Outline of the presentation

- Introduction
- Precision Agriculture from the farmers' point of view
- How to facilitate farmers' input in the PA technology design - extending Human-Centred Design approach
- Activity-Centred Design of a Farm Information Management System
- Conclusions: Towards a new practice
Introduction

- A social scientist typically takes technology as given – the interest is in the social consequences of implementing technology
- A Human Factors researcher is interested in
  - understanding the role of technology in human conduct and culture
  - developing technology for the benefit and well-being of people
    - Avoid human errors -> increase automation
    - Support the human element -> design better interfaces and decision aids
    - Develop human-technology joint intelligence and capabilities -> increase adaptability of the system

Farming as a domain for HF research

- Farming is a domain that only recently has become a focus of human factors research
- Farming process is a Complex Dynamic Uncertain (UDC) domain
- External demands on today’s farming
  - Efficiency
  - Quality
  - Compliance with standards
  - Environment
  - Ethical and health issues
- ICT-based automation, yes, but also informatisation (Zuboff 1988)
- Precision Agriculture (PA) is one expression of informatisation of farming
- Informatisation increases interpretative demands of actors
Precision agriculture from the farmers’ point of view

- Two studies: Pre PA technology situation (FIN), Experience of PA technology situation (SWE)
- Pre PA technology: Development of a concept for information management system of a plant production process (INFOX 2005-2007)
- Malting barley production, an example of a farming process in which information of the growing conditions and the process may bring better outcomes
- In the study several phases:
  - Generic functional model of malting barley growing
  - Definition of core-task demands of mastering the growing process
  - Orientation to farming =>
  - Definition of the information needs =>
  - Developing and testing a DSS concept

Eleven farms were visited, four of them twice
Interviews and workshops were accomplished
Interviews dealt with
- Purpose of farming
- Process management: quality, resources, constraints
- Attitude towards new technology
- Future of farming

Defining farming orientation

Conception of the object of activity
- producent-thinking, considers him/herself as part of the production chain
- biological thinking: Interest in the growth process of the plant
- service thinking: commitment to the idea of entrepreneurship

Conception of the uncertain and unpredictable character of farming
- coping with uncertainty by own active practice
- awareness of reasons of uncertainty

Conception of knowledge and its construction
- respect for experiential knowledge
- use of information tools
- societal nature of knowledge: active participation in the farmer community

Conception of good farmer – what is good, morally right and valuable in the profession
- confidence with own decision making and judgement
- control and development of own activity
- respect for nature and a communicative relationship with nature

Motivation for malt barely farming
- way of life, source of significance
- professional challenge
- usage of the economical possibility, profitability

Pesonen, Nurkka & Norros 2007
Farmers' orientation in pre PA situation

- Level of fulfillment of each criterion was graded (1, 1/2, 0) and a colour code given
- Interviewees' orientation profiles were formed
- Three types of orientation were defined
  - dominantly interpretative (Tarmo)
  - dominantly confirmative (Onni)
  - dominantly reactive (Taneli)
- Visual representations of these types were created

Orientation types identified in the pre PA situation

- **Interpretative / TARMO**
  - intentional, persistent
  - comprehends the complexity of the whole system
  - strong weight on competence, experience and knowledge—use of technical artefacts
  - Need to support development producent/ entrepreneur thinking

- **Confirmative / ONNI**
  - deep meaningful aims of work not evident, lack of enthusiasm
  - no particular development motivation due to uncertainties of the future
  - lots of potential, that could be triggered with proper incentives

- **Reactive / TANELI**
  - no expression or idea of active learning or development
  - deficient conception of the whole
  - change of attitude is need to create an active producent

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"other may do what they wish, I know. One has to get the whole in control"

"I do not see anything particular in it … I jus try to make it work alright …"

"If it happens to be good enough that's fine, if not, it is not the end of the world"

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The farming process and its information needs

- Easy recording of observations
- Support for active process management (monitoring and control)
- Enable availability in work situation, mobile connection

Conclusion of the pre PA situation

- Interest in farming process information and knowledge management is typical to one of the farming orientation types
- Precision Agriculture thinking exists before own experience of PA technology
- Key requirements for a usable tool defined
- Hypothesis: Farmers portaying interpretative orientation would benefit of PA technology, and be most helpful in co-designing of PA technologies
Farmers with experience of PA technology
(further Rydberg & Olsson)

• Benefiting from PA technology is contradictory
  • Main motivation economical efficiency
  • Technological immaturity and usability problems hinder usage
  • Automatic data handling valued
  • Evaluating of data considered non-motivating, difficult or too time consuming
  • New division of labour emerging, advisors in key role in farm decision making
• Exploiting the informing potential of PA technology assumes interest in interpretation and questioning
• Interpretative work orientation and a new informed PA practice do not emerge as spontaneous effect of PA technology

Some international findings

• Farmers' ignorance of the benefits of decision support systems (Fountas et al. 2006)
  • Provided information is not useful in practice
  • Systems are difficult and time consuming to use
  => Apply systemic approaches that are able to incorporate the farmers' experience and intentions in the scientific analysis
• Explanations for difficult diffusion (McCown 2002)
  • Science-based technical rationality vs. skill-based practical rationality
  • Systems materialise technical rationality easier
• Diffusion strategies:
  • Suppress practical rationality => Develop techniques, Teach farmers scientific thinking, Convince of benefits
  • Acknowledge both forms of rationality => develop technology by developing practices
• OUR EXTENSION: draw on the existing SEEDS of the new practice
How to facilitate farmers’ input to the PA technology design

Human-centred design (ISO-13407):
- active involvement of users and a clear understanding of user and task requirements
- appropriate allocation of functions between users and technology
- iteration of design solutions
- multi-disciplinary design
- Usability evaluation
  - Typically focused on interface features of consumer appliances

User-centred design is restricted

- When comprehensive and complex systems with several user interfaces are designed
- When deeper functional features of the system, not just user interfaces, need to be evaluated
- When design focuses on professional tools that require considerable knowledge of the work
Activity-centred design

- Focusing on human individuals is misleading, the target should be ACTIVITY
- Understanding generic TOOL FUNCTIONS to determine what is a "good tool"
- Synthetic criteria are needed for steering human factors work along the DESIGN PROCESS

Activity system

The appropriateness of a tool is connected to its ability to mediate the objectives, and the constraints of the work domain to the users, and to support realisation of objectives in daily tasks and situations
Generic functions of a tool

- Instrumental function - induces effects on the object and bring intended outcomes
- Psychological function - shapes human cognition and is fit to users’ demands
- Communicative function - communicates relevant content and supports shared understanding of situation and aims

Systems Usability (SU)

- Comprehensive, context-dependent and function-oriented approach to usability evaluation
  - Activity and work domain => content related core-task demands
  - Generic tool functions => tool demands
- SU enables definition of generic criteria for evaluation
- SU enables steering of human factors design during the maturation of the design
Alteration of science-based and practice-based modelling in the design process

Nurkka, Norros & Pesonen 2007

The activity-centred design process utilised in the InfoXT-project

THE PRESENT SITUATION & FARMERS' ORIENTATION

IDENTIFIED NEEDS IN INFORMATION MANAGEMENT

=> A. Rydberg & J. Olsson
Activity-centred design process utilised in the InfoXT-project

Core Task 1
PRESENT SITUATION & FARMERS’ ORIENTATION
Analysis of orientation
IDENTIFIED NEEDS IN INFORMATION MANAGEMENT
=> Rydberg & Olsson

INTEGRATED INFORMATION MODELLING FOR THE NEW SYSTEM / Precision spraying

Core Task 2
Science-based modeling
Analysis of interactions in use cases
Scenario-based concept construction

Core Task 4

CONCEPT IMPLEMENTATION, AND SCENARIO-BASED TECHNICAL VALIDATION

=> Sörensen; Nikkilä
Activity-centred design process utilised in the InfoXT-project

**Core Task 1**

- Present Situation & Farmers' Orientation
- Identified Needs in Information Management
- Concept Implementation, and Scenario-based Technical Validation
- Evaluation of Systems Usability, Scenario-based Testing of SU Claims

**Core Task 2**

- Integrated Information Modelling for the New System
- Research & Design

=> Rydberg & Olsson

=> Sörensen; Nikkilä

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**Scenario-based testing of Systems Usability (SU)**

- Designing a scenario of precision spraying with a new Farm Management Information System
  - mobile, process control-oriented, flexible, IP-based
- Constructing a usability case: a systematic investigation of the existence of desired quality features in a singular design object (at different phases of design)
  - Claims
  - Arguments (connect evidence to claims)
  - Evidence
- Interviews within the whole service chain to support claim definition
- Questionnaire design: Questions that connect scenario to claims
- Presentation of the scenario and questionnaire in internet
- Analysis of results (on-going)
The FMIS spraying scenario

Observations, disease warning and identification of disease

Selection of chemical and advisor-assisted planning based on farm information

Receiving plan from advisor service for review

Deciding to initiate spraying, retrieval of spraying plan from database to task controller

Specifying parameters for task execution and tank filling

Execution of spraying

Monitoring plan execution and driving, on-line notes

Finishing task, document uploaded to farm database

VTT TECHNICAL RESEARCH CENTRE OF FINLAND

USABILITY CASE

Tool function claim

Natural impacting

Core-task claim

- On-line observations and anticipation of changes
- Flexibility of farming tasks

Specific claims

- Understanding cause-effect relations of the farming process
- Shared situation awareness within the joint system
- Optimising farming efforts

System requirement, solutions & interface claims

Arguments expressing the benefits to the user

Evidence from user questionnaires, interviews and actions

Systems Usability

Co-operation of the joint human-technology system

Meaningful work

- Conceptual mastery and competence building
- Common farming culture
Example of usability inference

- Systems usability
- Seamless co-operation
- Understanding cause-effect relationships
- Documentation of accomplished work
- Automated documentation
- Collecting notes in the connection of spraying brings added value to farm management
- Answers, reactions of the users

Internet questionnaire

- In 5 Nordic languages and in English
- Visitors advised to watch the spraying scenario video
- Possibility to evaluate the spraying technology concept by answering about 20 questions
- Questions
  - follow the scenario
  - define features of the system and their assumed benefits for the user
  - connected to specified top claims
  - generic evaluation of promisingness
Conclusions

- The human factors issue is to answer whether, or not, PA technology and the particular product are promising:
  - Does the described technology support meaningful future of the profession?
  - What happens to farmers' professional competence?
  - Are new forms of information sharing and collaboration a possibility or a threat?
- Role of internet is crucial for rural work and living: capacity, quality and dependability requirements very high => realistic studies required; living labs
- Design processes should be developed further: extending production design with science-oriented "formative design" and practice-oriented "immediate design" & consider technology evolutive and as accumulation of culture

The Design Field Framework
Salo & Norros submitted
The CDU domain and Core-Task modelling scheme

- DYNAMIC: phases of growth process, temporal structures
- COLLABORATING: transparent, self-confidence
- COMPLEX: interactions in growth process, quality requirements
- ACTING: adaptive, sense of control
- KNOWING: interpretative, meaningfulness
- UNCERTAIN: weather, soil and environmental conditions, fluctuation of global product prices

The DCU domain and Core-Task demands modelling scheme

- DYNAMIC: phases of growth process, temporal structures
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Core-task demands are defined by: 
-transparent, self-confidence
-interpretable, meaningfulness
-adaptive, sense of control