Supporting C^2 Decision Support Design with Cognitive Work Analysis

William C. Elm

Scott S. Potter

James W. Gualtieri

Cognitive Systems Engineering Center
ManTech International Corp.
436 Seventh Ave, Suite 2500
Pittsburgh, PA 15219
Scott.Potter@ManTech.com
412.471.3456 x20 (voice)
412.471.3461 (fax)

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Supporting C^2 Decision Support Design with Cognitive Work Analysis

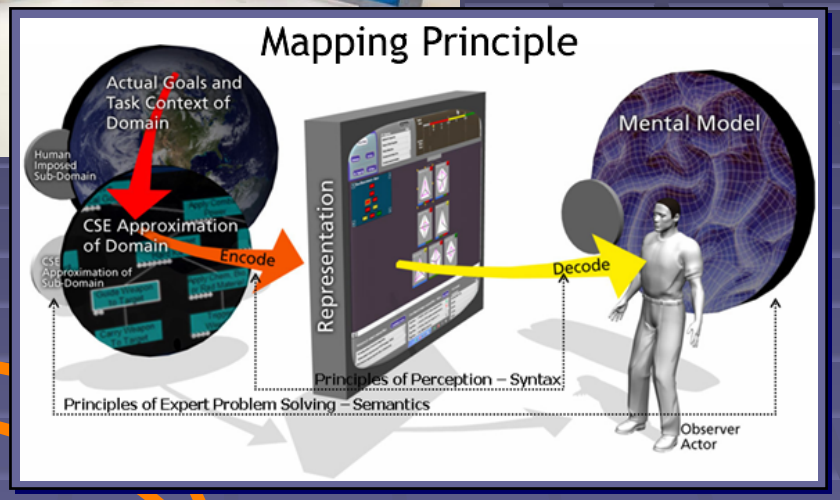
- Some important questions:
  - How do we get CWA results that are relevant to design… that make a significant impact on the resulting C^2 system?
  - How do we identify and capture the essential cognitive demands of the C^2 work domain as the underlying basis for decision support tools?
  - How do we conduct an iterative analysis / design process that is agile in the face of certain change?
  - ***Bottom line…*** how can Cognitive Analysis make a difference in the C^2 fight… how can we support the design of innovative Decision Support Systems?

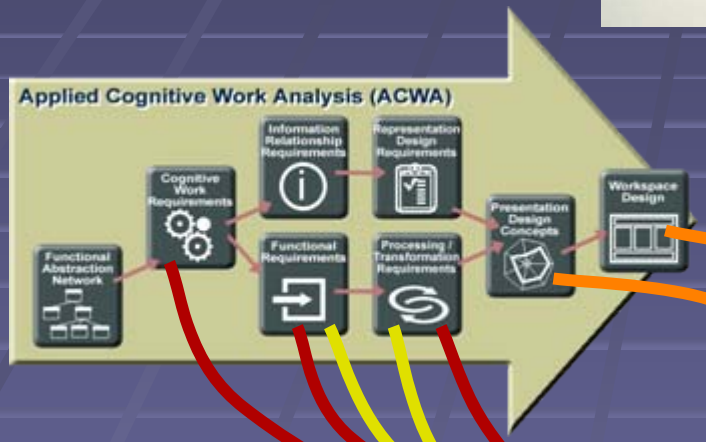
CSE Support Requirements

- Observability
- Directability
- Teamwork with agents
- Directed attention
- Resilience

Levels of Representation Design

- Workspace Coordination
- Making Sense of Change
- Pattern Views





CWA Evaluation Criteria

- Efficiency of the CWA
- Validity of the CWA
- Effectiveness of CWA in design
- Tractability of CWA results in design
- Predictive Power of the CWA

Representation Design Techniques for Establishing Direct Correspondence

- Frames of Reference
- Context
- Events
- Contrast

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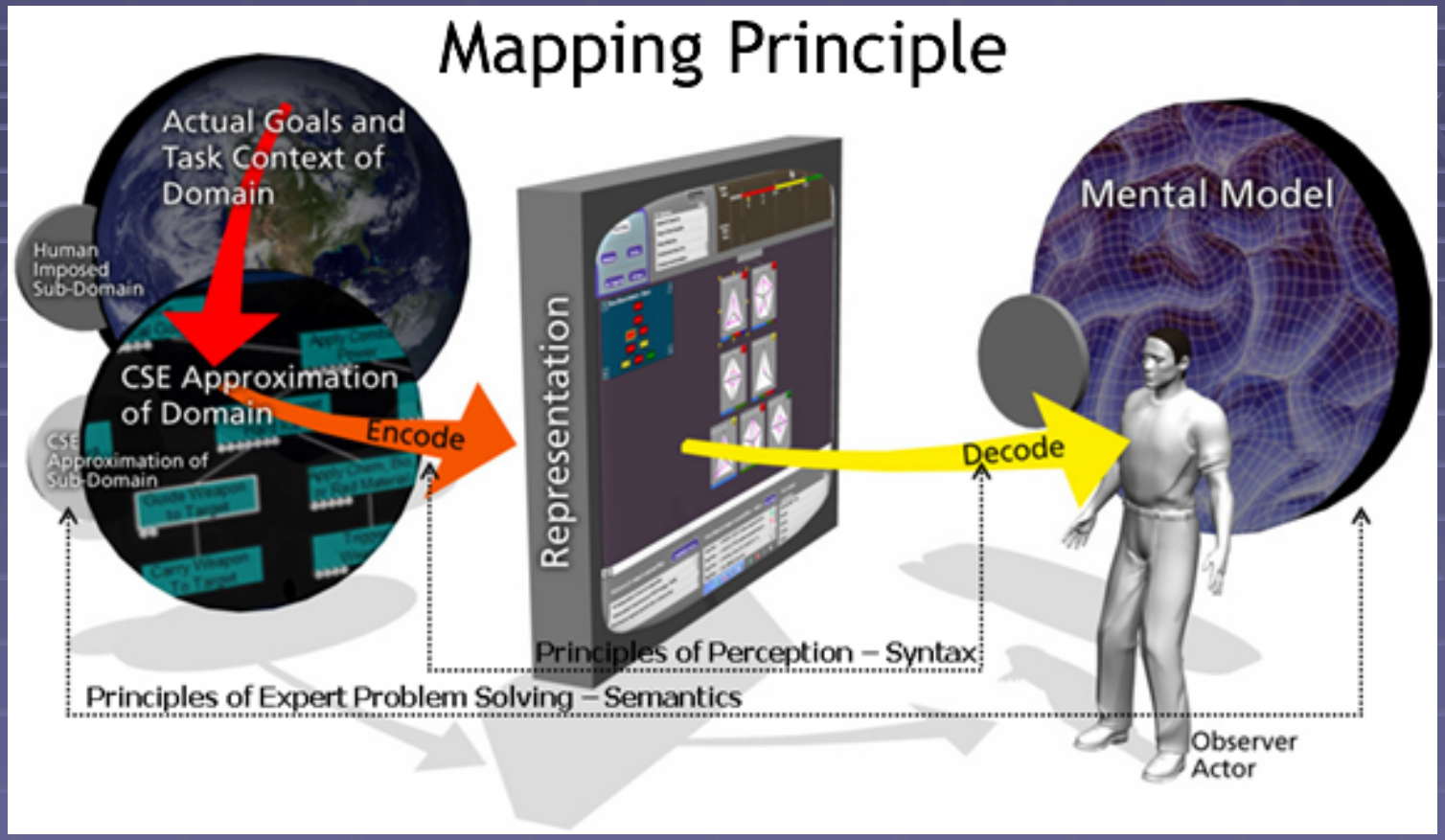
An Example

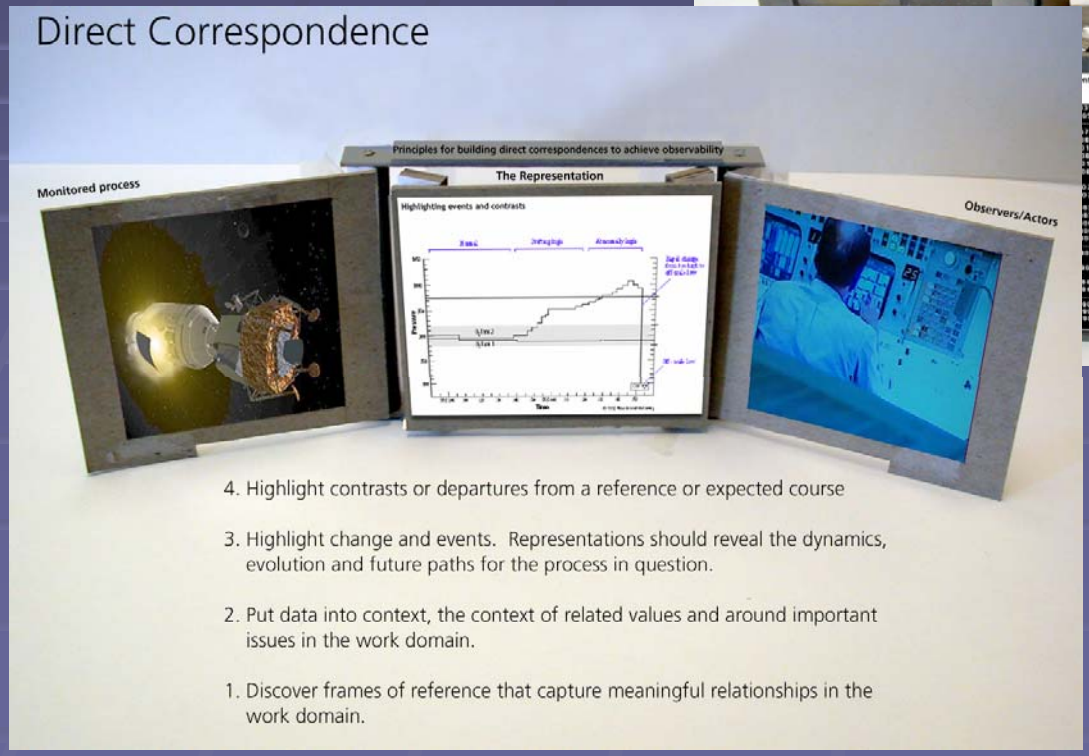
At the Heart of the Issue…



Representation Design Requires:

- The decision aid be defined in terms of how data on the state and semantics of the domain is mapped into the syntax and dynamics of visual forms in order to produce information transfer to the decision maker using the representation

Representation Design… Building Correspondence



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CSE Support Requirements for Achieving Highly Effective Joint Cognitive Teams

Observability –

the ability to form insights into a process (either a process in the work domain or in the automation).

Directability –

the ability to direct/redirect resources, activities, and priorities as situations change and escalate.

Teamwork with agents –

the ability to coordinate and synchronize activity across agents.

Directed attention –

the ability to re-orient focus in a changing world.

Resilience –

the ability to anticipate and adapt to surprise and error.

CWA Evaluation Criteria

Efficiency of the CWA in itself

- Are the resources being invested in the CWA activities commensurate with the value of the results being obtained?

Validity of the CWA

- Does it capture what it is like to function in the field of practice?

Effectiveness of CWA in design

- Does the CWA point to what is likely to be useful support?
- Does it help generate new aiding concepts and innovations?
- Does it generate ideas that can be readily converted to system requirements to guide system design and testing?

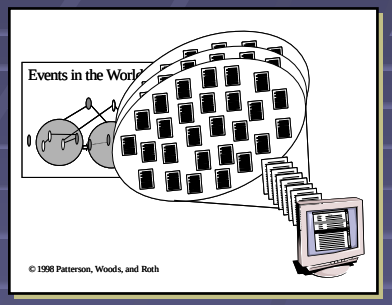
Tractability of CWA results in design

- Are the products of the CWA documented in a way that can be meaningfully reviewed, tracked, and updated not only throughout the CWA phase but also throughout the entire system design life-cycle?
- Do the products of the CWA make contact with artifacts utilized in the software design process and can the results of the CWA be integrated into the software and product development process?

Predictive Power of the CWA

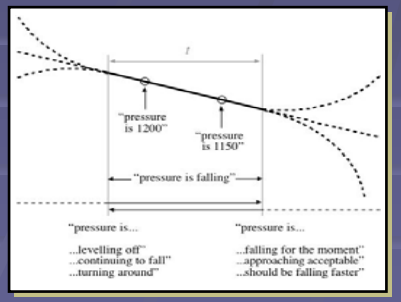
- Does it help anticipate the impact of the introduction of new technologies and aiding concepts on practitioner performance?
- Does it predict how new technological power can change roles, expertise and error?
- Does it help address the envisioned world problem?

Levels of Representation Design



Coordinating Multiple Perspectives –

Coordinating shifts and contrasts among different perspectives over task sequences and as situations evolve. Coordination of multiple points of view into the processes of the work domain to create a virtual perceptual field or a workspace in which practitioners carry out their domain activities.



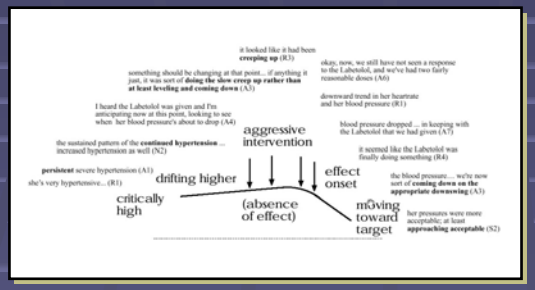
Making Sense of Change –

Organize and integrate pattern views around classes of events in the work domain in order to reveal operationally interesting changes. The key is to transform from changes in individual physical characteristics to changes of higher-order semantic properties.

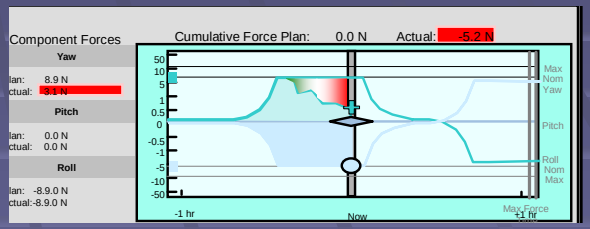
Pattern Views –

Organize data to reveal relationships and patterns in the work domain. Integrated representations inter-relate data to provide a coherent view into a process. The key criterion is to help practitioners pick up status at a glance rather than having to read and mentally integrate many individual pieces of data.

Design Techniques for Establishing Direct Correspondence

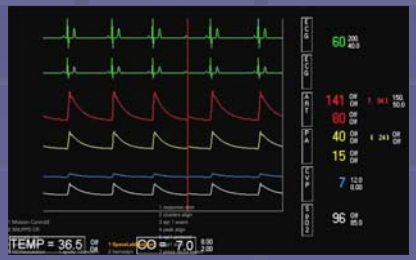


Events – Highlight spatial and temporal events. Representations should reveal the dynamics, evolution and future paths for the process in question. Events are temporally extended behaviors of the device or process involving some type of change in objects or situations.



Contrast – Highlight contrasts. Meaning lies in contrasts – some departure from a reference or expected course. Representing contrast means that one indicates the relation between the contrasting objects, states or behaviors.

Frames of Reference – Discover frames of reference that capture meaningful relationships in the work domain. Each frame of reference is like one perspective from which one views or extracts meaning from data about the underlying process or activity.



Context – Put data into context; the context of related values and around important issues in the work domain. One prerequisite is to know what relationships are informative in what contexts in the field of practice.

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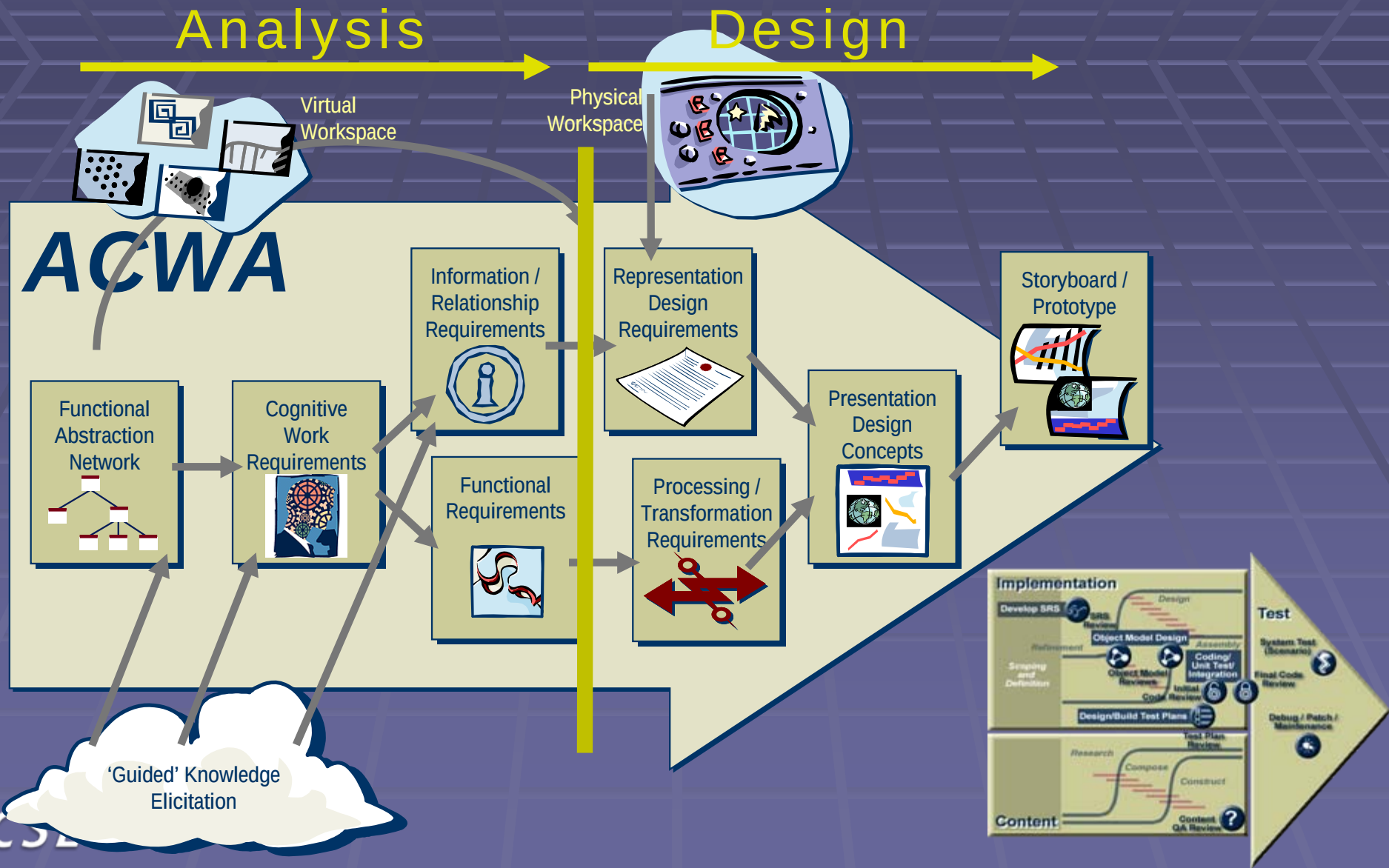
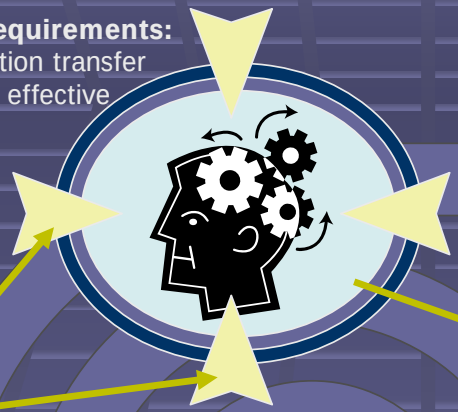
The ACWA Methodology… Providing an Integrated Approach to Support Design



In Actual Practice… An Iterative Bootstrapping Process

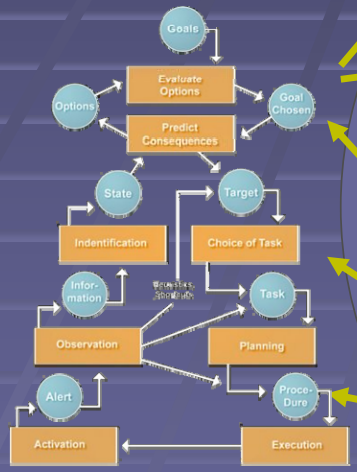
Information Requirements:
Defining information transfer requirements for effective decision-making

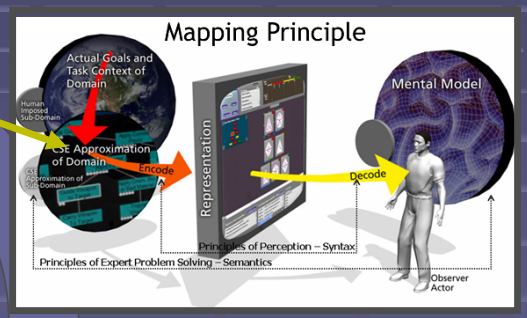


Representation Requirements:
Mapping domain semantics to syntax and dynamics of support tools to achieve information transfer requirements

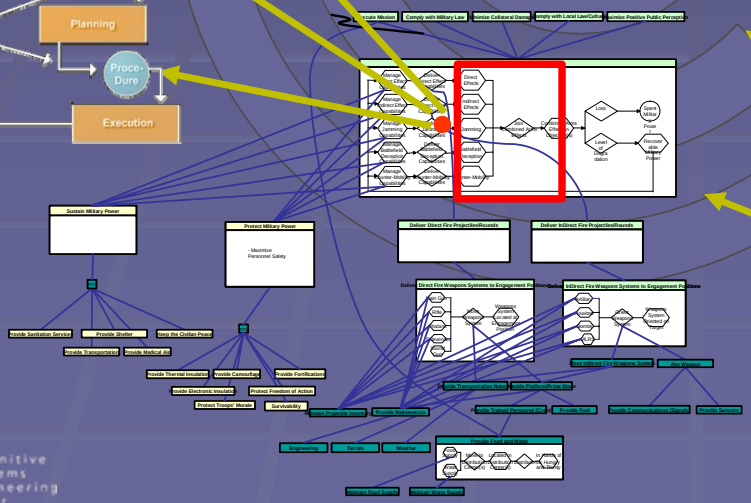
Transition to Design:
Explicit linking to follow-on design phase

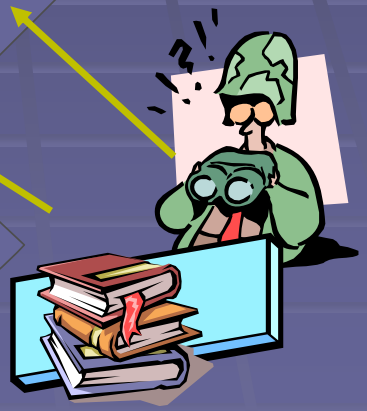
Cognitive Work Requirements:
Defining requirements for effective decision-making in work domain





CWA Model:
Modeling Fundamental Relationships and Demands in the Work Domain





Knowledge Elicitation:
Finding demands, decision-making challenges, expert strategies, etc.

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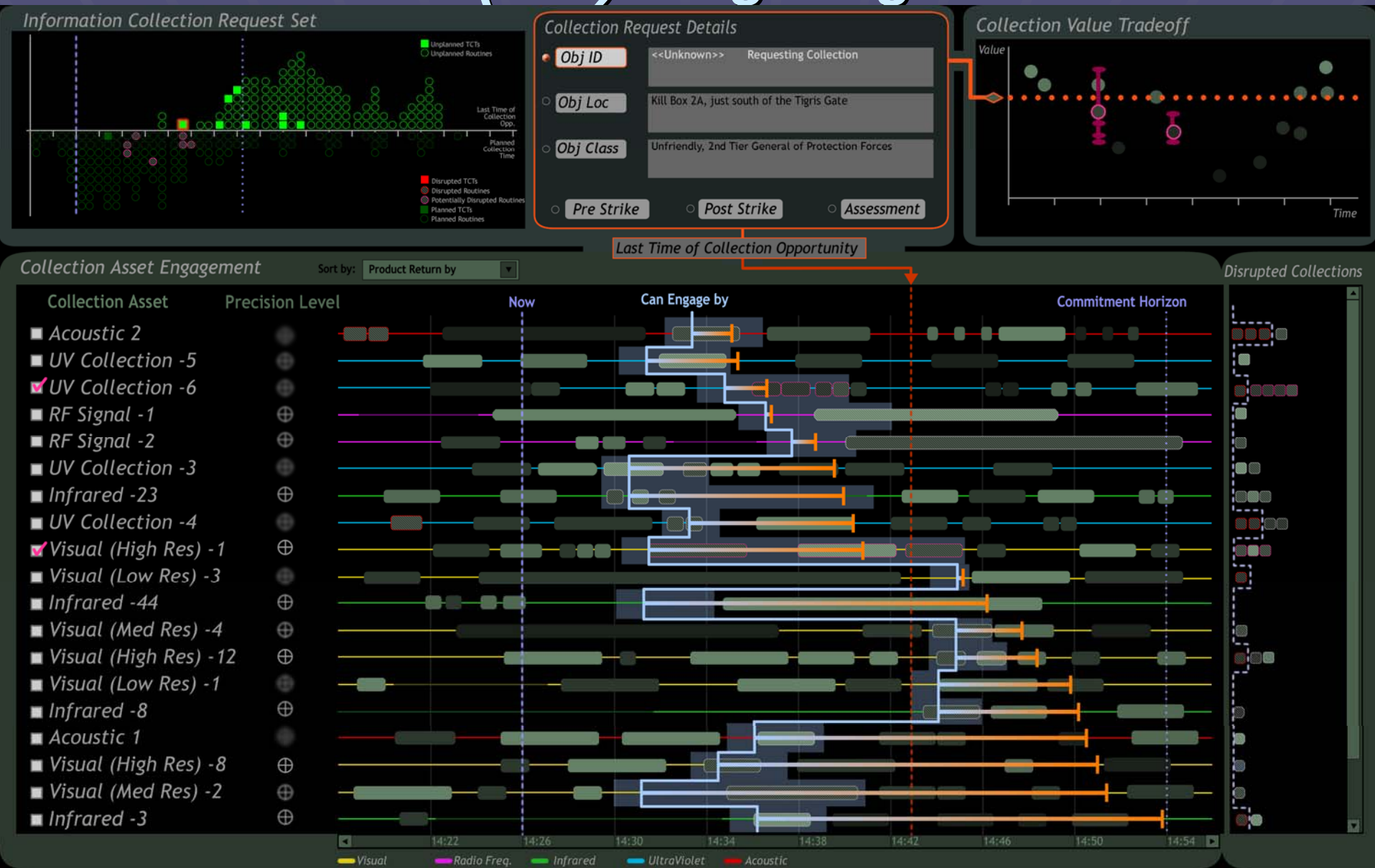
Walkthrough of an Example… Time Critical (ISR) Targeting



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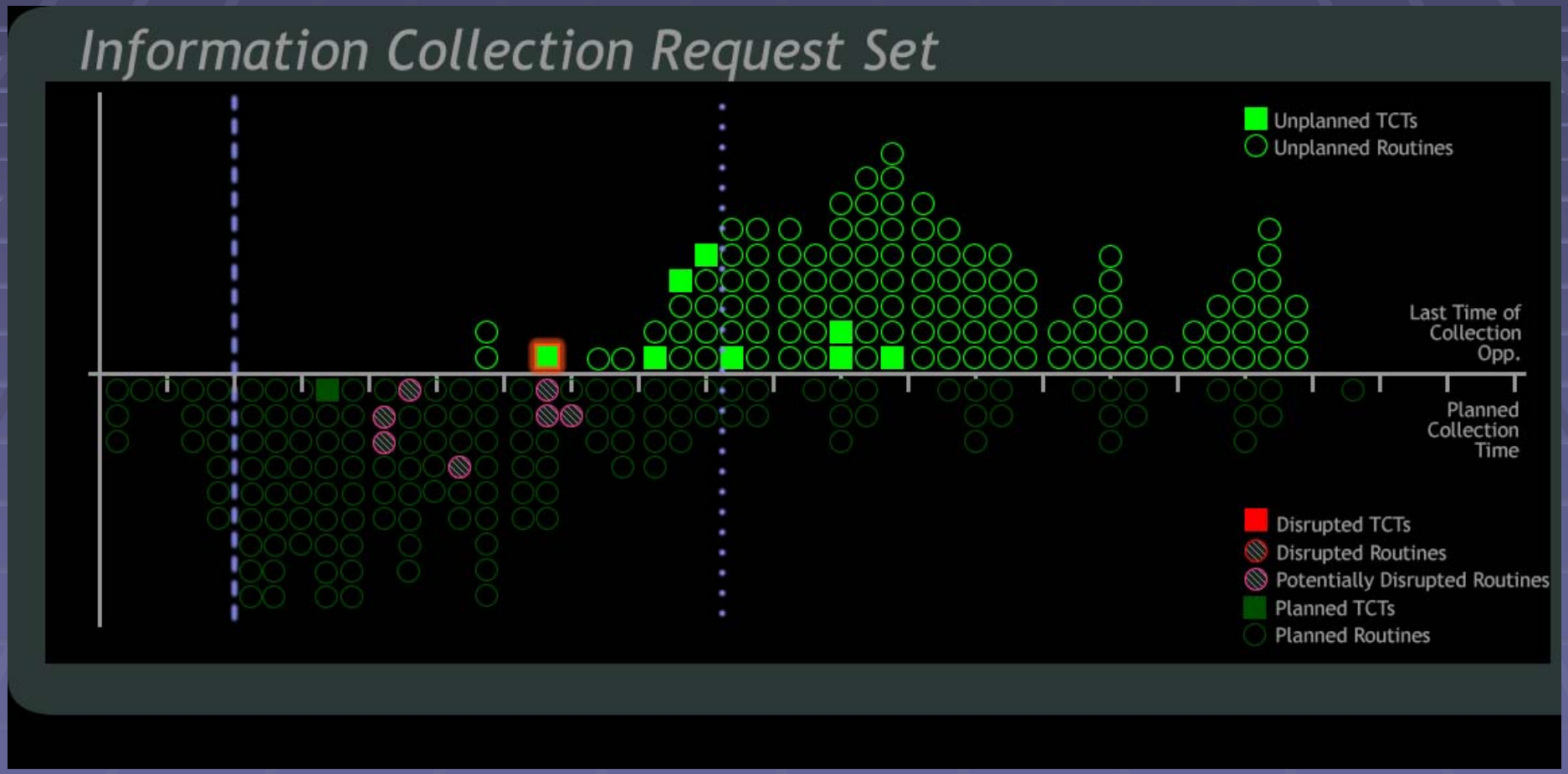

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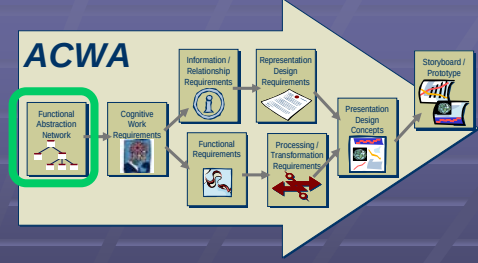

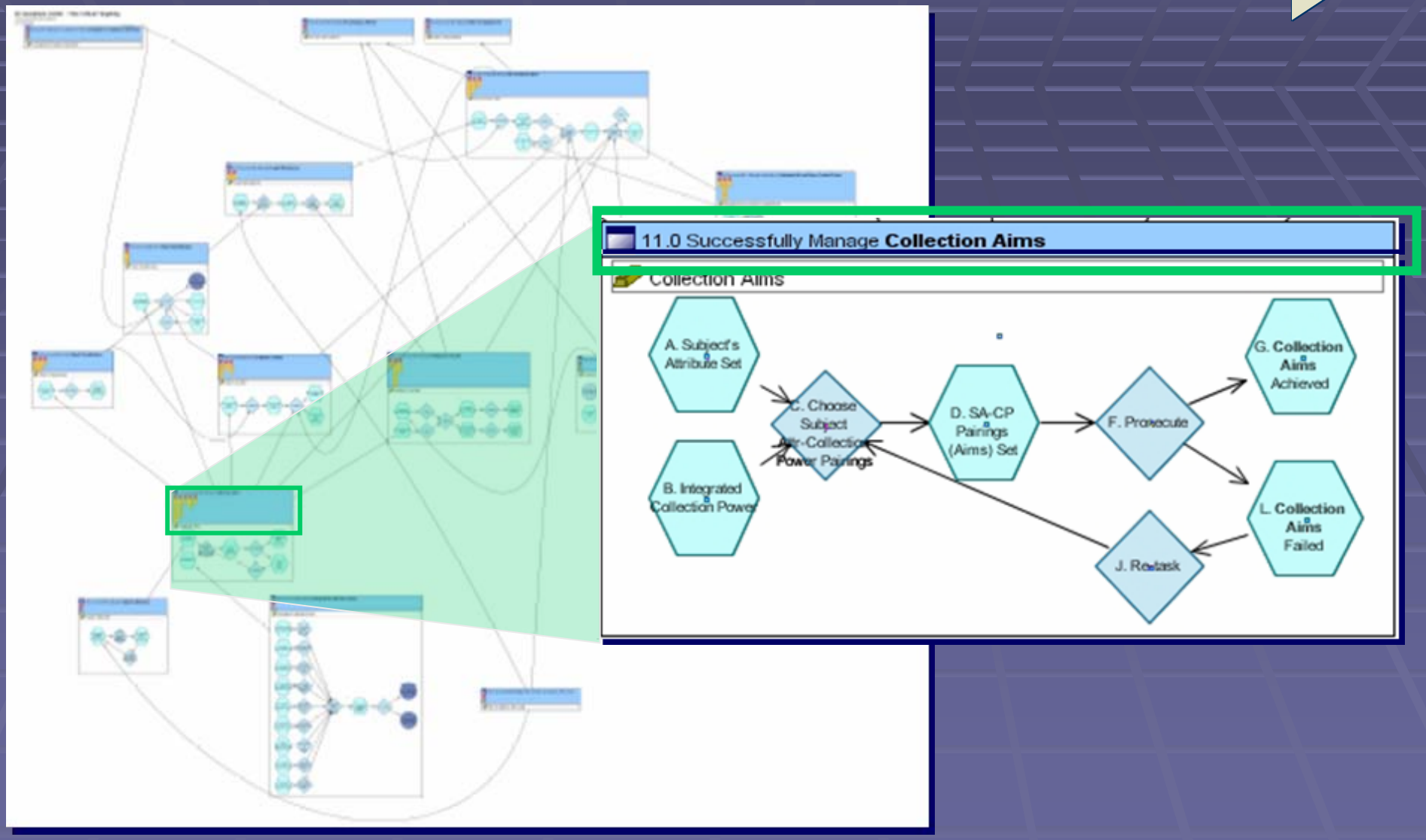

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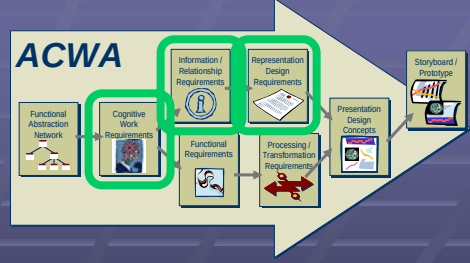

Cognitive Work and Info Rqmts:

- Monitor Collection Aim status with respect to the collection requests
  - Achievement status of individual aims over time.
  - Commander's priority of each aim.
  - Status of each collection request (planned, unplanned, disrupted) based on existence of associated Collection Aim.
  - Latest time of collection return value for each individual collection request with respect to the set.

Representation Design Rqmts:

- Depict each result as independent symbol of equal screen real estate.
- Encode status and priority within each symbol; higher salience for high-priority TCTs.
- Spatially separate planned and unplanned results; higher salience for unplanned.
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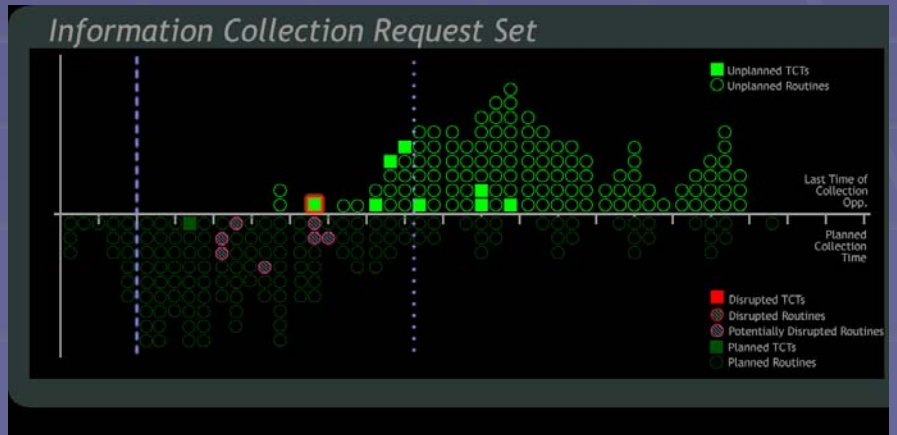

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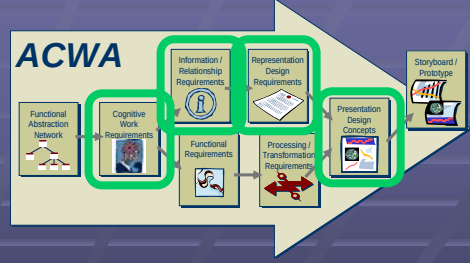

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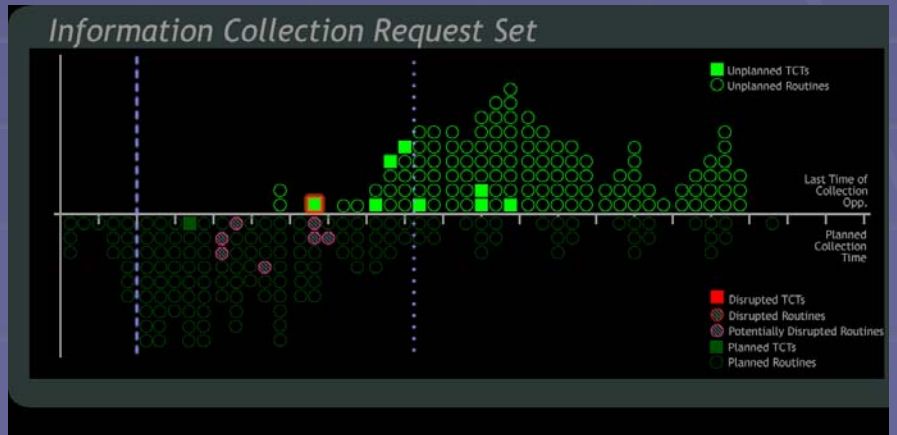

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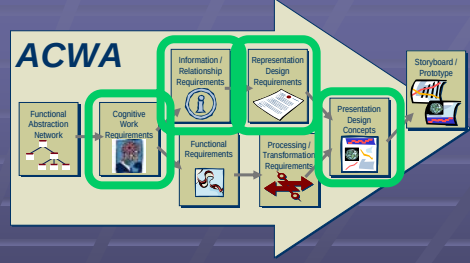

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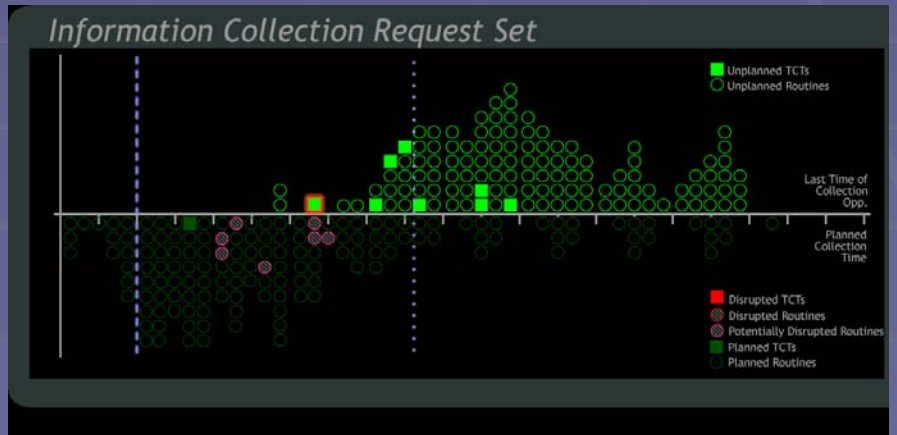

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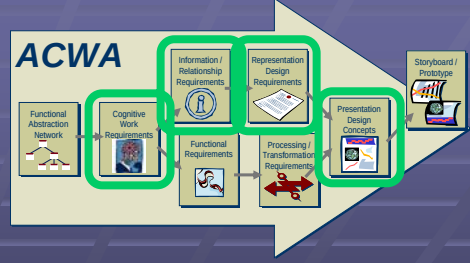

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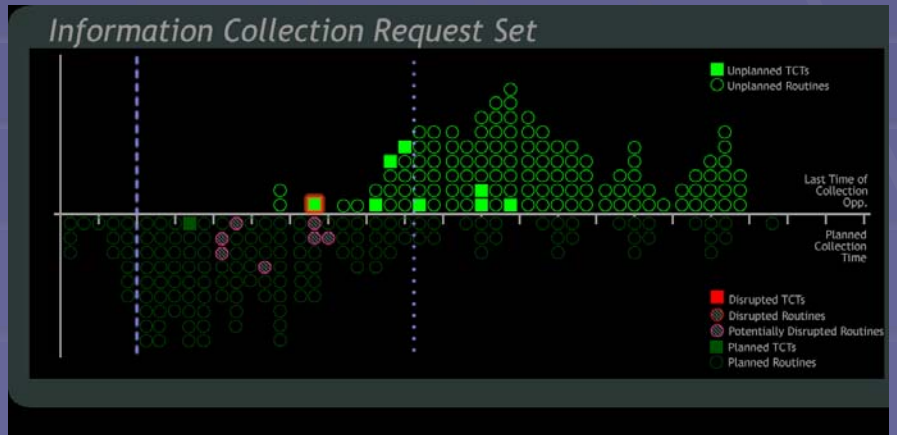

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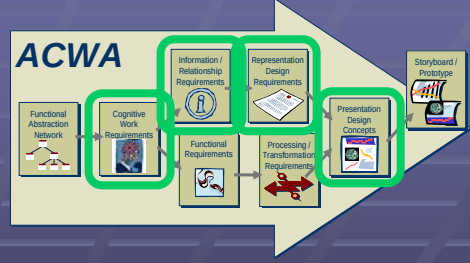

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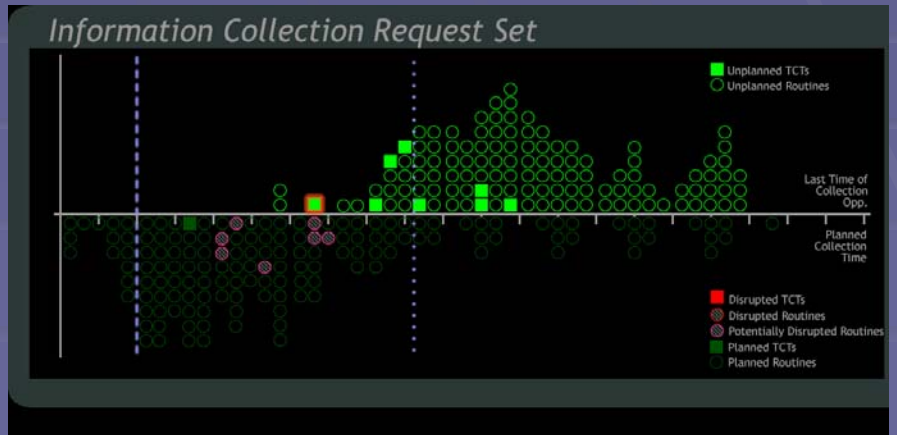

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Supporting C^2 Decision Support Design with Cognitive Work Analysis

- Cognitive Analysis must be able to capture the cognitive demands of the envisioned C^2 work domain.
  - ACWA is based on a robust framework of decision-making in complex work environments.
- Cognitive Analysis must truly integrate with and significantly impact C^2 development efforts.
  - ACWA extends well past cognitive analysis… it produces design artifacts based on Cognitive Systems Engineering principles that directly support Decision Support System implementation;
  - ACWA specifies the mapping from the demands of the work domain to the representation for the warfighter.
- Cognitive Analysis CAN make a difference in the C^2 fight by supporting the design of innovative Decision Support Systems!

To Read More…

- E. Hollnagel, Ed. Handbook of Cognitive Task Design. Lawrence Erlbaum. 2003. (ISBN: 0-8058-4003-6).
  - Chap 16: Applied Cognitive Work Analysis: A Pragmatic Methodology
  - Chap 27: Case Studies: CWA in the design of Advanced Decision Support