Objective Metrics For Evaluation of Collaborating Teams*

Presented to

2003 Command and Control Research and Technology Symposium

Presented by

David Noble, and John Kirzl

June 17, 2003

Evidence Based Research, Incorporated
1595 Spring Hill Road
Vienna, VA 22182

* Phase 2 SBIR from Office of Naval Research

Agenda

- Evaluation goals
- Subjective and objective performance measures
- Measuring product quality
- Identifying reasons for improved performance
  - Single person
  - Team efforts
- Summary

Evaluation Goals

- Assess the impact of new technologies, organizations, and operational concepts on C2 and mission effectiveness
- Understand reasons for changes
- Balance cost, complexity, and intrusiveness with evaluation goals
- Maximize applicability of results across different domains

Subjective Evaluation

- Asks users their opinions on utility of new technology, organization, or process
- Metric is how well users like it
- Advantages
  - Provides valuable insights on utility
  - Alerts to problems with user acceptance
  - Straight forward to collect data
- Disadvantages
  - User's opinions do not always correlate with improvements to performance or product*
  - Evaluation may depend on backgrounds of particular evaluators, and may not apply to people with other backgrounds
  - Reduces credibility with evaluation client or program managers
  - May be difficult to discover reasons for why the intervention works (since don't actually know it does)
  - May require intrusive data collection

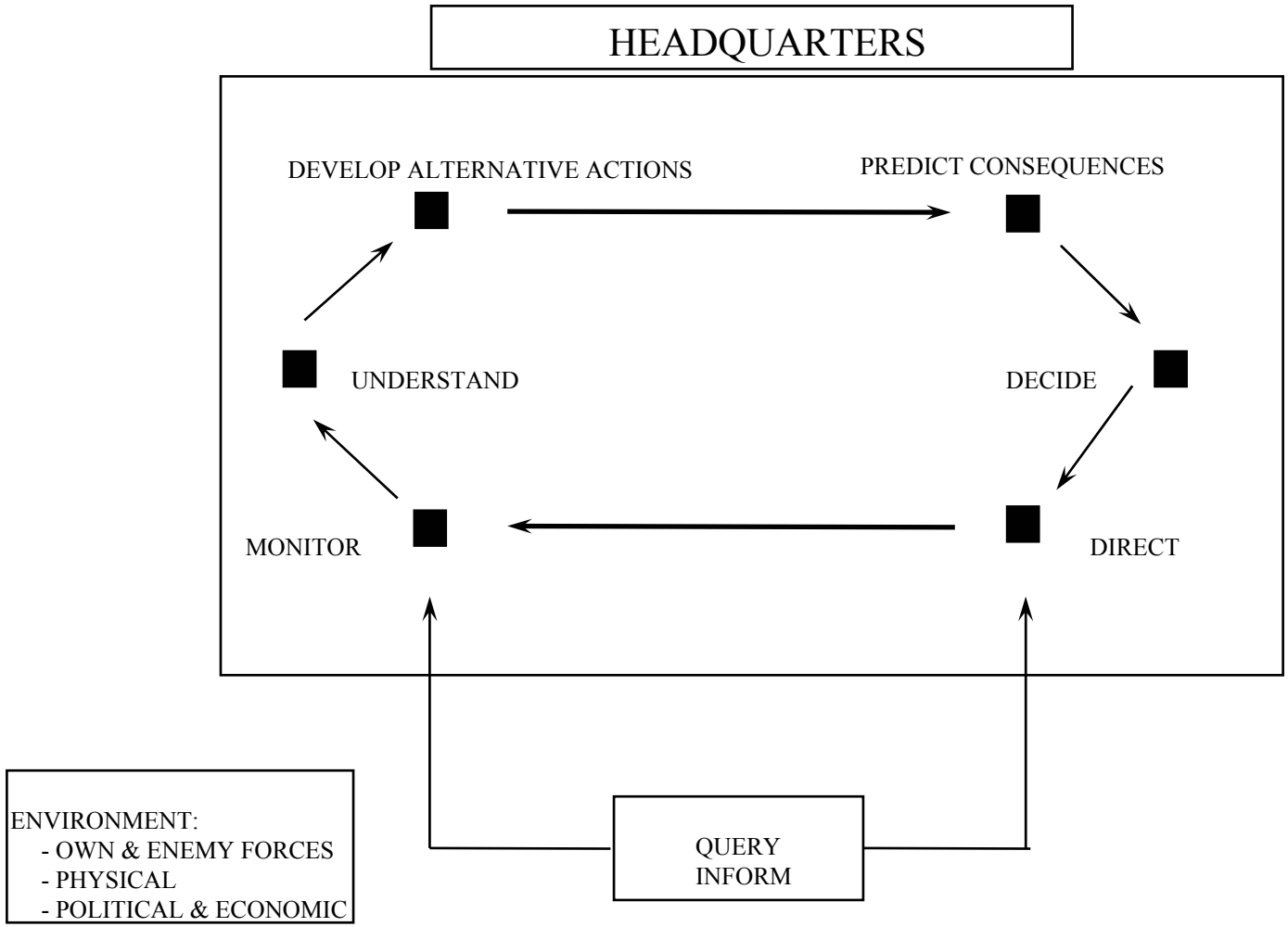
e.g., JFCOM Visualization LOE

Objective Evaluation

- Measures change in product quality or team performance after introducing new technology, organization, or process
- Metric is change in product quality or team performance
- Advantages
  - Provides best evidence for sponsors
  - Provides audit trail to underlying reasons for performance
  - Can be non-intrusive
  - Can be low cost. Simple evaluations can produce results good enough for many purposes
  - Good methods now exist for measuring intellectual products associated with situation understanding, planning, and decision making
- Disadvantages
  - Requires good judgment to define appropriate metrics and to balance needs of evaluation with costs and complexity of evaluation

Pioneering Objective Measures

HEAT Analytic Structure



Objective Measures of Product Quality

- Bottom line “proof of the pudding” metrics
- Depend only on the particular product and not how that product is produced
- Usually requires an expert “answer key”
- Measurements are non-intrusive
  - Requires examining the product
  - Minimizes interactions with users

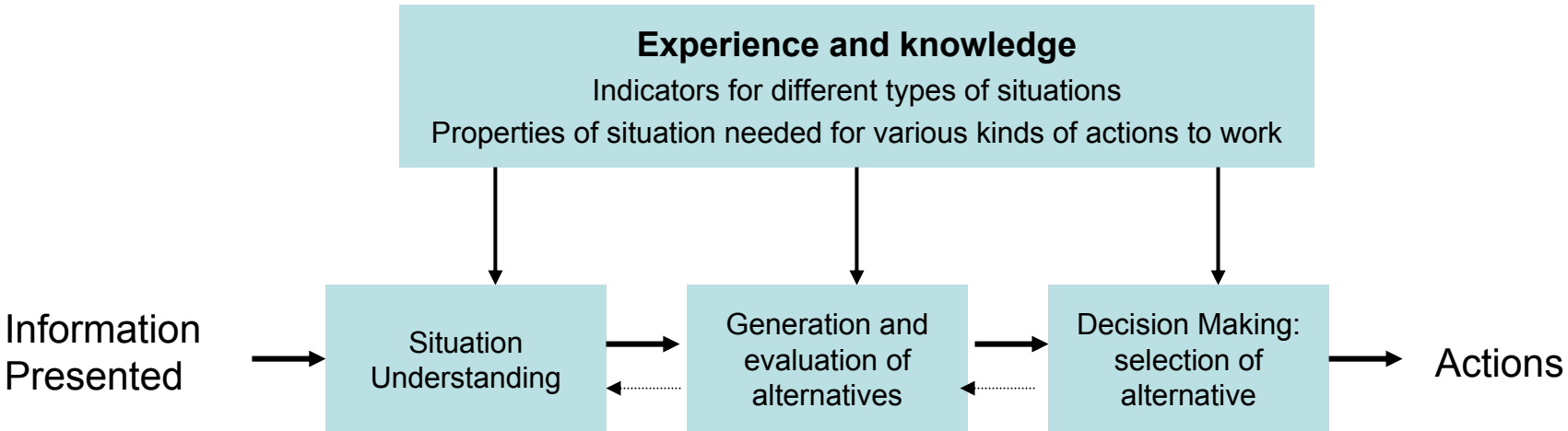
Some Product Quality Measures

- Situation Assessments
  - Correctness/completeness of location, identity, status and capabilities of forces
  - Plausibility of estimates for adversary intent and possible courses of action
  - Recognition of opportunities and risks
- Plans
  - Useful life of plan compared to its intended useful life. No plan "survives contact with the enemy," but better plans last longer
  - Fraction of commander's objectives that plan addresses
  - Fraction of plausible contingencies covered by plan
- Decisions
  - Extent that decision maker considers key factors: e.g., consideration of situation drivers such as centers of gravity, hedging for critical uncertainties
  - Expert rating of alternative selected

Understanding Reasons for Product Quality

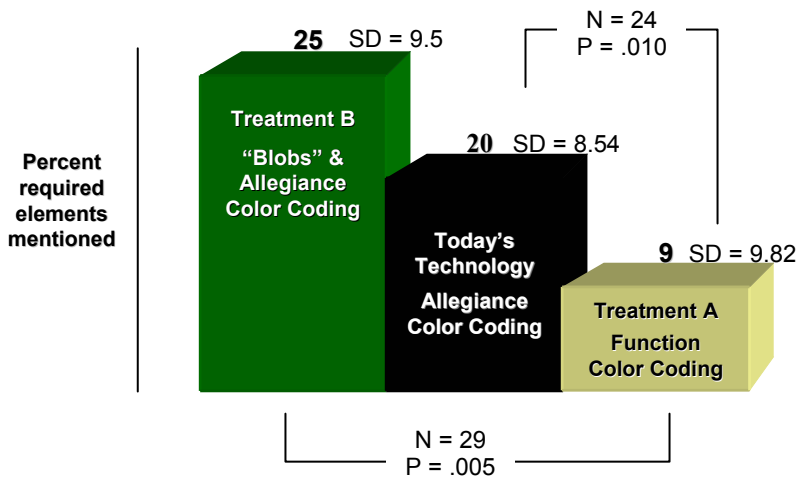
Single Person Producer

- Audit trail between infrastructure and product quality requires a model of cognitive processes
- Model for single person product creation is:



Example: CPOF LOE

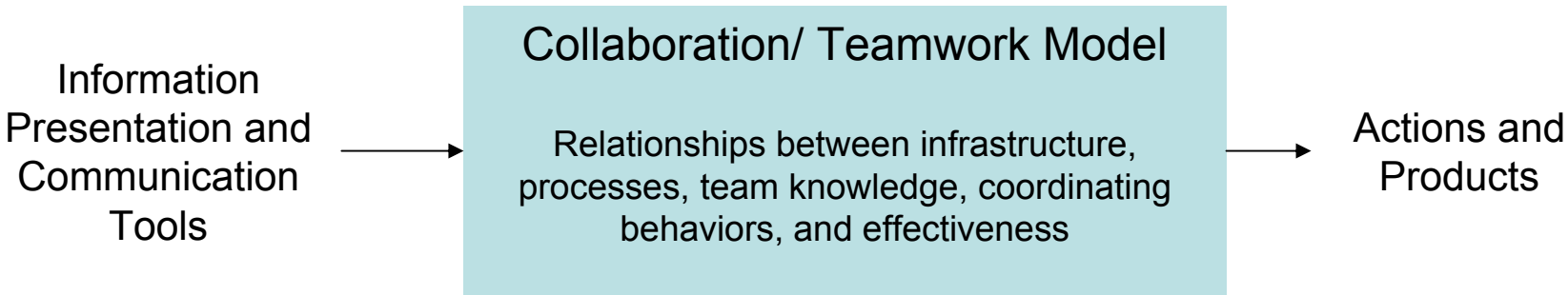
- CPOF LOE 1
  - Maps where color coding designated force allegiance were significantly more effective than maps where color coding designated function of unit, regardless of allegiance
- Cognitive explanation:
  - Key assessment issues required estimating relative force strength of opposing sides
  - Color coding for allegiance supported quick estimate of that feature; color coding for function obscured it



Understanding Reasons for Product Quality

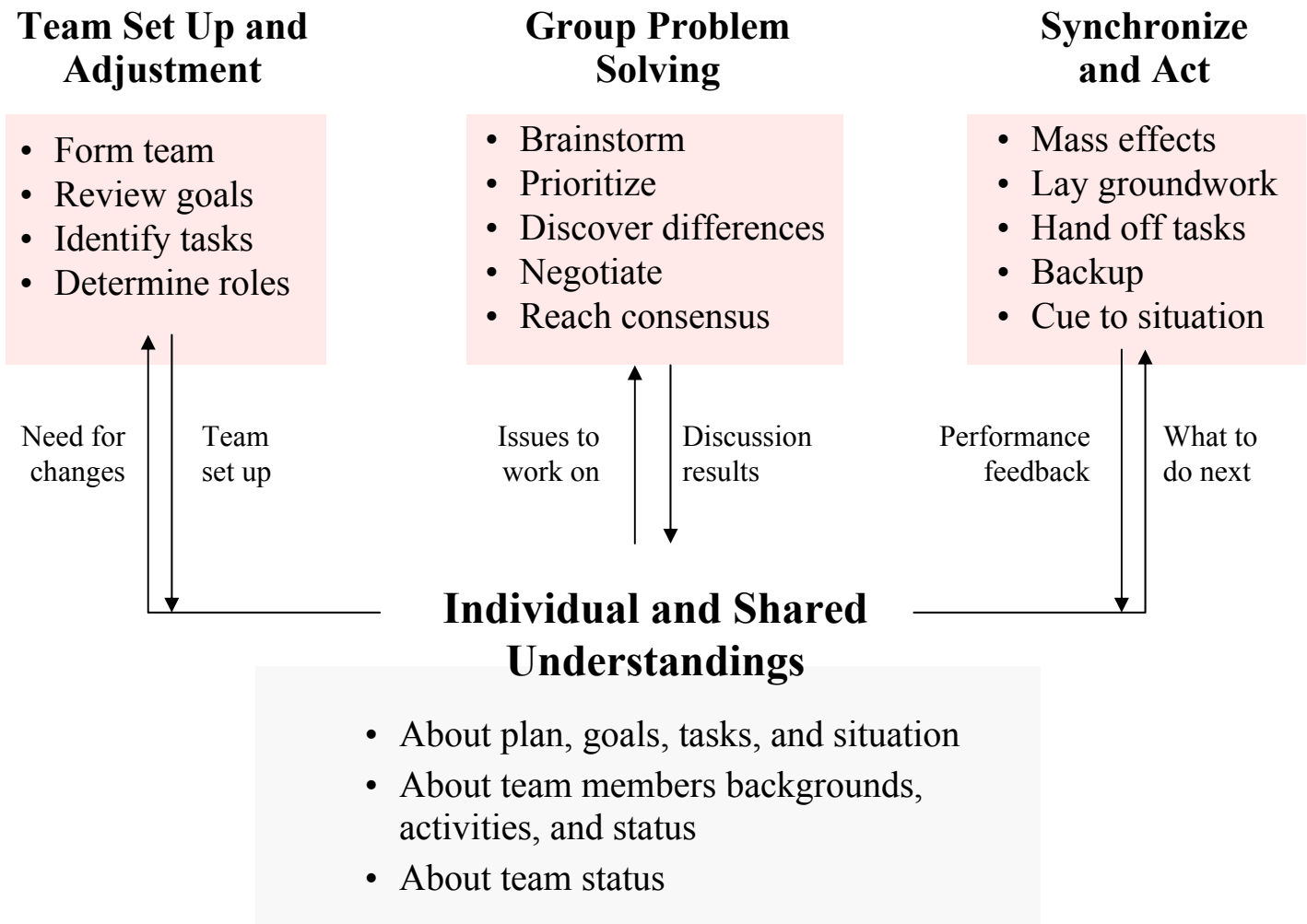
Collaborating Teams

- As in single person case, need a process model that connects information presented to properties of product
- Models for collaborative product creation now available from ONR SBIR
- Extension of single person models to team models detailed in subsequent viewgraphs

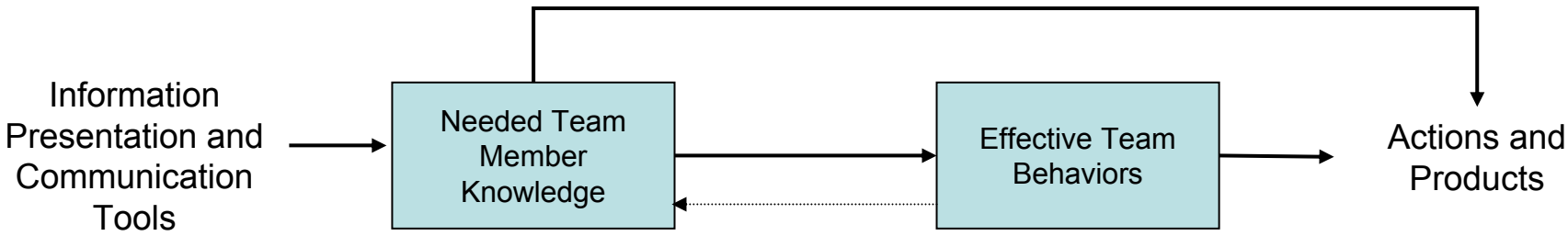


Theory: How Teams Work

Building Blocks of Collaboration and Teamwork



Model: Enabling Knowledge and Behaviors



12 Knowledge Enablers

- Goals
- Plan
- Dependencies
- Familiarity
- Business Rules
- Task experience

- Others' activities
- External situation
- Task progress
- Mutual understanding
- Plan viability
- Decision factors

9 Critical Behaviors

- Right level of busyness
- Effective coordination
- Working on right tasks

- Identifying needed information
- Sharing with right people at right time
- Effective leveraging of perspectives
- Effective information organization

- Recognizing need for adaptation
- Implementing the adaptation

Example: Evaluation of ONA

- Experiment evaluated use of Operational Net Assessment
- Product measures showed no impact from new processes
- Participants were handed the tools “cold” with no instructions except to “use them”
- Audit trail analysis suggests lack of understanding of team business rules and agreement of goals blocked possible benefits
- Subsequent evaluation showed value of ONA

12 Knowledge Enablers

- Goals
- Plan
- Dependencies
- Familiarity
- Business Rules
- Task experience

- Others activities
- External situation
- Task progress
- Mutual understanding
- Plan viability
- Decision factors

Knowledge gaps in “goals” and “business rules” may have prevented tool effectiveness

Reducing effective information sharing

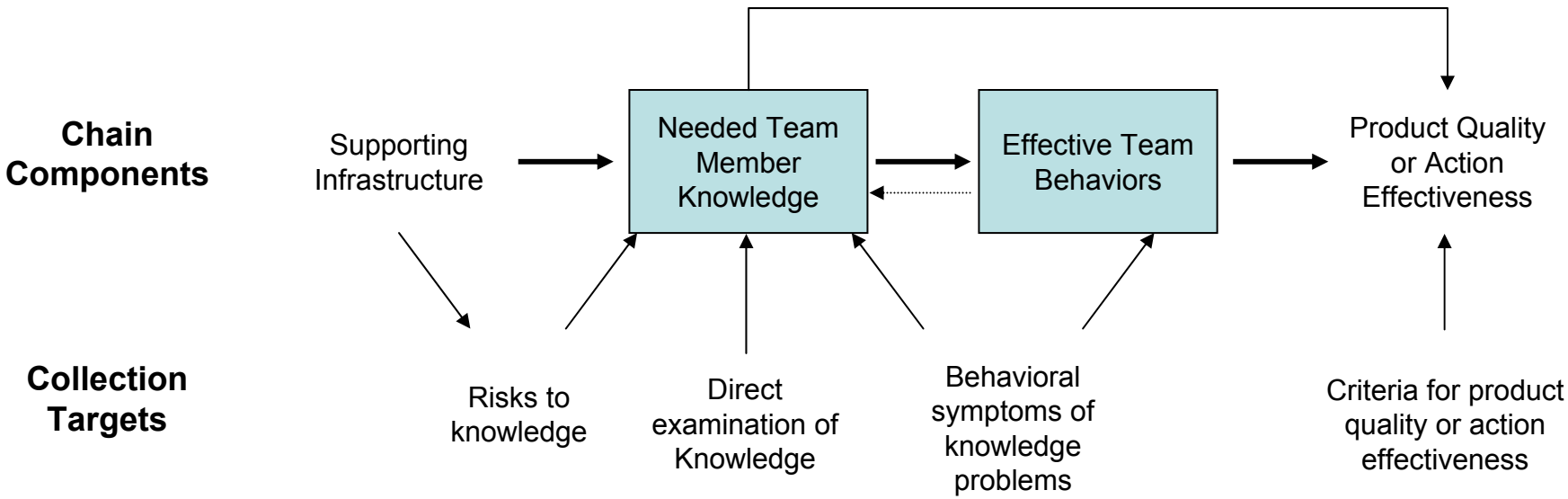
9 Critical Behaviors

- Right level of busyness
- Effective coordination
- Working on right tasks

- Identifying needed information
- Sharing with right people at right time
- Effective leveraging of perspectives
- Effective information organization

- Recognizing need for adaptation
- Implementing the adaptation

Evaluating Collaboration



- Observables available from, examination of Infrastructure, from participants answers to questions, from participants statements and behaviors, and from examination of product
- Assessment of product, behavior, knowledge, and infrastructure provide desired effectiveness causality audit trail

Evaluation Aids

- Evaluation handbook
  - For evaluation professionals
  - Describes how to collect data for evaluating infrastructure, knowledge, behaviors, and product
  - Discusses data analysis methods
- Collaboration advisor expert system
  - Team self help for diagnosing and fixing problems
  - “Value driven” expert system
  - Employs medical diagnosis strategy
    - Asks team members about environment and observed behaviors
    - Diagnosis possible knowledge shortfalls
    - Recommends process and tool remedies

Summary

- Objective evaluation measures are most “bottom-line” and most credible
- Coupled with cause-effect models linking infrastructure to product, they provide an audit trail of underlying reasons for impact
- Useful models are now available that describe how individuals and teams create intellectual products
- Data collection and analysis tools support cost-effective and efficient evaluation