impact users' motivation and frequency of use and potentially minimize duplicates and spam in total reports.

Analysis of collected questionnaire data revealed that approximately 40% of participants expressed fun in collecting points and badges as well as reaching new levels and considered gamification as a highly engaging mechanism that encourages reporting behavior. We were able to also confirm these findings through the analysis of user logs.

In a second step, the application was evaluated in a field test involving 60 participants followed by expert interviews, an online survey and a focus group. The median time to create a report was less than one minute, which indicates an efficiently designed reporting workflow. The experiences collected during the closed beta test showed the suitability of a mobile application for reporting nuisances in public transportation infrastructures.

However, the findings and implication of this study have to be considered in view of its limitations. This research focused on reporting nuisances in train stations. Issues related to trains, buses or the subway were not considered. To extend the scope of *BahnScout* to these vehicles and infrastructures, various technical challenges (e.g., position determination in the underground) need to be addressed. Another major limitation of this work is the (assumed) strong loyalty of the closed beta participants. Exposing the system to an open user group is an interesting further research direction. In addition, future studies could examine the effects of close integration with social networks for motivation purposes.

This study has several important implications. A mobile application for reporting nuisances offers a promising new channel for public transportation operators to gather instant data about the state of their infrastructure. Nuisance reporting can be designed as a crowdsourced process that can be enhanced through unobtrusive game elements that sustains user motivation and is considered fun by users. This study provides important initial evidence towards the suitability of gamification as a persuasive technique.

Personalized eco-feedback as a design technique for motivating energy saving behavior at home

In our research on *EnergyWiz*, we found that the majority of persuasive applications provide the same information to users irrespective of differences in their environmental concerns and different motivations to conserve energy. Furthermore design decisions in these applications are often taken intuitively, rather than being theoretically determined [4]. Furthermore, applications are often designed to provide the same feedback to different people [5] and therefore contradict theories such as the *Value-Belief-Norm theory* (VBN) [12], which suggests that individuals value different things depending on their environmental values.

As a consequence, individuals' motivations to behave in a more sustainable and environment-friendly manner will depend on the kind of environmental concerns they have. Therefore, the information used to persuade them to change their energy consumption behavior should be adjusted accordingly. However, we found that the current genre of applications for energy conservation is pre-dominantly based on the notion of resource management, i.e., the representation of energy consumption is in abstract units, such as kilowatt hours (kWh) without detailed explanation about the consequences of this consumption). These applications assume strong user motivation to save energy and a high level of expertise with regards to energy saving [13].

Our research therefore attempted to bridge the gap between environmental psychology and the design of persuasive applications in the context of energy saving [8]. Based on the VBN, we identified three different individual values – egoistic, altruistic, and biospheric. These values are used to determine the information (feedback) that is considered relevant by individuals, and should therefore be presented to them so that their beliefs about the threat for valued objects and the ability to reduce this threat are activated. Therefore, our approach was guided by the basic proposition: Feedback that is tailored towards an individual's motivation for pro-environmental behavior will be more effective in influencing energy conservation and persuasion of a user in general. Based on the above proposition, it is conjectured that users' preferences for energy consumption related feedback is presumably determined by their individual values. Since contextual factors such as social influence may have different meanings to different people depending on their beliefs and attitudes [12], a further goal of this research is to provide insights on how eco-feedback can be enhanced by incorporating information that captures social influence.

Our overall research design can be summarized as follows:

1. Theory-driven design of the mock-up screens containing eco-feedback tailored to specific environmental concerns, and one providing social norm-related feedback
2. Measuring users' environmental concerns (arising from different values) and susceptibility to social influence using validated scales (questions).
3. Getting users' feedbacks and preferences regarding the mock-up screens through an online survey.
4. Analyzing the survey data to refine design guidelines, and outline the implications of this research.

We assume that our approach to understand personalized eco-feedback as a design technique for motivating energy saving behavior at home can be transferred to other use scenarios and applied to optimize users' persuasion through application use.

THEORETICAL BACKGROUND

Persuasion is an important aspect of human interaction. Persuasive efforts attempt to influence our attitudes and behaviors with regards to diverse topics such as political beliefs, purchase decisions, lifestyle choices, environmental conservation, etc. While the role of media technology (e.g., advertisements through newspapers, journals, television) in delivering persuasive messages is a well-understood topic, there is growing recognition that information and communication technology can play an important role in facilitating interactive persuasion techniques. This group of technologies is referred to as *persuasive technologies*, i.e., technologies that are intentionally designed to change a person's attitude or behavior [6].

Although human beings are recognized as the strongest persuaders, since they have higher social presence and can sense the appropriate mood and context for persuading another person, they are also more intrusive towards privacy. In this respect, the advantages offered by technological interventions are manifold. They can be both persistent as well as non-intrusive at the same time. Further, they can rely on a wide range of information sources in order to design and deliver the appropriate, context- and temporally-specific persuasive messages. Finally, the growing popularity of ubiquitous and sensor technologies, and social media applications make it possible to design persuasive interventions that can be easily replicated and distributed, and address a large number of people at the same time.

There are various theories that explain the mechanism through which persuasion works. For example the *Elaboration Likelihood Model* [11] identified two mechanisms of persuasion: the central and peripheral route of persuasion. In the central route of persuasion, the receiver of the message attends more carefully to the message that is being received and compares it to his or her attitudinal position regarding the message and generate a number of cognitive responses to the message. In the peripheral route of persuasion, the user focuses on the attractiveness of the source of the message, and the context within which the message was presented. In terms of designing appropriate systems and products, these two routes of persuasion therefore directly bear upon identifying and providing relevant information to the user based on his values and beliefs, such that they appeal to him cognitively; and identifying appropriate social and contextual cues that can activate the peripheral route of persuasion.

Independent of the mechanism of persuasion, persuasive messages, especially those catered to change behavior with respect to a global problem, must have a massive reach. The proliferation of online social networks of various types, such as Facebook, Twitter, Pinterest, and Instagram, provide designers with the platforms to activate users rapidly and in an automated manner. Fogg outlines six components of technology-assisted mass interpersonal persuasion [3]:

- Persuasive experience
- Automated structure, which depends on the design of the underlying platform
- Social distribution, such as forwarding and sharing
- Rapid cycle of distribution and from information to action
- Huge social graph
- Impact that can be measured

Nowadays, each of the enlisted properties above can be seen in various online social networks, therefore designers can leverage these platforms to massively scale their persuasive reach.

The scale, as described above, can be seen as the level of reach of persuasive messages. However, the scale can also be defined in terms of the desired outcome. For instance, in sustainability context, one can argue that persuading users to live in an environment-friendly way may not be as effective as persuading them to build political movements that suggest and execute pro-environmental policies [2]. In this line of thought, not only the massive reach of the communication, but also the formulation of the goal of the persuasive design is of significant importance.

OUR VIEW

We strongly assume that systems/sub-systems and products/components designed and produced to target users' or consumers' behaviors by the application of persuasive techniques will increasingly play a significant role in various use scenarios such as transportation, purchasing and consumption related choices, energy-/environment-related behavior and influence in public policies to name but a few. Designers need to understand novel ways to empower their users to "activate" their networks in order to support a particular cause.

The three studies reported above provide us with some initial insights regarding the design and deployment of effective persuasion mechanisms. For instance, our findings from the three studies reported upfront highlight the importance of providing relevant information to users in bringing about behavior change. However, there is a need to be able to first identify what characterizes information as relevant or irrelevant from a user's perspective. This calls for drawing from appropriate knowledge bases and theoretical models from the domain of human psychology, and a more nuanced understanding of individuals' and groups' value systems.

Our study also highlighted the importance of social influence in the decision towards using systems targeting behavior change in the domain of environmental conservation. Current technological advances provide ample means of transmitting and amplifying social influences. Techniques such as gamification and social comparison are relatively easy to built in into such systems. However, it is more difficult to finetune the balance between users' inherent needs towards competition and comparison without overwhelming them. Therefore, designed systems should be able to adapt and learn according to past history and usage behavior. This will help in designing successful crowdsourcing systems.

Finally, the availability of huge amounts of information from various sources make it an attractive proposition to combine various forms of information to appropriately motivating users to both use the systems and also act as transmission mediums for their social networks and peer groups. This imposes significant challenges for designers, where not only do they have to meaningfully combine and filter the most relevant information to trigger some behavior, but they also have to do it in a manner that each user not only remains and acts as a user, but can be convinced to activate his or her network in order to propagate behavioral challenges. This also calls for analyzing the underlying structure of various social networks to identify the more centrally located nodes in the network, and also nodes with the farthest reach and bridging nodes.

In accordance with fellow scholars, we proclaim that designers and developers of such systems or products need to stop regarding the users as mere consumers of the design, but consider them as co-creators in the overall design of systems or products.

In the following, we identify several potential areas of future research to better understand the design of interpersonal persuasion in the context of applications/systems and products that are designed on a massive urban scale to promote sustainable lifestyles or enable citizens to positively impact their environments.

Identification and empowerment of users to foster persuasion within their networks of reach

Emerging from network and graph theory, social network analysis has gained significant interest among researchers from different areas such as economics, organizational studies and computer science, to better understand the formation and structure of online social networks in recent years. We propose to apply documented metrics, modeling methods and algorithms to understand, segment and visualize online social networks to, e.g., identify core users in a certain network in order to control and optimize dispersion of persuasion. Research approaches could further focus on the design of concepts and methods for effective and rapid inclusion of 'supporters' with the network of reach, e.g., to determine matching individuals for comparative feedback functionalities.

Data-driven design of adaptive gamification concepts and persuasive techniques

As previously mentioned, we discovered that continuous adjustment and orchestration of gamification concepts such as a points-based system, levels, rankings and logic of badges in the application *BahnScout* is crucial for the effectiveness of applied concepts and the overall success of such applications. Our current approach is based on a data-driven deduction of design principles and patterns to finetune the interaction of various concepts implemented in *BahnScout* and the users' inherent needs. Prospective research approaches could therefore focus on data-driven design of gamification and persuasive techniques to provide a responsive user experience.

Application of participatory design to optimize gamification concepts and persuasive techniques

In addition to above stated quantitative approaches, research to understand and optimize the interplay of gamification concepts and persuasive techniques applied in a single system or product could further benefit from the application of participatory design to actively involve users and consumers.

Derivation of personas through 'persuasion profiling'

Prospective research on interpersonal persuasion in large-scale systems could focus on the derivation of personas through 'persuasion profiling' since we found that the majority of persuasive applications provide the same information to users irrespective of differences in their motivations and attitudes. For examples, personas could be a promising approach to further optimize the application of personalized eco-feedback as a design technique for motivating energy saving.

Kaptein and Eckles suggest creating *persuasion profiles* that are collections of "expected effects of different influence strategies for a specific individual" to build "persuasive systems that adapt to their users' susceptibility to individual strategies" [7]. However, literature lacks to document methods and their application to deduce such personas and apply them in the design of applications or products.

Analysis and application of 'hybrid persuasion' to align online and offline experiences

For several years, marketing researchers have attempted to understand and optimize the interplay between offline and online marketing campaigns and activities.

Parallel to these approaches, we propose that future research should focus on 'hybrid persuasion' to better understand, align and optimize online and offline persuasion and user experiences.

Building trust in the pre-persuasion phase

Various research approaches in the field of Information Systems and HCI research are dedicated to comprehend the formation of trust in virtual communities and online social networks. These studies could serve as starting points to better understand the socio-psychological concept 'trust' in interpersonal persuasion. Since we found that the length of a user's attention span during interaction with application such as *BahnScout* is highly limited, research should focus on the role and formation of trust in the 'pre-persuasion phase'.

PROSPECTIVE RESEARCH QUESTIONS

In a next step, we derive various prospective research questions based on above stated considerations:

- What are methods and concepts to foster, direct and control interpersonal persuasion on a massive urban scale (with respect to promoting sustainable lifestyles)?
- How can (opinion leaders/power) users be identified and activated to co-create persuasive experiences?
- What are methods and concepts to provide data-driven design to facilitate responsive user experiences and optimize applied persuasive techniques in large-scale systems?
- How can online and offline persuasion be aligned to optimize persuasion and to facilitate 'hybrid persuasion' experiences?
- What is the role of 'trust' in interpersonal persuasion on a massive urban scale?

CONCLUSION

To conclude the underlying position paper, we advise designers and developers of systems or products that pursue interpersonal persuasion on a massive scale, to stop regarding the users as mere consumers of the design, but consider them as co-creators in the overall design of systems or products. Furthermore, we propose that persuasion on a massive scale requires specific efforts to design persuasive experience that caters to various motivations and makes efficient use of the communication channels as well as novel ubiquitous and mobile technologies, to which users have access now.

Therefore we promote several prospective research areas and directions that focus on the empowerment of users with means to persuade their peers.

REFERENCES

1. Climate Central. Available at http://www.climatecentral.org/news/carbon-dioxide-passes-400ppm-milestone-for-first-time-in-modern-human-history-noaa-says-15975 Accessed on June 18, 2013.
2. Dourish P. HCI and Environmental Sustainability: The Politics of Design and the Design of Politics. In Proc. DIS 2010.
3. Fogg BJ. Mass Interpersonal Persuasion: An Early View of a New Phenomenon. In Proc. Persuasive 2008.
4. Froehlich, J., Findlater, L. and Landay, J. The Design of Eco-Feedback Technology. In Proc. CHI 2010, ACM Press (2010).
5. He, H. A., Greenberg, S. and Huang, E. M. One size does not fit all: Applying the Transtheoretical Model to Energy Feedback Technology Design. In Proc. CHI 2010, ACM Press (2010).
6. IJsselsteijn, W., Kort, Y. de, Midden, C. J. H., Eggen, B., and Hoven, E. van den. Persuasive technology for human well-being: Setting the scene. In W. IJsselsteijn, Y. de Kort, C. J. H. Midden, B. Eggen, & E. van den Hoven (Eds.), Persuasive technology (Vol. 3962, pp. 1-5). Springer, 2006.
7. Kaptein, M. and Eckles, D. Selecting effective means to any end: Futures and ethics of persuasion profiling. In T. Ploug, P. Hasle, & H. Oinas-Kukkonen (Eds.), Persuasive technology (pp. 82-93). Springer, 2010.
8. Petkov, P., Goswami, S., Köbler, F. and Krcmar, H. Personalised Eco-Feedback as A Design Technique for Motivating Energy Saving Behaviour at Home. In Proc. NordiCHI 2012.
9. Petkov, P., Köbler, F., Foth, M. and Krcmar, H. Engaging energy saving through motivation-specific social comparison. In Proc. C&T 2011.
10. Petkov, P., Köbler, F., Foth, M., Medland, R. C. and Krcmar, H. Engaging energy saving through motivation-specific social comparison. In Proc. CHI 2011.
11. Petty, R.E. and Cacioppo, J.T. The Elaboration Likelihood Model of Persuasion. Journal of Consumer Affairs, 1986.
12. Stern P. Toward a Coherent Theory of Environmentally Significant Behavior. Journal of Social Issues, 56, 3, 407-424, 2000.
13. Strengers, Y. Designing eco-feedback systems for everyday life. In Proc. CHI 2011.
14. Wheeler, L., Martin, R. and Suls, J. The proxy social comparison model for self-assessment of ability. Personality and Social Psychology Review 1, 1, 54-61, 1997.

Ambient visualization of energy consumption information

Jože Guna
University of Ljubljana,
Faculty of Electrical Engineering
joze.guna@fe.uni-lj.si

Matevž Pogačnik
University of Ljubljana,
Faculty of Electrical Engineering
matevz.pogacnik@fe.uni-lj.si

ABSTRACT
We present the *eAMBI*, an unobtrusive ambient visual interface for displaying the current electrical energy consumption information in real time. The system consists of a smart IP enabled electrical energy meter, a RaspberryPi embedded computer, a controllable colour led strip display and software components. Energy consumption data is stored on a service provider's smartgrid data server. This information is conveyed to the users by using various colour patterns in a subtle, yet informative way. A dynamic VU-meter like ambient lighting visualization was selected. The system is installed in a typical home environment and allows the users to perceive their energy consumption in real-time in an unobtrusive way and thus help them change their behaviour and possibly habits.

Keywords
Energy monitoring; in-home display; ambient; HCI

INTRODUCTION
Efficient methods of energy and resource management present an important and growing research field, often combining technical – energy data gathering and analysis, alternative energy production, as well as non-technical aspects, such as sustainable design, social behavior governing the energy consumption and cultural background. However, as stated in [1], effective energy reduction strategies will require not only efficient buildings but also approaches that help occupants modify their social energy use behaviors. Energy consumption can be significantly reduced by simply changing how occupants inhabit and use buildings, with little or no additional costs. The authors propose an emerging measure of grid energy capacity - the *negawatt*: a unit of power saved by either increasing efficiency or reducing consumption. Simply put, the cheapest watt is the one that's never created.

To increase the awareness of responsible energy use the visualization methods clearly play an important role in enabling the residents to understand and manage their behavior. One way of providing the energy consumption feedback is by using the In-home Displays (IHD). There are multiple ways of visualizing the energy consumption related information, from very precise and data packed display interfaces to more subtle ambient and implicit interfaces. As shown in [2], the direct informational feedback provided through various IHDs can have an important impact on user behavior and consequently on energy consumption and costs. Thus a once opaque and static energy (electric) bill turns into a transparent, dynamic, and controllable process. The authors show by analyzing the results of extensive studies done worldwide that the direct feedback provided by IHDs does indeed encourage consumers to make more efficient use of energy. The electricity consumption was reduced by 7 percent on average when a prepayment of electricity was not involved and twice that amount with a prepayment system.

Of course, the sheer amount and diversity of energy consumption related data presents a problem and an opportunity for HCI related research as well. In [3] the authors explore common misconceptions of energy usage in the home, establish the potential of feedback to change energy consumption behavior, and introduce ten design dimensions of feedback technology with which to build and evaluate such systems, specifically: frequency of updates, measurement units, data granularity, push/pull concept, presentation medium, location, visual design, action recommending, data comparisons and social aspects. Among these, lightweight ambient-like displays are discussed with positive impact, as although they provide less information, they also require much less attention than traditional information rich displays.

With this in mind, we present an intuitive and information wise lightweight ambient interface -*eAmbi*- for visualizing electrical energy consumption in real time. The information is conveyed by using various colours and patterns in a subtle, yet informative way.

The rest of the paper is organized as follows: related work is presented in section 2; a description of the proposed electrical energy consumption ambient rendering system is described in section 3; results are presented in section 4; while discussion, key conclusions and future work references are drawn in sections 5 and 6 respectively.

RELATED WORK
An extensive overview of energy-related work within HCI as well as from literature outside of HCI is given in [4]. The authors identify a central cluster of works focused on electricity consumption feedback (ECF) while considering the experiential, behavioral, social, and cultural aspects of these emerging systems. Based on review of 51 papers related to "energy" from HCI-oriented venues, the authors conclude that more than 70% of works focus on electricity consumption feedback research. Main topics discovered are: lack of engagement with emerging energy systems, energy awareness and conservation behavior and

consumption feedback. The last topic is traditionally conveyed by using various displays and interfaces, where ambient displays utilizing lighting other than pixel-based displays are specifically mentioned.

In [5] the authors explore the use of ambient and artistic visualizations for providing feedback on residential electrical energy consumption. Three different visual abstract visualizations are presented while considering four design requirements, namely pragmatic, aesthetic, ambient, and ecological. The findings of the user study suggest that this approach is a viable way to provide resource use feedback and that both the aesthetics of the representation and the context of use are important elements that must be considered in this design space.

An interesting design, named "Watt-Lite", to increase the increase awareness of electricity consumption is presented in [6]. The Watt-Lite concept, consisting of a set of three oversized torches projecting real time energy statistics of a factory in the physical environment of its employees, is meant to explore ways of representing, understanding and interacting with electricity in industrial workspaces.

In [7] the authors present the 'Power-Aware Cord', a re-design of a common electrical power strip that displays the amount of energy passing through it at any given moment. This is done by dynamic glowing patterns produced by electroluminescent wires molded into the transparent electrical cord. Initial user testing has proven the Power-Aware Cord to be a very intuitive and intriguing tool with an overall positive response from the test subjects; however the actual usage remains to be seen.

Finally, social aspects can be a powerful motivator for reducing the domestic energy consumption, as shown in a study [8]. The authors explore the impact of integration of the Wattson energy monitor with Facebook, allowing users to compare domestic energy consumption. The results of the user study encompassing eight homes over an eighteen day period show a positive impact of social interactions on energy consumption. Two scenarios were observed, one with access to only participants' personal energy data, and the second with access to all participants' data in order to make comparisons. A significant reduction in energy was observed in the socially enabled condition whilst providing a more enjoyable user experience.

AMBIENT ENERGY CONSUMPTION DATA RENDERING SYSTEM

Considering the importance of energy/electricity related consumption feedback we decided to build a system that would convey this information in a simple, lightweight, yet informative and intuitive way to the user in real-time as part of the ambient environment itself. The *eAMBI* system was built using a linear fully controllable colour led-strip visual interface for visualization.

Electrical energy metering

A CurrentCost EnviR electrical energy metering device [9] has been used to measure and transmit current electrical energy consumption and ambient temperature information to the central smartgrid data server. Data is measured by using current clamps on the main power conduit and transmitted every five minutes by using the IP bridge to the server in Internet. Over time, several parameters can be calculated, such as: consumption over time, maximum, minimum and average consumption and costs related. The installed control unit is shown in Figure 1.

Figure 1: CurrentCost electrical energy meter control unit

Real time and historic data is available for preview and analysis on the service provider's web page. The interface is informative and quite intuitive, but requires a computer for access. Typical layout of the dashboard is shown in Figure 2.

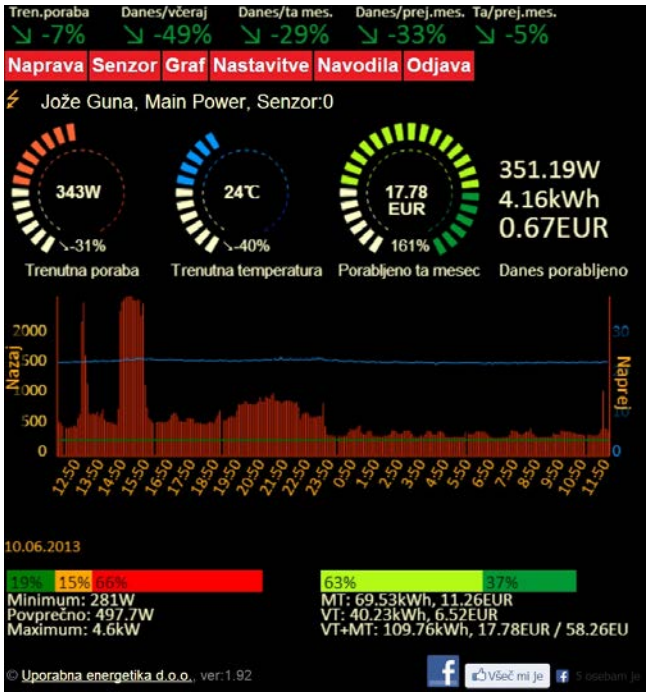

Figure 2: Existing service provider's energy consumption dashboard web application

Another possibility to access the energy consumption data is by using a simple web based API. Data is received as a response to HTTP GET method requests. This is the API we used in our solution.

Components

Beside the IP-enabled CurrentCost electrical energy metering device, the proposed system consists of the following key components:

- RaspberryPi board, model B (with 512 MB RAM),
- Connection breakout board,
- Adafruit LPD 8806 fully controllable colour led strip (1m long with 32 discrete leds),
- eAmbi Python application running in Linux OS.

Main hardware components are the new RaspberryPi board, the appurtenant connection breakout board and a smart led strip. The latter can fully be controlled in software, where every led (representing a single pixel in a one dimensional display) can be set in any RGB colour and intensity level in 7 bit precision.

The software part of the system was developed in Python v2.7. The underlying OS environment is Linux based distribution Occidentalis, v0.2.

Hardware components are shown in Figure 3.

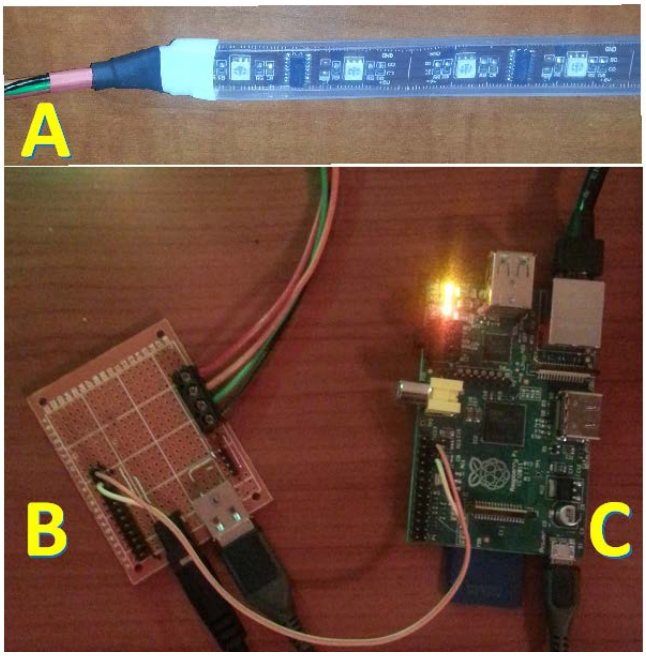

Figure 3: Hardware components – led strip (A), connection breakout board (B) and RaspberryPi board (C)

Architecture and operation

The main part of the system is the RaspberryPi board with the *eAMBI* application. On one hand it is connected to the Internet via the Ethernet interface and on the other to the led strip via the SPI interface. Electrial energy consumption data is received from the service provider's smartgrid data server, processed on the RaspberryPi board and the resulting visualization information is sent to the led strip. The process is executed in real-time with the refresh rate of 5 minutes. This is currently also the maximum temporal resolution of the system imposed by limitation of the electrical energy metering device. The architecture is shown in Figure 4 in detail.

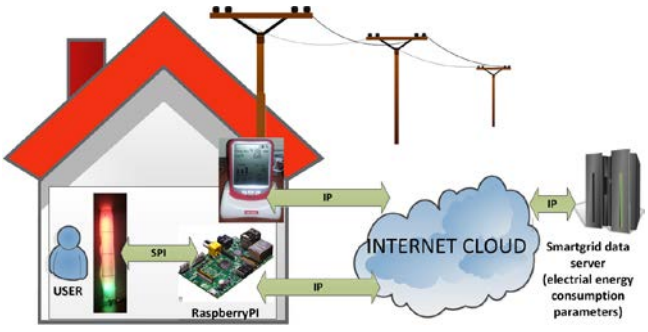

Figure 4: *eAMBI* system architecture

RESULTS

Current electrical energy consumption has been selected as information to be visualized using the one dimensional led strip based display. While various visualization strategies are possible, a simple, yet informative colour/position VU-meter type visualization was selected. In the presented setup the electrical energy consumption is indicated by the position (from bottom to up) and changing colour (from green to yellow and finally to red colour hues) and brightness (from low at the bottom to high on top). Lowest consumption is thus indicated by lighting only a few green leds on the bottom while the highest by displaying a full led bar. The display itself is mounted vertically on the wall in the living room so it can be easily observed but not to be overly intrusive.

In the final setup a simple, yet effective paper diffusor was installed, as shown in Figure 5. A fully lit display is shown.

Figure 5: Displaying the image without (A) and with the installed paper diffusor (B)

DISCUSSION

In theory, any kind of single scalar information can be visualized using the proposed system. Our measuring system allows for measuring and recording of current electrical energy consumption and ambient temperature parameters. Considering the literature overview and trends we decided on visualizing the current electrical energy consumption information as the main focus. Energy related costs could present another interesting parameter.

First question was how best to visualize this information using only a single led strip as a display. Considering the information light and unobtrusive ambient interface as one of the main goals of the study, we decided on simple VU-meter type of visualization. Other types of colour/position/intensity based visualization are, of course, possible as well.

Another interesting issue presented itself when we installed the system and performed first lighting tests. The led strip was simply too bright (easily corrected), but too “digital” in a sense of discrete single lit led lights as well. Therefore, we corrected the issue by installing a simple, yet effective paper diffusor made of plain A4 white office paper sheets. This sufficiently diffused and blended the lighting, resulting in a pleasant subtle ambient background light and consequently providing better final user experience. Other, professionally built types of diffusors, such as matte plastic or glass diffusors, could be used as well.

Still, a question of lower and upper electrical energy consumption parameter limits remained. Several strategies are possible, from using static presets to dynamically learnt values. We decided on a simple approach of using the average value of electrical energy consumption as a basis and specifying the visualized range of values based on that value. In our case, the average consumption was in the range of approx. 350W. As the maximum value, 5-times the average value was selected, resulting in the 1500W upper limit. Should the need arise; these settings can easily be changed.

Of course, one can argue that reducing, or at least increasing the awareness of the energy consumption by using an additional device with its own consumption, can be considered as an oxymoron. However, the proposed eAMBI system is very energy efficient. The maximum electrical consumption of the RaspberryPi board is 3.5 W and the fully lit led strip consumes approx. 9 W. Under typical operational conditions these values are much lower, and are in the range of 3-5 W. Thus, we think that the potential benefits offset these disadvantages.

A typical installation of the proposed *eAMBI* system in a home environment is shown in Figure 6. The users can thus perceive their energy consumption in real-time. The system is not directly interactive, requires low cognitive load and can be perceived by peripheral vision only.

Figure 6: *eAmbi* system in operation in a typical home environment

CONCLUSIONS

We present the *eAMBI*, an ambient visual interface for displaying the current electrical energy consumption information in real time. The system is installed in a typical home environment and allows the users to perceive their energy consumption in real-time in an unobtrusive way.

We plan to visualize different data parameters (e.g. energy related consumption costs, ambient temperature, etc.), implement additional visualization patterns and more importantly, evaluate the system by real users. For the latter we plan to use standard methodologies, such as SUS or ATTRAKDIFF questionnaires, in order to compare our results with other studies. Finally, we hope that the proposed system could find its way into users' homes and positively reduce energy consumption in general and change users' behaviour and possibly habits.

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REFERENCES

1. Bartram, L., Rodgers, J., Muise, K. Chasing the Negawatt: Visualization for Sustainable Living. *IEEE Computer Graphics and Applications 3*, 30 (2010), 8-14.
2. Faruqui A., Sergici, S., Sharif, A. The impact of informational feedback on energy consumption - A survey of the experimental evidence. *Energy* 35 (2010), 1598–1608.
3. Froehlich, J. Promoting Energy Efficient Behaviors in the Home through Feedback: The Role of Human - Computer Interaction. In *Proc. HCIC Workshop*, (2009).
4. Pierce, J, Paulos, E. Beyond Energy Monitors: Interaction, Energy, and Emerging Energy Systems. *In Proc. CHI 2012*.
5. Rodgers, J., Bartram, L. Exploring Ambient and Artistic Visualization for Residential Energy Use Feedback. *IEEE Transactions on Visualization and Computer Graphics* 12, 17 (2011).
6. Li Jönsson, L., Broms, L., Katzeff, C. Watt-Lite; Energy Statistics Made Tangible. In *Proc. of the 8th ACM Conference*, (2010).
7. Gustafsson, A., Gyllenswärd, M., The Power-Aware Cord: Energy Awareness through Ambient Information Display. *CHI 2005*.
8. Derek Foster, D., Lawson, S., Blythe M., Cairns, P. Wattsup?: Motivating reductions in domestic energy consumption using social networks. In *Proc. NordiCHI 2010*.
9. Petrol Monitel electric energy meter, http://www.petrol.si/za-dom/energija/elektricna-energija/monitel/ .

Issues and Topics to Consider for Information Management Research in eMedia Industries

Bjoern Stockleben
University of Applied Sciences
Magdeburg-Stendal
Breitscheidstrasse 2,
D-39114 Magdeburg
bjoern.stockleben@hs-magdeburg.de

Artur Lugmayr
EMMi Lab., Tampere Univ. of Technology (TUT)
POB. 553, Korkeakoulunkatu 1,
FIN-33100 Tampere
lartur@acm.org
+358 40 821 0558

ABSTRACT
The digital media industry produces vast data along the content value chain. Any interaction with digital media yields data, often in real-time, both on production and consumption side. This data can be turned to immediately available business information on the operational level, e.g. editors continuously tweak their workflows upon social media feedback. This questions the traditional distinction between organization levels, changing the role of strategic management in the media business and the kind of information it is acting upon. An integration of business information and content management systems throughout the whole value chain holds great potential for future business intelligence applications in the media sector.

Keywords
Multimedia, eMedia, Information Management, Information Systems, Multimedia, Media Technology

1. MEDIA IN THE CONTEXT OF INFORMATION MANAGEMENT SYSTEMS

In this article we discuss the significance of information management systems in the media industry. We understand media industry as companies that create content through narrative structuring of fictional or non-fictional events. The created content obviously has to be managed for proper distribution, yet this should not be mistaken for information management. Content management is indifferent to the information the content may convey, at least if we follow Gregory Bateson, who defined information as "a difference that makes a difference" [1]. A difference cannot exist independent from the subject that perceives this difference and the context in which it makes a difference. Thus, the information value of content can only be judged in relation to the individuals that consume this content in a certain context.

In contrast to content management systems, information management systems comprise the "process of managing information as a strategic resource for improving organizational performance [and involving] strategies and [introducing] systems and controls to improve information quality over time" [2]. Information management always has to have a perspective, which is usually that of the related business entity.

Now when applying information management concepts in the media industry, the challenge is to examine the whole process of content creation, management and consumption from a viewpoint of organizational performance in order to discover information vital to the improvement of organizational strategy. The different parts of the value chain where this kind of information is generated are described in detail in [3]. Within this article, the basis for discussions is a generic value chain model considering the creation, management and consumption of content, which will be examined for its information potential. The primary question is whether the special nature of the digital product in the media industry does make a difference in the approach to business information management. In particular it has to be explored whether the fact that content is represented as digital data yields changes the quality of information and whether any business information can be inferred from the theme and genre of the content. If not, the product can be treated as a 'black box' and no special considerations are necessary to apply information management concepts to the media industry. If yes, media information management will likely see a continuous integration of content management and business informations systems. An architectural vision for this kind of integrated content and information system is the so-called 'Interactive Knowledge Stack' as envisioned by [4].

Slow Cycle vs. Fast cycle Media Products

The challenges to media business information systems differ depending on the type of content a media company produces. For this discussion, we introduce the terms of slow product cycle and fast product cycle media. Slow cycle media companies produce complex content with a high degree of collaboration in the workflow. The production flow is linear similar to industrial production and the cycles span from months to years, with customer

feedback cycles of similar length. Typical examples are movies, games and books. On the other hand, fast product cycle media companies produce small content units in cycles of hours to days. These smaller units may be fitted into a larger structure to form a marketable product, yet this structure changes slowly and is independent from the production cycle. A high number of pieces of content are produced in a parallel workflow in a very short time frame. Accordingly, the customer feedback cycle is short as well, giving feedback almost already during production. Blogs and online news services are examples of this kind of media companies.

Most other media sectors can be positioned in between these extremes. It should be noted that especially the relation between the production cycles and the feedback cycles are of interest. TV, for example, has long planning and production cycles for most non-live formats such as serials or documentaries, but real-time feedback. Due to this mismatch, a typical TV station cannot react as fast as e.g. a blog to the information gained through business intelligence.

The opportunities depicted in the following chapters refer largely to fast cycle media in this sense, the applicability to slower media varies.

Media Content Consumption

In this article we understand media consumption as the perception of and interaction with edited and distributed media content. This may involve creative acts such as commenting or remixing as a consequence, but not as primary intention of the consumption. Any media consumption invariably changes the consumer, regardless whether the content is enjoyed or despised. This may or may not trigger an observable behavior, which could be measured and captured as data. The fundamental change between analog and digital media is that any interaction with a digital artifact directly produces new digital data, which can be easily captured without the need of additional means of measurement. This allows for real-time tracking of user behavior, which can be analyzed to gain marketing insights.

However this data can inform about what the customers are doing, but it remains silent about why they are doing it. Only the interaction with the digital artifact is captured, but not the process of internal reasoning nor any other action triggered by the media consumption. It can be questioned whether the 'why' is needed at all in a real-time feedback loop (see [5]). That said, some secondary interactions can be captured, e.g. by the use of social media monitoring. Like any interaction with a digital artifact, social media interactions can be captured and be linked more or less directly to the observed behavior with the original media content. This generates more qualitative data, e.g. on user sentiments and sometimes about motives when those are content of a social media interaction (for an overview of use cases see [6]).

Media Content Creation

Content production is sometimes regarded as a creative process that cannot be formalized and thus optimized as it is done with other production processes. Yet especially daily productions like news programs have established the need for more formalized routines in content production. On a more general level, paradigms like Design Thinking have shown the potential that lies in formalizing creative processes [7,8].

In fast cycle media, the media creation is tightly interrelated with media consumption. Social Media Intelligence allows for real-time feedback to the editors. This constitutes a disintermediation of the feedback process, i.e. social media monitoring tools extend the editor's capability to perceive the interaction with the user more closely than before. At the Huffington Post, the feedback process is already an integral element of the editorial workflow [9,10], with arguable success.

Yet the usage of editorial information systems should not be restricted to one perspective, even if it is that of the user/customer. In order to get a multi-perspective model, as argued strongly in [16], more data sources are necessary. These can be found by monitoring the media creation process itself, as well as the media management process. As both processes involve the interaction with digital artifacts, these interactions leave traces as well. But while tracking any click of the user is a common exercise today, there is no similar tracking of the users of the production systems inside the company. Depending on the production process, different information for different purposes could be generated this way. Monitoring a nonlinear editing or content management system might give valuable insights on workflows and how to improve them. Any GPS-enabled video camera gives information not only on the location of the pictures that were shot, but as well on the logistics of the shoot. However it is obvious that these issues touch sensitive privacy issues, which have to be considered when introducing such a kind of business information system.

Media Content Management

The term media content management shall refer to any act of aggregation and organization of content in the context of this article. This involves the editing of metadata, especially semantic content annotation. Any media company needs to structure the produced content for two main purposes, namely the internal organization of workflows and external distribution. Ideally the internal and external structure are congruent or at least complementary. A reference example of state-of-the-art media content management is dynamic semantic publishing as demonstrated by the BBC, e.g. during the London Olympics. Instead of statically mapping a produced content item to one or more pages, each item has to be annotated accordingly to a pre-defined ontology.

The editors may generate new thematic page views ad lib, describing the desired content semantically using the very same ontology. The editorial opportunities of this architecture have been well discussed in [11], yet the use of this structure as business information has not been considered so far. Doing so might answer questions like: which type of content is best fit for repurposing (i.e. fits into the widest range of semantic contexts) or does the organizational structure of the editorial room match the actual distribution of themes.

2. AMBIENT MEDIA PRINCIPLES IN MEDIA INFORMATION MANAGEMENT

The five principles of ambient media as developed in [12,13] describe the processes of enrichment and transformation of content due to a constant oscillation between the real and the virtual world.

Manifestation

The manifestation principle does mean that any data from the virtual layer can only be perceived by humans in a manifestation that is accessible to human senses. In the media business, this usually means image or audio rendering using media devices. However, ambient media encompasses also any other kind of rendering of data into objects or object behavior.

Morphing

The principle of morphing describes the necessity to define rules for the translation of phenomena in the real world into the virtual world and vice versa. In other words, it is about how data is rendered into a human-perceivable manifestation, the way that interactions with this manifestations are translated back into data and how this changes the original data. Any morphing operation yields data about the manifestation, as well as about the operation itself. The morphing principle is particularly interesting for the design of information systems, as it sees the content itself and the interaction with the content as part of the same entity. Both content and interactions would have to be processed by the same system, questioning the traditional separation between strategic business information systems and operational content management systems.

Intelligence

The principle of intelligence refers to the need of defining operations on the data in the virtual world. Intelligence does only work on the data available on the virtual layer. Any phenomena in the real world have to be converted to data by a morphing process – thus content can be seen as a specific process or phenomenon of manifestation of data form the virtual layer, following a certain smart 'construction plan'. From a business intelligence point of view, the intelligence principle means to apply operations on data in order to gain information and using this data to enrich the original data, thus changing the possible manifestations of this data.

Collaboration

The term of collaboration addresses the fact that in ambient media, content is created and shaped through countless interactions on manifestations by users and on data by agents. Content evolves in a vast human-machine collaboration. In current content management systems we still need human actors to evaluate social media intelligence and change the content accordingly. A logical consequence of the ambient media collaboration principle would be to integrate machine actors into the editorial process, adapting not only content aggregation (as in recommender systems), but the content itself.

Experience

One aim of ambient media is to convey knowledge, not only information, in form of experiences by choosing suitable manifestations to be consumed by the user. An experience implies not only information one can interact upon, but as well the knowledge of the impact of possible actions following this information. Translated to the context of business information systems we could say that scenarios are the tool that comes closest to this quality of ambient media content. Scenarios take information on the current status and generate a contexts depicting possible consequences of decisions that can be derived from this information (see e.g. [18]). They allow a kind of pre-experience of a future status to decide whether it is desirable or not. In fast cycle media however, scenarios are likely to be replaced by the real experience, as real-time feedback cycles leave little time for lengthy considerations and the information on the status quo has to be a sufficient base of decisions to be taken.

3. IMPACT BY ORGANIZATION LEVELS OF INFORMATION SYSTEMS

Taking again the example of the Huffington Post, the discrimination between organization levels in information systems as described in [14] is not directly applicable to enterprises in fast cycle media. It relates certain types of information systems to different functional parts and levels of hierarchy within the enterprise. Yet audience analysis is about to become an integral part of an editor's tool-set, i.e. what used to be a tool of the middle management and basis for mid-term decisions becomes a real-time tool influencing daily work. Due to the extreme short feedback cycles between content production and consumption, systems used by editors unite operational, knowledge and management level aspects.

Undoubtedly it took strategic foresight to empower an enterprise to be as reactive to its customers as the Huffington Post is. Yet it poses the question of what kind of formerly strategic decisions are now handled on the operational level and what strategy means in a market where the product adapts to its audience nearly in real-time. While strategy used to be developed in a top-down approach and provided the guiding frame for all employees, suddenly every employee has a real-time model of the

company at hand, which continuously challenges the viability of the company strategy. Editors become knowledge workers that are continuously analyzing the reception of their product and refine their workflows in real-time. The question is, how many room for strategic decisions remains in such a setting and in which way the data analysis in strategic information systems differs from the daily data analysis available to each employee.

Not all sectors of the media industry are affected alike. It appears that the length of the production cycle is the main determinant. Slow cycle media like cinema are more close to traditional linear industrial production (a parallel that is discussed in detail in [15]). Fast cycle media like blogs with text, image and short video content, distributed on interactive distribution channels are heavily affected by the rise of real-time information systems. The result is a recursive production process with a short initial creation phase and a longer refinement phase that embeds feedback information on the fly over the whole content lifecycle.

4. INFORMATION SYSTEMS AS DRIVER FOR CHANGE MANAGEMENT IN MEDIA ORGANISATIONS

Information systems create a dynamic model of the current state of an organization. This model depends on the measured data, i.e. what is not measured, has no influence on the model. In order to use such a model as a tool for change management, it is necessary to reach a common interpretation of the model. This can be achieved by providing a vision, i.e. an ideal that the model can be compared to continuously. The Balanced Scorecard [16] is a way to implement this; the relation between company vision and the choice of indicators and measurements is argued extensively in [17].

There is one problem in taking strategic decisions upon measured data: Only the present state of the company and its customers can be measured. The distinction between leading and lagging indicators made by the Balanced Scorecard even indicates that measurements often point to events way in the past. Yet strategic decisions will have impact only in a future context that is unknown at the time the decision is taken. Strategic foresight can be used to contain, but not eliminate uncertainties [18]. In order to make sensible decisions, business information systems have to provide relatively stable models. In practice this means that e.g. clicks to articles must be translated into more persisting concepts, such as general thematic interests of the users or types of media preferred. A lot of market research efforts is usually spent on this 'know-why' qualitative research. Insights on user motivation and needs is then in turn used to predict future user behavior. Recurring on the discrimination between fast and slow cycle media, all this holds true for companies in slow cycle media.

For fast cycle media, the case looks different. Given real-time production and feedback cycles, the user behavior measured in the presence is sufficiently close to the user behavior in the next cycle to be used as a direct prediction. There is no need to take the long way by inferring user needs and motivations and then again deriving future user behavior. Thus, we argue that in fast cycle media the classical strategic planning is split into two parts: First there is a perpetual change process on the operational level based on the model of the present state ('know-what'). Second, the strategic management ensures the adaptive capabilities of the operational level based on higher level analyses ('know-why'). From a system theory point of view, the capability of monitoring and reacting to changes in the environment has become decentralized, with the strategic subsystem (the strategic management) of a company now monitoring and acting upon both changes in the environment and adaptation strategies of the production subsystems (the production departments). Formerly solely responsible for any adaptation to changes to the economic environment, the strategic management now becomes a second order observer (following the terminology established by [19] and others) of change processes within its company.

In media enterprises, especially those dealing with daily news and information, information management will likely establish a third layer of data on the content value chain. The first layer is content data, the second layer is content management data and the third layer is business information data, measuring each step in the value chain in real-time.

This business information data creates a dynamic model of the status at the various stages of the value chain. Expressed in the terms of ambient media, the primary challenge is now to select suitable manifestations for this data and to formulate a vision, so that employees at various positions will use it for the best possible adaptation of their workflows in the light of the aims of the company.

5. SCENARIOS FOR FUTURE INFORMATION SYSTEMS IN THE MEDIA INDUSTRY

The following scenarios suggest different directions for future research in information systems for the media industry.

Scenario 1: From Dynamic Semantic Publishing to Dynamic Semantic Business Intelligence

Dynamic Semantic Publishing enriches the editorial work in that the editor has to consider multiple contexts in which the produced content could likely be displayed. Simple tagging gives way to the creation of more general content relationships and rules. This is only one of many examples how more and more metadata is generated and used at different stages of content creation, management and consumption. The rich data usage data resulting from this development holds a vast potential for next generation media information systems.

Scenario 2: Business Information as Media Content

Business information systems can profit from ambient media content concepts. Business information as a whole creates a model of a company, but all too often it is considered sufficient to visualize numbers in order to generate an unambiguous representation. Yet if it is to be used as a tool in change management, much more attention has to be paid to the choice of manifestations in order to create the desired experience with the user, i.e. the company employee.

Scenario 3: Second Order Observation Tools

The availability of a rich real-time feedback empowers media company employees to directly take adaptation decisions within their field of responsibility. In order to gain a representative model of their company, the strategic management would need tools that dynamically observe these adaptations. Otherwise they are running the risk of taking decisions that run against bottom-up change processes based on a divergent interpretation of the first order observation of the environment the company is acting in.

6. CONCLUSION

The special nature of the digital product lets media business information management stand out as a special and demanding case of application of business information systems. This short paper has indicated the potential of integrating business information systems with the specific data generated along the media content value chain. Especially in the sector of fast cycle media, business intelligence is already applied at an operational level in the form of social media intelligence, but by far has not reached its full potential on the strategic level. The vast availability of real-time feedback data on all organizational levels calls for new models of strategic planning and supporting information systems.

REFERENCES

[1] G. Bateson, *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology*, University of Chicago Press, 1972.

[2] D. Chaffey, S. Wood, and G. White, *Business Information Management: Improving Performance Using Information Systems*, Financial Times Prentice Hall, 2011.

[3] A. Lugmayr, "Brief introduction into information systems amp; management research in media industries," *2013 IEEE International Conference on Multimedia and Expo Workshops (ICMEW)*, 2013, pp. 1–6.

[4] W. Behrendt, "The Interactive Knowledge Stack (IKS): A Vision for the Future of CMS," *Semantic Technologies in Content Management Systems*, W. Maass and T. Kowatsch, eds., Springer Berlin Heidelberg, 2012, pp. 75–90.

[5] V. Mayer-Schönberger and K. Cukier, *Big Data*, Houghton Mifflin Harcourt, 2013.

[6] H. Kasper, *Marktstudie Social Media Monitoring Tools: IT-Lösungen zur Beobachtung und Analyse unternehmensstrategisch relevanter Informationen im Internet*, Fraunhofer Verlag, 2010.

[7] A. Lugmayr, "Applying 'Design Thinking' As a Method for Teaching in Media Education," *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, New York, NY, USA: ACM, 2011, pp. 332–334.

[8] R. Buchanan, "Wicked Problems in Design Thinking," *Design Issues*, vol. 8, Apr. 1992, pp. 5–21.

[9] J. Pavley, "Sneak Peek: HuffPost Brings Real Time Collaboration to the Newsroom," *Huffington Post*, Aug. 2013.

[10] G. Hamann, "Alle 56 Sekunden was Neues," *Die Zeit*, Oct. 2013.

[11] J. Rayfield, "Dynamic Semantic Publishing," *Semantic Technologies in Content Management Systems*, W. Maass and T. Kowatsch, eds., Springer Berlin Heidelberg, 2012, pp. 49–64.

[12] A. Lugmayr, T. Risse, B. Stockleben, K. Laurila, and J. Kaario, "Semantic ambient media—an introduction," *Multimedia Tools and Applications*, vol. 44, Sep. 2009, pp. 337–359.

[13] B. Pogorelc, R.-D. Vatavu, A. Lugmayr, B. Stockleben, T. Risse, J. Kaario, E.C. Lomonaco, and M. z Gams, "Semantic ambient media: From ambient advertising to ambient-assisted living," *Multimedia Tools and Applications*, vol. 58, May. 2012, pp. 399–425.

[14] K.C. Laudon and J.P. Laudon, *Management Information Systems: Managing the Digital Firm*, Pearson Education, Limited, 2010.

[15] L. Manovich, *The Language of New Media*, MIT Press, 2001.

[16] R.S. Kaplan and D.P. Norton, *The Balanced Scorecard: Translating Strategy Into Action*, Harvard Business Press, 1996.

[17] P.R. Niven, *Balanced Scorecard Step-by-Step: Maximizing Performance and Maintaining Results*, John Wiley and Sons, 2010.

[18] D. Mietzner and G. Reger, "Advantages and disadvantages of scenario approaches for strategic foresight," *International Journal of Technology Intelligence and Planning*, vol. 1, 2005, pp. 220–239.

[19] N. Luhmann and D. Baecker, *Einführung in die Systemtheorie*, Carl-Auer-Systeme-Verlag, 2002.