



# A human-centered approach for the optimization of human-system-interaction in future naval C2 systems

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# New challenges

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- Participation in international operations for precaution of and coping with crises
- Presence of neutral, friendly, and hostile objects necessitates non-ambiguous identifications
- Fast changing situations in modern warfare demand decisions be made and actions be taken quickly
- Wrong decisions can have serious consequences
- Optical reconnaissance is of special importance in typical 21st century missions like Operation Active Endeavor
- Task is not trivial
  - Many different classes / frequently modified
  - Image material varies concerning its quality
- Easy-to-use and easy-to-learn user support systems desirable

# Inherent complexity

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- Ill-structured problems
- Uncertain dynamic environments
- Shifting, ill-defined, or competing goals
- Action/feedback loops
- Time stress
- High stakes
- Multiple players
- Organizational goals and norms

# Degrees of automation according to Sheridan

Degree of automation	System features
1	The computer offers no assistance, human must do it all.
2	The computer offers a complete set of action alternatives, and
3	narrows the selection down to a few, or
4	suggests one, and
5	executes that suggestion if the human approves, or
6	allows the human a restricted time to veto before automatic execution, or
7	executes automatically, then necessarily informs the human, or
8	informs him after execution only if he asks, or
9	informs him after execution if it, the computer, decides to.
10	The computer decides everything and acts autonomously, ignoring the human.

# Support system development

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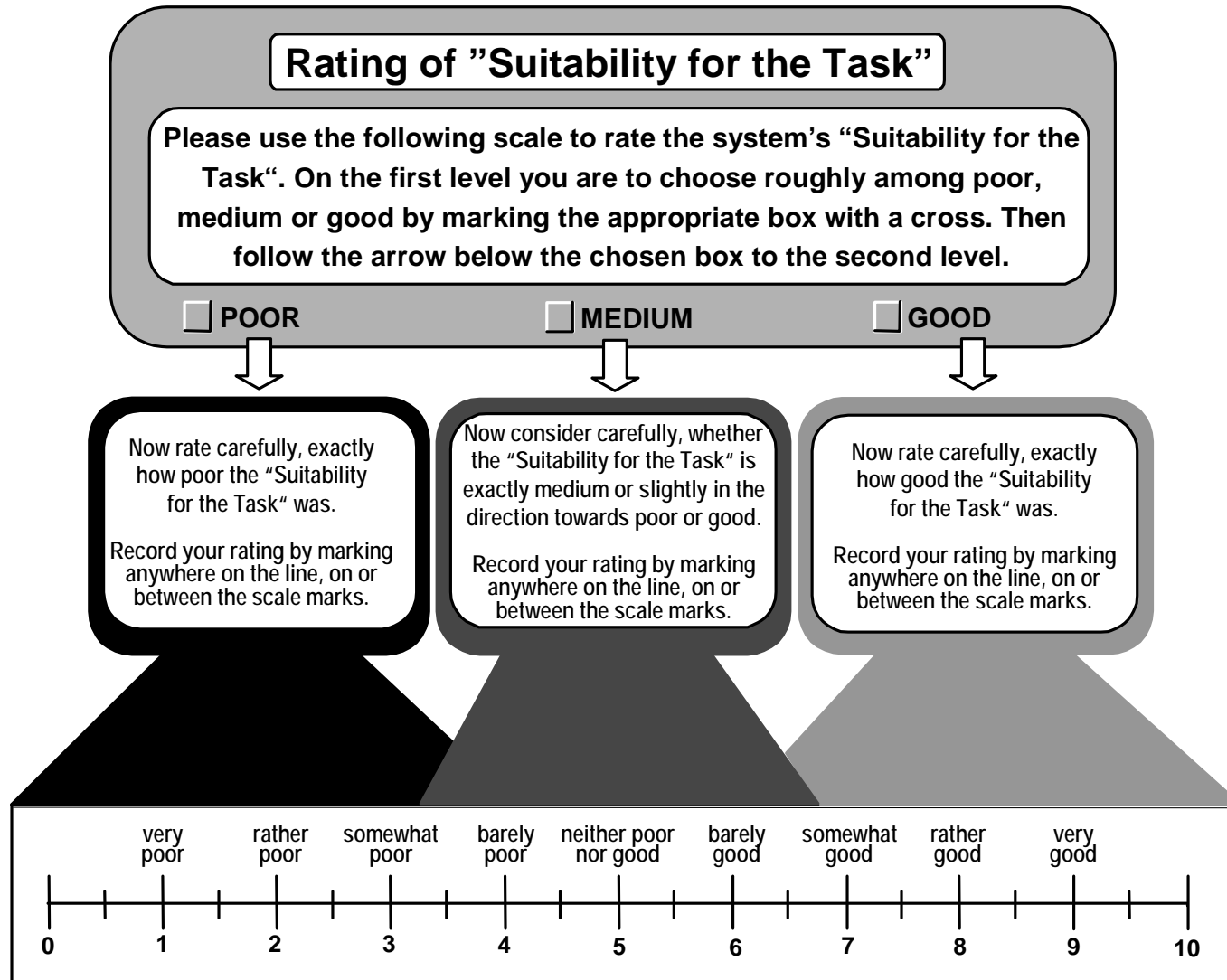
- Demonstration facility with two workplaces
  - User support for overall C2 tasks (prototypical)
  - Operational support system for surface vessel classification based on electro-optical imagery (KEOD)
- Rapid prototyping with graphical development environment
- Subject matter experts are frequently asked to examine systems and give feedback
  - Expert talks with officers and sailors take place at Naval C2 Systems Command (KdoMFüSys) in Wilhelmshaven
  - Evaluation on naval vessels under realistic circumstances
- Optimization and enhancement based on advice

# Empirical evaluation

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- Onboard naval vessels under realistic service conditions
- All subjects are experienced operators
- Standardized personal introduction with exemplary scenario
- Subjects have to accomplish challenging scenarios with the system
- ISO 9241, part 10 qualities rated with 2-level rating scale ZEIS directly afterwards
- Additional text questions on what displeases and what appeals to operators

# Two level rating scale (ZEIS)



# KEOD: Algorithms

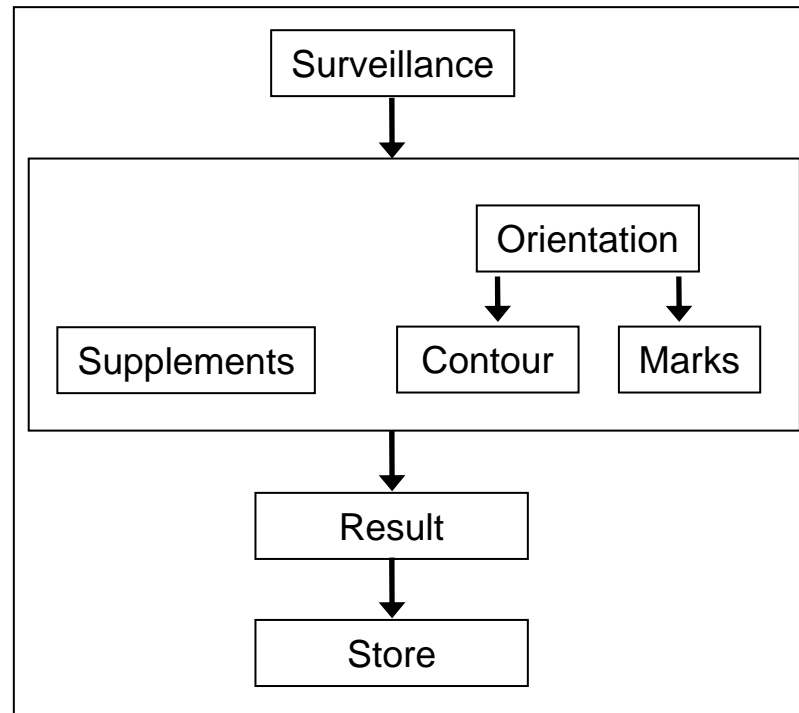
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- Contour classifier
  - Input: Silhouette, spatial orientation
  - Processing: Standardized OTBC is compared with reference silhouettes of all known ship classes in the database
- Marks classifier
  - Input: Visible marks with position, position independent marks, spatial orientation
  - Processing: Distances between OTBC and DB mark positions are calculated
- Supplements classifier
  - Input: Marks without position, size, flag, hull form, ...
  - Processing: Filter like comparison of equality



# KEOD: Overall design

- Sequence of clear cut process states to guide users through steps necessary to feed algorithms with data and to interpret results
- Developed in cooperation with subject matter experts

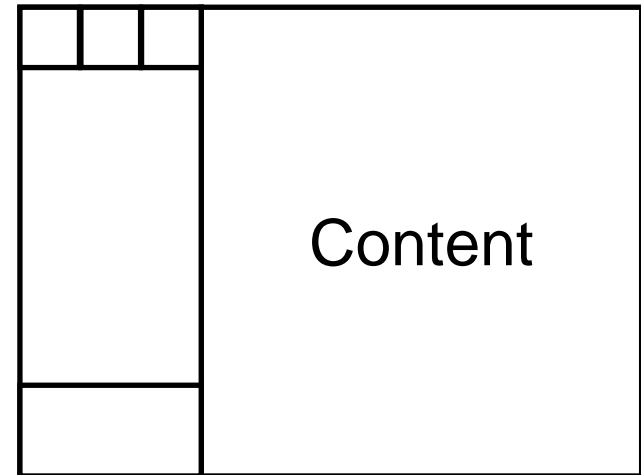


# KEOD: Screen layout (Surveillance)

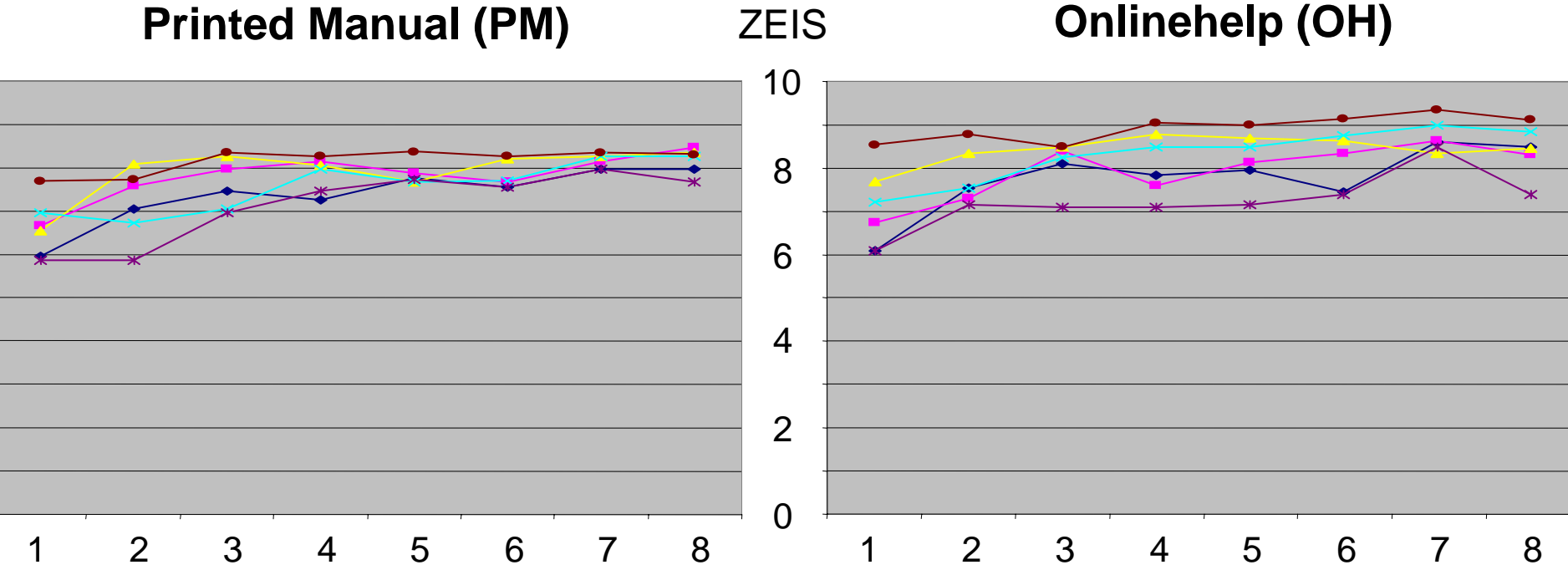


# Online help for KEOD

- Allows accessing all help topics without leaving the system
- Access at previously opened page using F1 key
- Context sensitive access via F2 key
- Additional tool tips as minimal invasive support
- Clear navigation concept
  - Table of contents
  - Index
  - Search function
  - Browser functions
- Special help pages



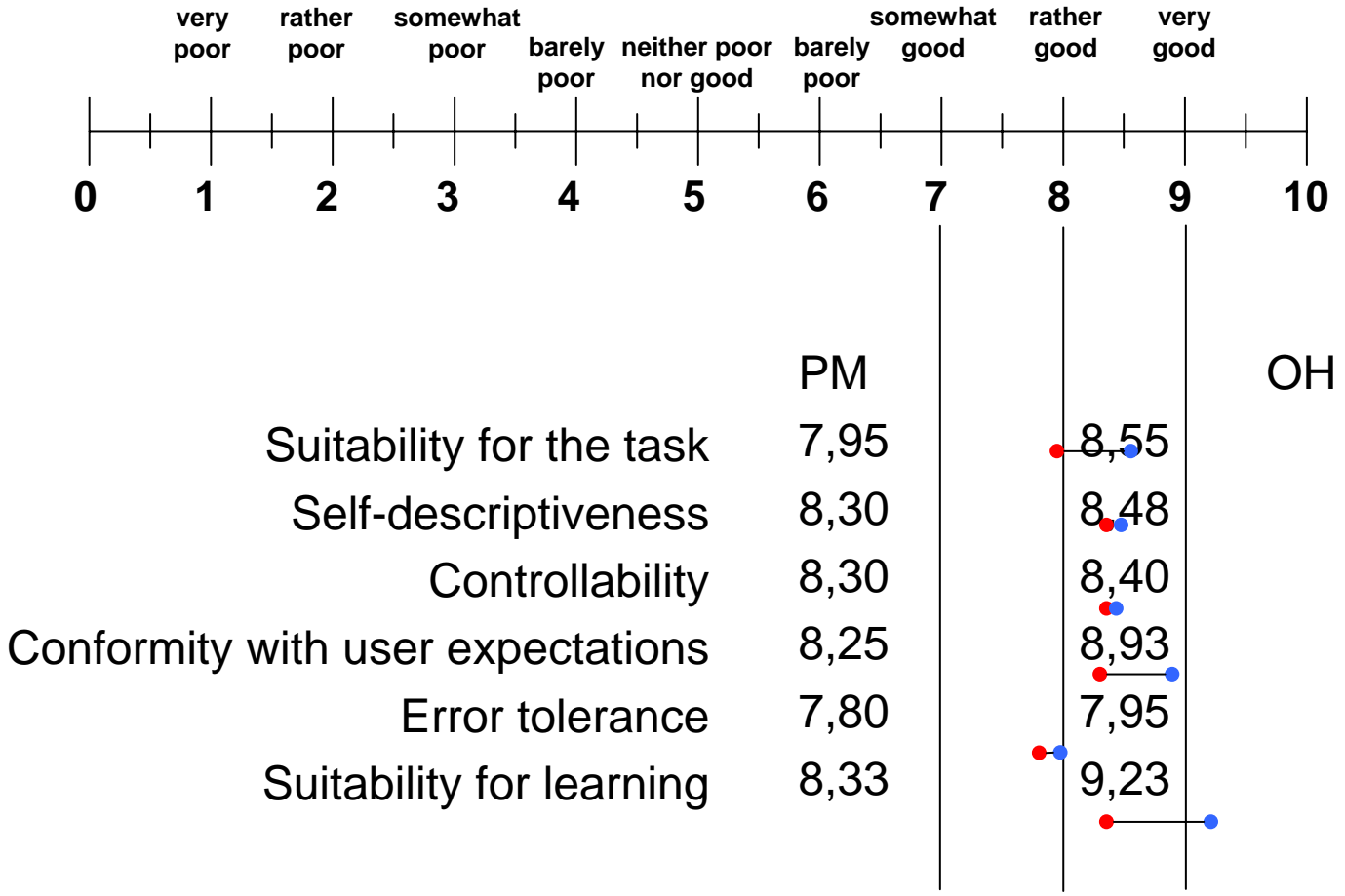
# Arithmetic means of the two groups



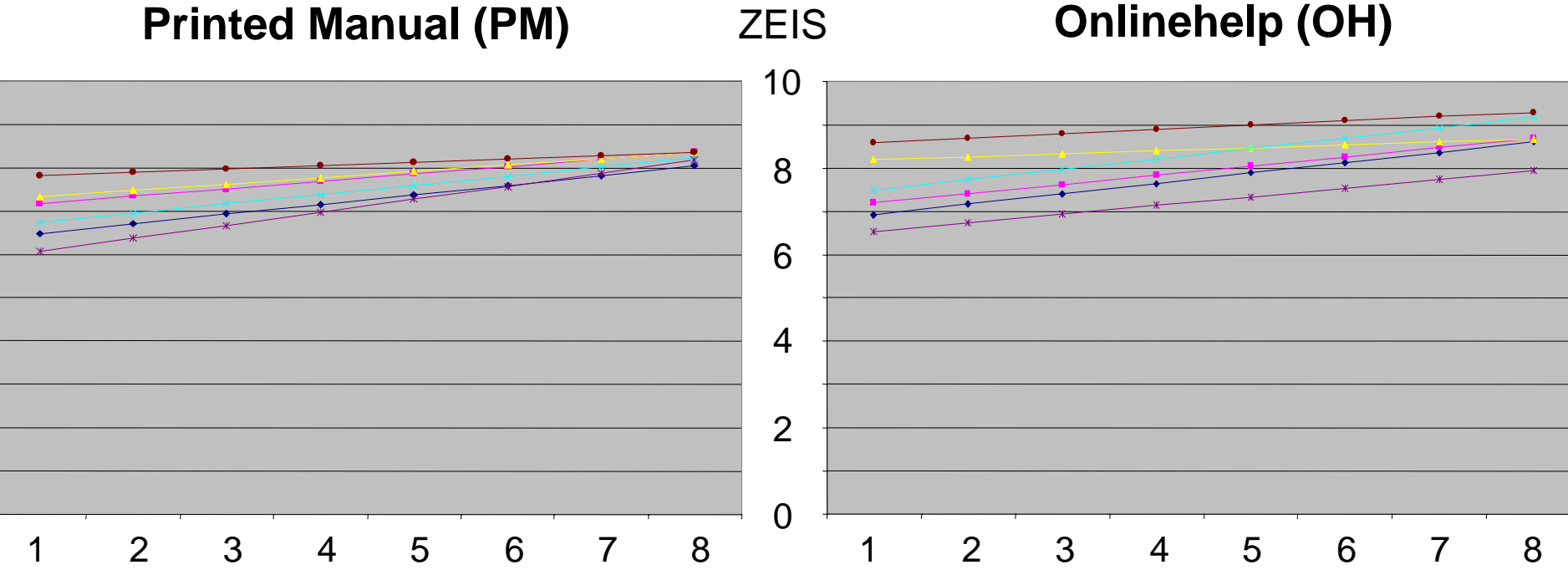
Day →

- ◆ Suitability for the task
- Self-descriptiveness
- ▲ Controllability
- × Conformity with user expectations
- \* Error tolerance
- Suitability for learning

# Arithmetic means of last two runs



# Linear regression of arithmetic means



Day →

- ◆ Suitability for the task
- Self-descriptiveness
- ▲ Controllability
- × Conformity with user expectations
- \* Error tolerance
- Suitability for learning

# Lessons learned from UNIFIL NAVOPS

- Naval component to assist Lebanese navy in securing coast and to prevent arms smuggling
- All German vessels with electro-optical sensors got support system KEOD 2.0 provisionally
  - Frigates Mecklenburg-Vorpommern and Karlsruhe
  - Fast patrol boats S74 Nerz, S77 Dachs, S78 Ozelot, and S80 Hyäne
  - Task group tender Frankfurt am Main
- Despite incomplete briefings, operators managed to handle the system easily
- Operators got adequate and helpful results from the support system
- Feedback was predominantly positive

# Conclusion & Outlook

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- Providing operators with adequate support is an essential for 21st century naval C2
- Experimentation has proved that systems developed following a human-centered approach are highly accepted and appreciated
- Graphical representations make data and coherences more comprehensible
- Further optimization of KEOD based on lessons learned on deployment
- Realization of prototypical workplace for overall C2 tasks



QUESTIONS

