Developing an Analytical Framework for Cognitive and Social Experimentation in Team Decision-Making and Collaboration

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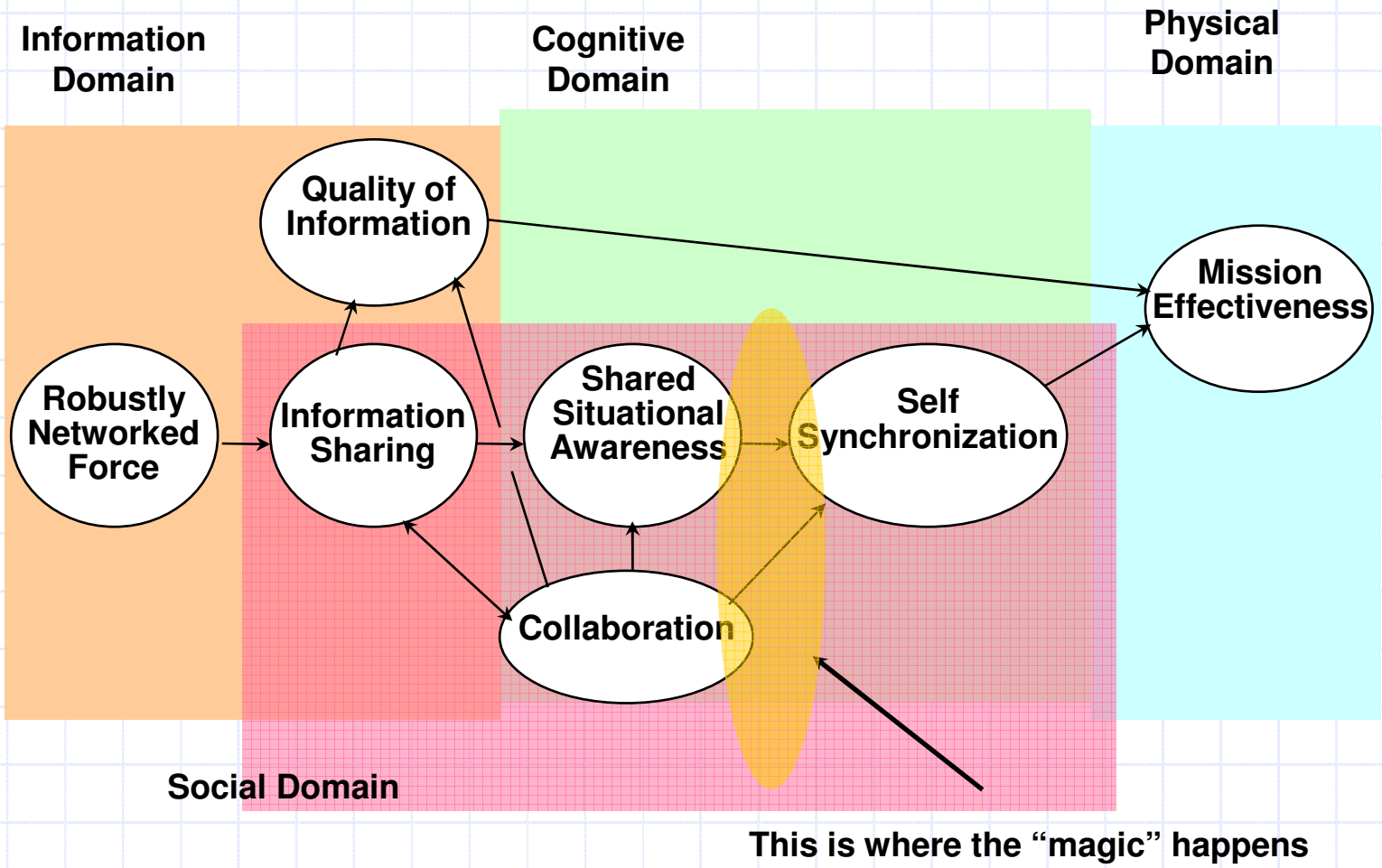
NCW Tenets

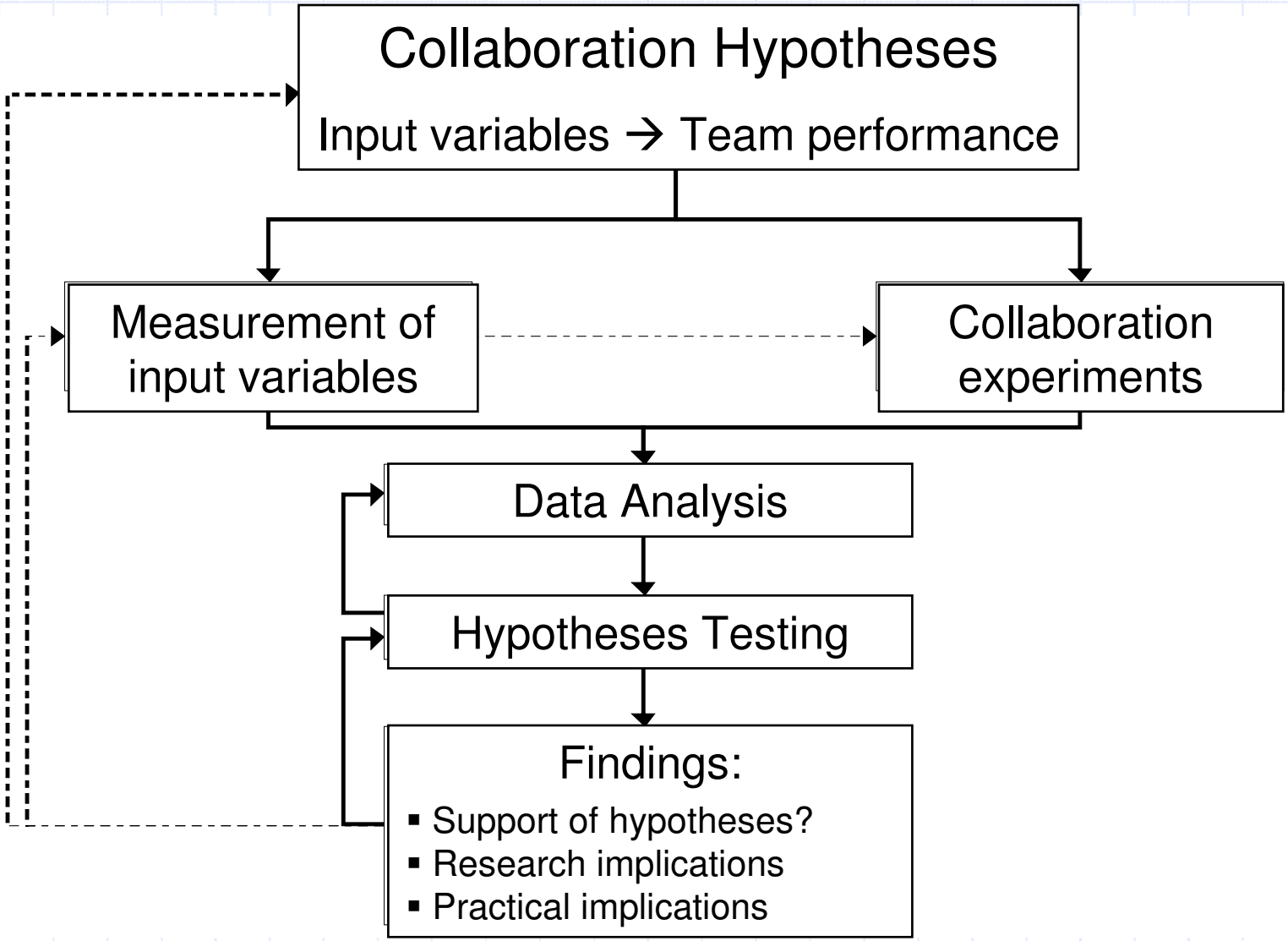

Information Domain
Cognitive Domain
Physical Domain
Quality of Information
Mission Effectiveness
Robustly Networked Force
Information Sharing
Shared Situational Awareness
Self Synchronization
Collaboration
Social Domain
This is where the "magic" happens

Research Question

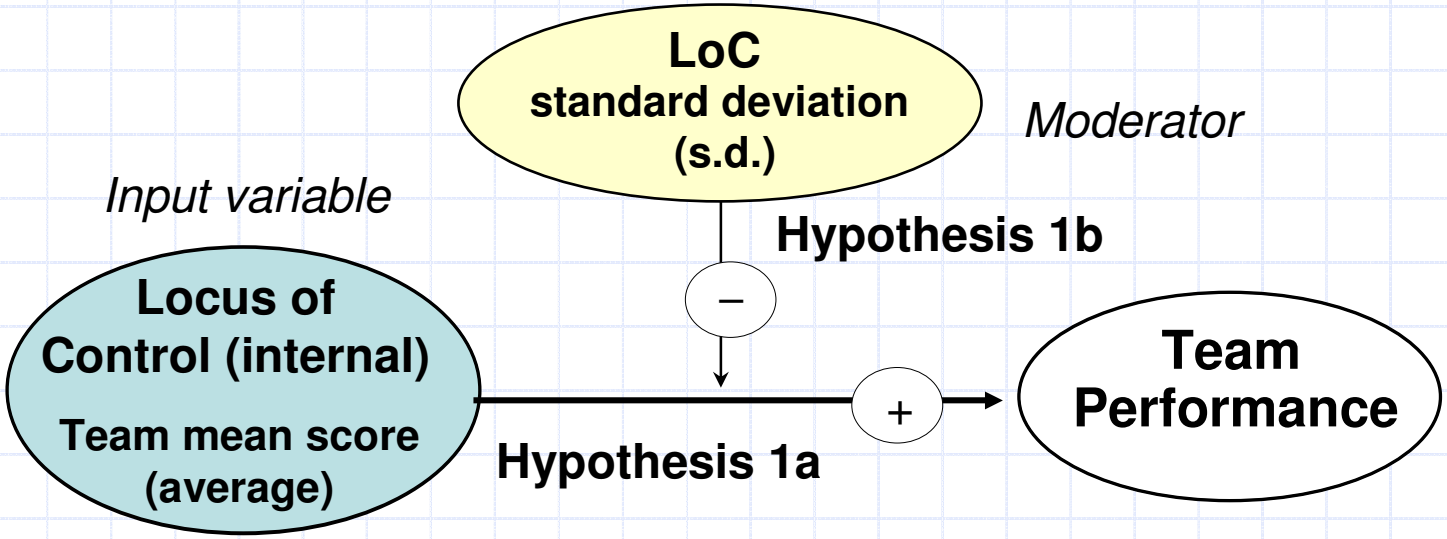
- **Underlying question: What team composition supports the quality of collective decision-making and team performance?**
- Research question: What are the effects of individual and team characteristics on team collaboration and performance?
- **Input (independent) variables**
  - **Individual characteristics**
    - Locus of Control (internal – external)
    - MBTI® Extraversion – Introversion
    - MBTI® Sensing – Intuition
    - MBTI® Thinking – Feeling
    - MBTI® Judging – Perceiving
    - Ambiguity Tolerance
    - Field Dependence

    } Team composition parameters: means, variances
  - **Team-specific characteristics**
    - Task Cohesion
    - Social Cohesion
- **Control variables**
  - Age (→ experience)
  - Gender
  - Mental ability (Figural intelligence)
  - Mental ability (Numeral intelligence)
- **Output (dependent) variables**
  - **Team effectiveness measures**
  - **Efficiency measures**

Research Design



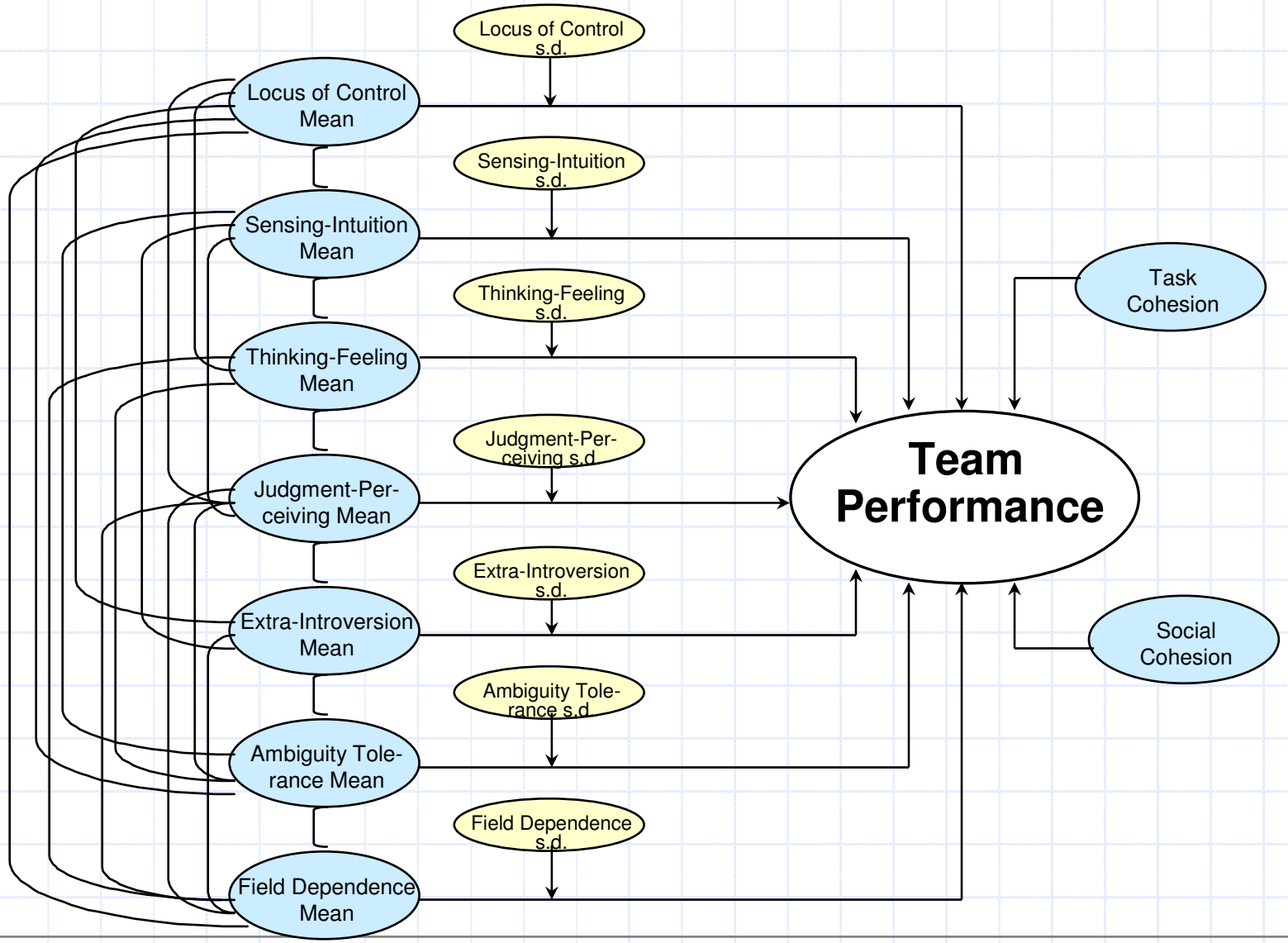
Hypotheses: An Example



Hypothesis 1a:
A team's average internal LoC is **positively related** with team performance.

Hypothesis 1b:
The standard deviation (s.d.) of a team's LoC **moderates the relationship** between the team's mean internal LoC and team performance, i.e., the higher the team's LoC s.d., the lower the correlation between the team's average LoC and team performance.

Hypotheses: Overview



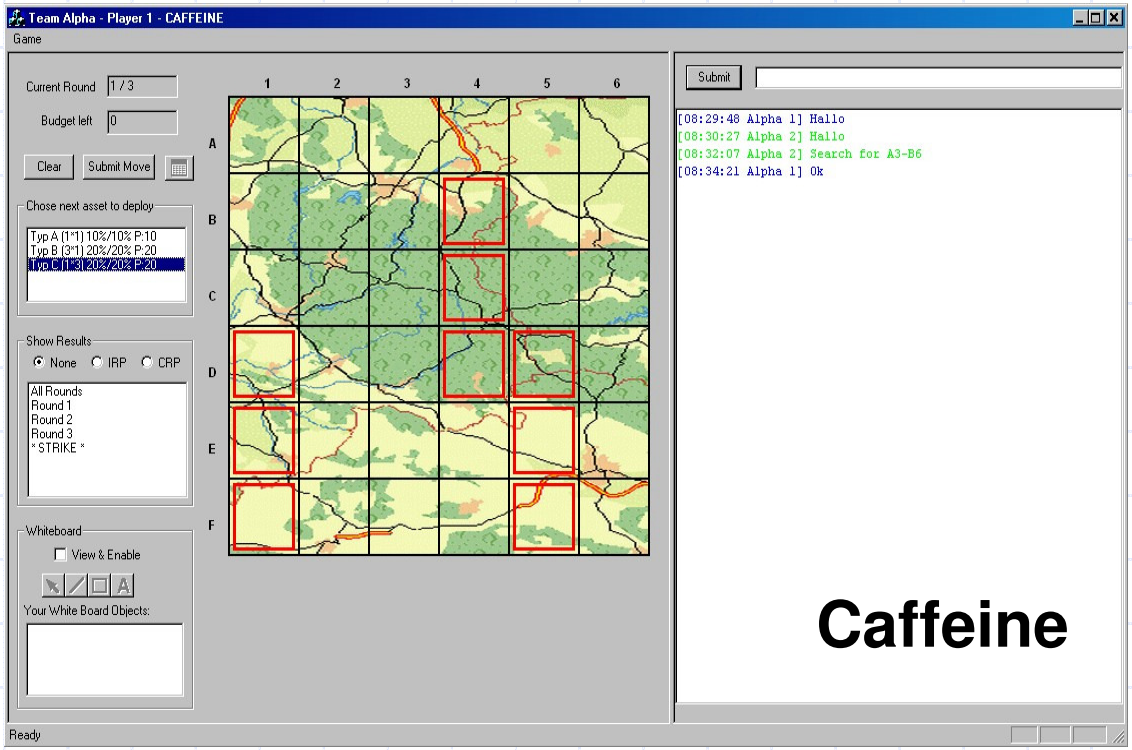
Schedule

Step	Activities	Deliverables
Step 1: Preparation (March – June 2006)	- Identification of appropriate measures for independent variables (individual and team-specific characteristics) - Identification of appropriate measures for dependent variables (measures of effectiveness and efficiency of team performance) - Development of the research design	- Measures and methodology to assess the independent variables - Measures and methodology to assess the dependent variables - (Preliminary) research design
Step 2: Pre-Investi-gation (July – Sept. 2006)	- Pre-test data collection from a small test sample (N = 13 teams (52 individuals)) - Collection of feedback from test subjects - Evaluation and, if necessary, refinement of the measures and/or research design	- Pre-investigation report - Final research design
Step 3: Data Collection (Oct. – Dec. 2006)	- Collection of data on input and output variables - Sample: approx. 600 officer cadets (Air Force officer school, University Bw Munich)	- Data base for evaluation
Step 4: Evaluation (Dec. 2006 – Feb. 2007)	- Generation of statistics - Test of hypotheses - Discussion of results - Draft of the final report	- Final report

Measurement of Collaboration

Instrument

- ***C**ollaborative G**a**me **f**or **F**irst **E**xperiences **i**n a **N**etworked **E**nvironment (CAFFEINE)*: Software for assessment of distributed team performance of C2
- Based on the ideas of ScudHunt or StrikeCOM



Measurement of Collaboration

Setting

- Teams of four individuals
- Collaborative solution of team tasks
- Local computer networks, locally distributed work
- Individual Result Picture (IRP) vs. Common Result Picture (CRP)

Methodology

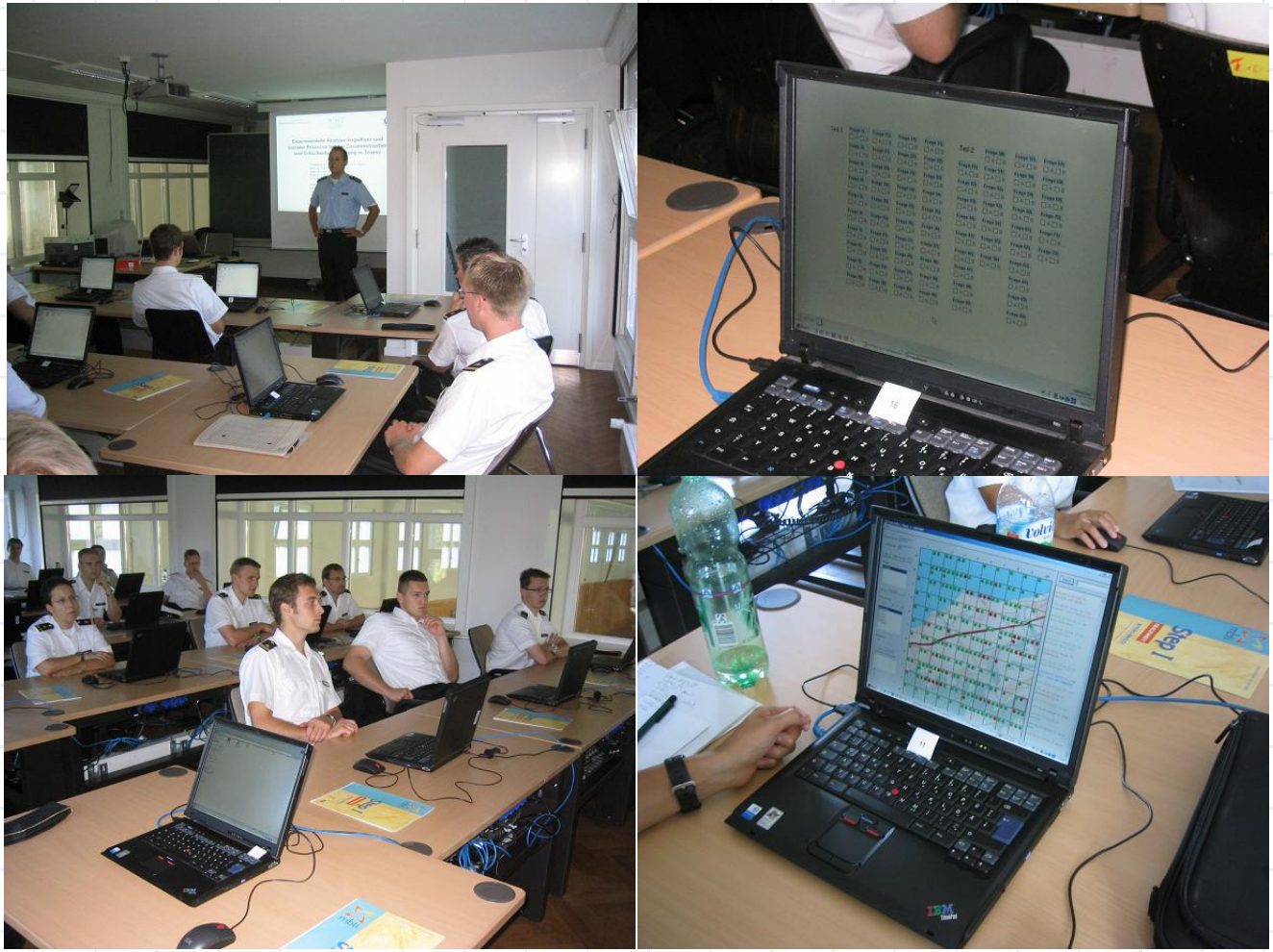
- Measurement of Team Effectiveness (hits, failures)
- Measurement of Team Efficiency (effectiveness vs. resources [time, budget, communication])
- Measurement of Shared Situational Awareness (SSA)

Self Assessment

Team members are asked to assess the quality of collaboration in their team before results are reported

Pre-study

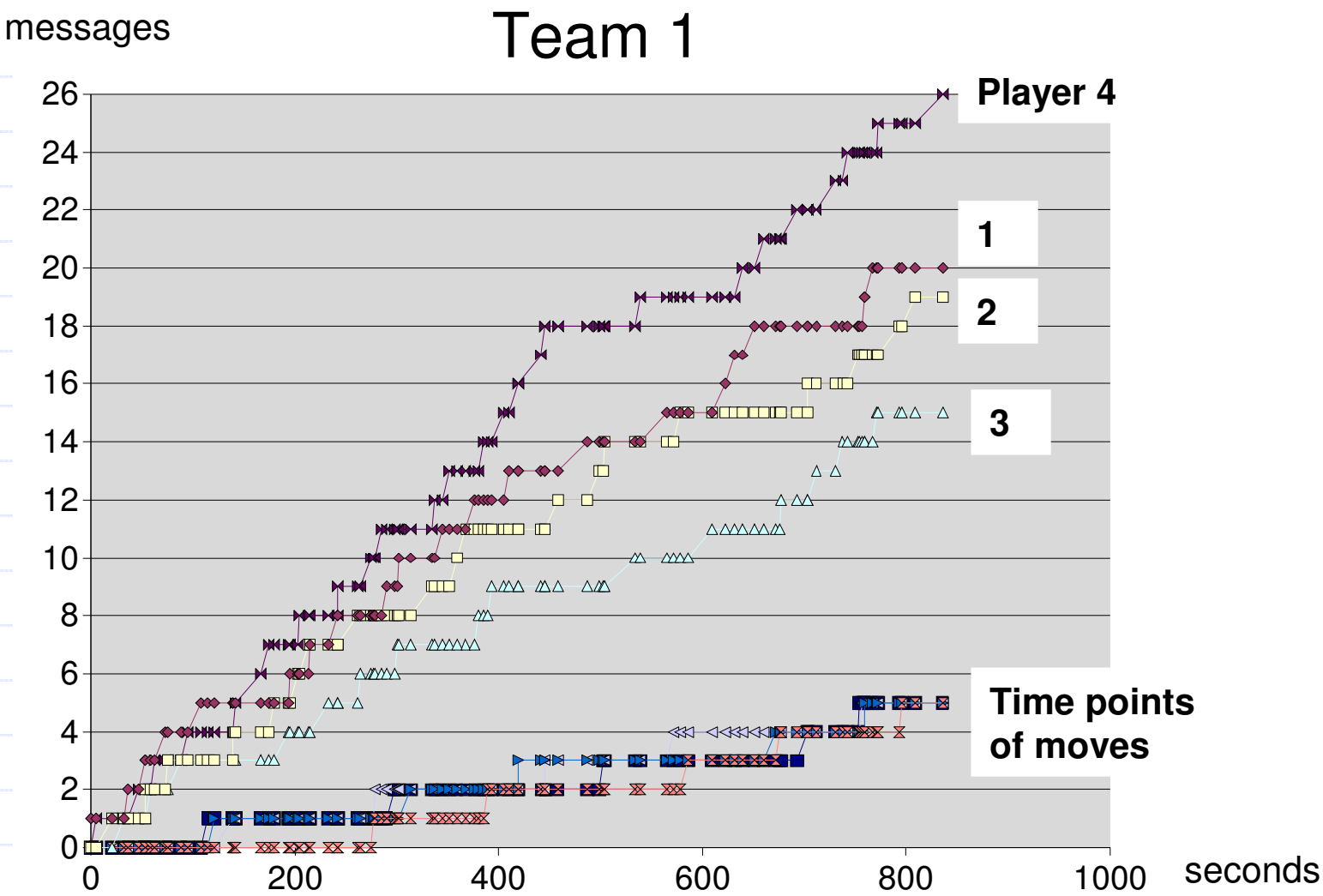
Navy School August 2006



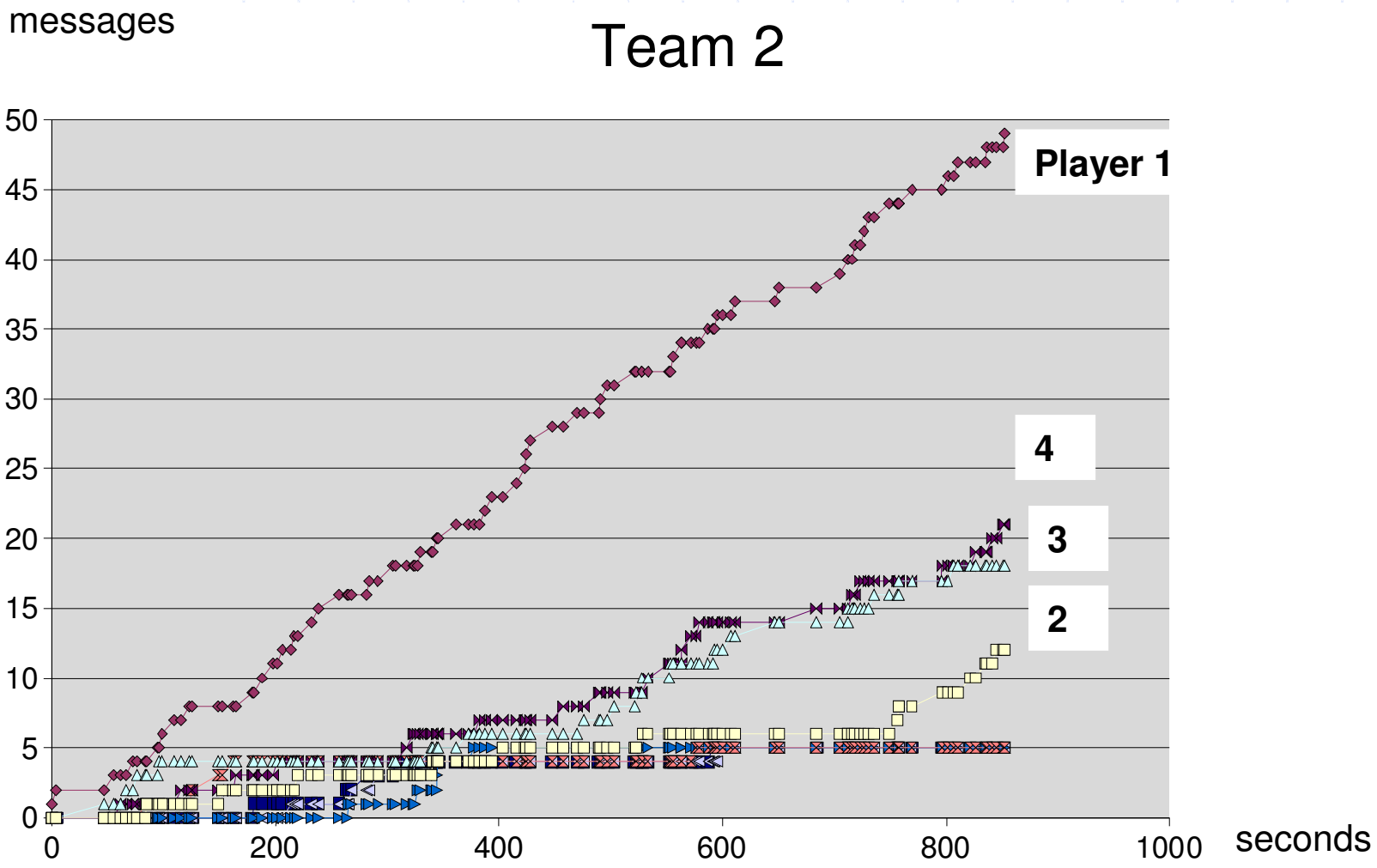
Pre-study: Some preliminary findings

- Availability of **Common Result Picture (CRP)** reduces (direct) communication and required time
- Availability of CRP gives members the impression of "competing individually against the computer"
- Team processes yield **emergent leadership**, but members may have different perceptions of the leadership process
- Teams seem to develop their own "jargon"
- Analyses of the **team process** may be at least as insightful as assessment of **output scores**
- **Qualitative analysis** of message contents and their effects on team processes may reveal additional insights

Team Process Example: Action Time Points

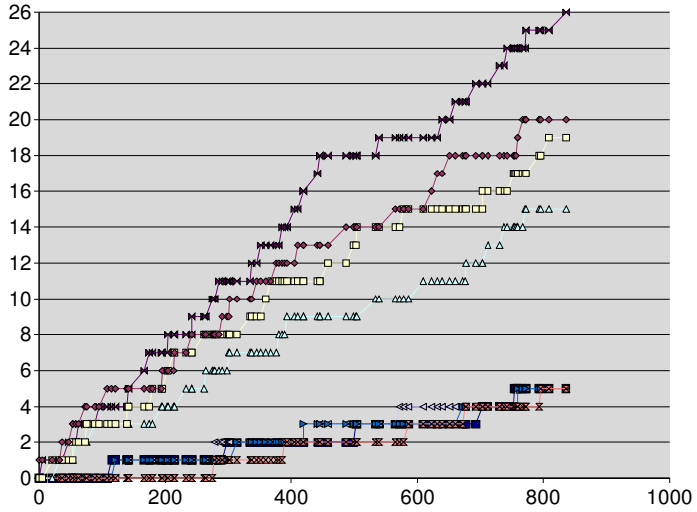


Team Process Example: Action Time Points

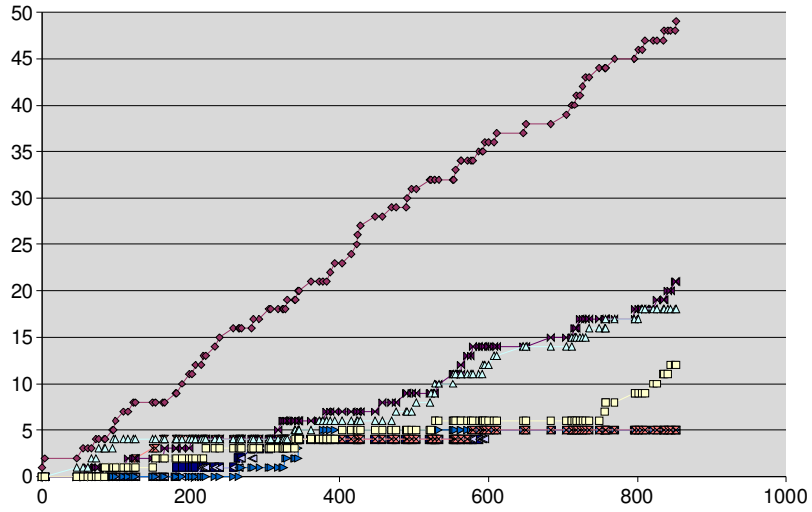


Team Processes: Comparison of examples

Team 1



Team 2



- Balanced communication pattern among the involved individuals
- Messages show a broad range of contents and functions:
  - Providing information
  - Requesting information
  - Making suggestions
  - Confirming/ reinforcing

- Unbalanced communication pattern
- Individual 1:
  - Most messages, but not a “team leader”
  - High percentage of messages that disturb rather than support the process

Pre-Study: First Individual Level Results

Correlations between input/moderator variables and output measures

	Age	Gender	E - I	S - N	T - F	J - P	LoC int.	Amb.Tol.	Num.	Fig.	Tsk.coh	Soc.coh
CRP: Hits	**.25+**	.04	.07	- .02	.00	- .04	- .16	**- .26+**	.16	.14	.17	**.28***
CRP: Miss	- .19	- .02	.00	.05	- .13	- .05	.23	.10	**- .28***	- .11	- .02	- .12
CRP: Time	- .08	- .08	- .13	- .18	- .16	- .01	.16	**- .27+**	.04	.11	.07	.04
CRP: Msgs	.22	- .17	.10	**.34****	.11	- .14	**- .32***	- .09	- .07	- .11	.07	.04
CRP Bgt left	- .01	.20	- .14	- .08	-.04	.09	- .13	- .17	- .21	- .18	- .19	- .18
CRP: Score	.16	.12	.04	- .02	.10	- .02	- .05	.00	.19	.12	.15	**.25+**
IRP: Hits	**.29***	.00	- .02	.10	- .03	- .06	.01	**- .31***	**- .25+**	.05	.25 +	.18
IRP. Miss	- .19	.04	- .05	- .05	- .15	.09	.13	.12	.16	- .06	- .13	- .18
IRP: Time	.10	.08	.01	- .20	- .07	.04	.03	**- .24+**	.16	**.38****	.18	.12
IRP: Msgs	**.42****	- .12	- .06	.21	.12	- .08	**- .43****	**- .35***	- .18	.01	- .11	- .14
IRP: Bgt left	.18	.07	- .22	- .03	.04	- .06	- .12	- .14	- .22	**- .27+**	**- .24+**	- .12
IRP: Score	.02	- .05	- .01	.07	- .01	- .02	.12	.05	- .20	- .19	.09	.15

CRP = „Common Result Picture“ available; IRP = only „Individual Result Picture“ available

N = 52 individuals **** p < .01** *** p < .05** **+ p < .10**

Pre-Study: First Team Level Results

Correlations between input/moderator variables and output measures

	Age	Gender	E - I	S - N	T - F	J - P	LoC int.	Amb.tol.	Num.	Fig.	Tsk.coh	Soc.coh
CRP: Hits	.54+	.11	.21	- .33	- .29	.14	- .20	- .48+	.23	.02	.22	.39
CRP: Miss	- .19	- .09	.02	.21	.03	- .33	.18	.11	- .39	- .10	- .11	- .36
CRP: Time	- .27	- .12	- .35	- .37	- .42	.31	.21	- .23	.16	.29	.12	.17
CRP: Msgs	.33	- .18	.14	.10	- .47+	.00	- .52+	- .73**	- .14	.00	- .04	- .17
CRP: Bdg left	.35	.05	.05	.14	- .24	.04	- .55*	- .20	.16	.15	- .03	- .39
CRP: Score	.12	- .05	.30	- .23	.21	- .24	.02	.10	.29	.24	.17	.05
IRP: Hits	.55*	.23	- .06	.24	- .05	.02	- .13	- .38	- .44°	- .05	.40	.26
IRP: Miss	- .39	- .44°	- .22	- .28	- .38	.33	- .07	- .02	.36	.08	- .33	- .44°
IRP: Time	- .12	- .06	- .07	- .69**	- .24	- .05	.18	- .09	.37	.71**	.31	.07
IRP: Msgs	.03	.46	- .49+	.07	.01	.60*	- .38	- .21	- .21	- .31	- .62*	- .12
IRP: Bdg left	.53+	.42	- .42	- .04	- .32	.54+	- .72**	- .39	.02	.10	- .248	- .33
IRP: Score	.61*	.03	.00	- .24	- .28	.19	.06	- .30	.02	.00	.56*	.62*

CRP = „Common Result Picture“ available; IRP = only „Individual Result Picture“ available

N = 13 teams ** p < .01 * p < .05 + p < .10

Expected Implications of Research Project

- Findings from research in non-military contexts (e.g. on relevant input variables, team heterogeneity, task complexity) may be relevant for collaboration settings in military contexts as well
- Results expected to contribute to our knowledge about the role of human factors and team structure with regard to team effectiveness in C2
- Support of team composition and training for networked environments

Limitations

- Interdependencies between input variables expected (multiple regression analyses)
- Random team composition
- Task cohesion and social cohesion to be generated by “manipulation” (manipulation checks)
- External validity
  - Laboratory environment
  - Simplified (low-complexity) task used for measuring cooperation

Issues for further Research

- Task-related effects on team collaboration
  - How does task complexity affect relationships between individual and team characteristics and team collaboration?
  - Is there a task complexity-related limit to collaboration if response time for team decisions is limited?
- Education/training/experience and collaboration
  - How does education/military training/field experience affect team collaboration?
  - How does education/training/experience affect the limits of task complexity?
- Team collaboration in multinational operations
  - How does national military culture affect relationships between individual / team characteristics and team collaboration?
  - How do intercultural differences impact on collaboration in multinational teams and between teams of different nations?