

# The Entity Relationships within Cognitive Work Analysis

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## Introduction

An Entity Relationship Diagram is a figure used by Systems Engineers to show the relationships between various entities within a complex, technological system. My colleague, Duarte Goncalves, a Systems Engineer from South Africa, has recently suggested that an Entity Relationship Diagram for Cognitive Work Analysis would clarify the relationships between its many elements. I remain uncertain whether an Entity Relationship Diagram is a useful pedagogical representation but I offer it here (Figure 1) in the hope that those struggling with understanding how all of this fits together will find it informative.

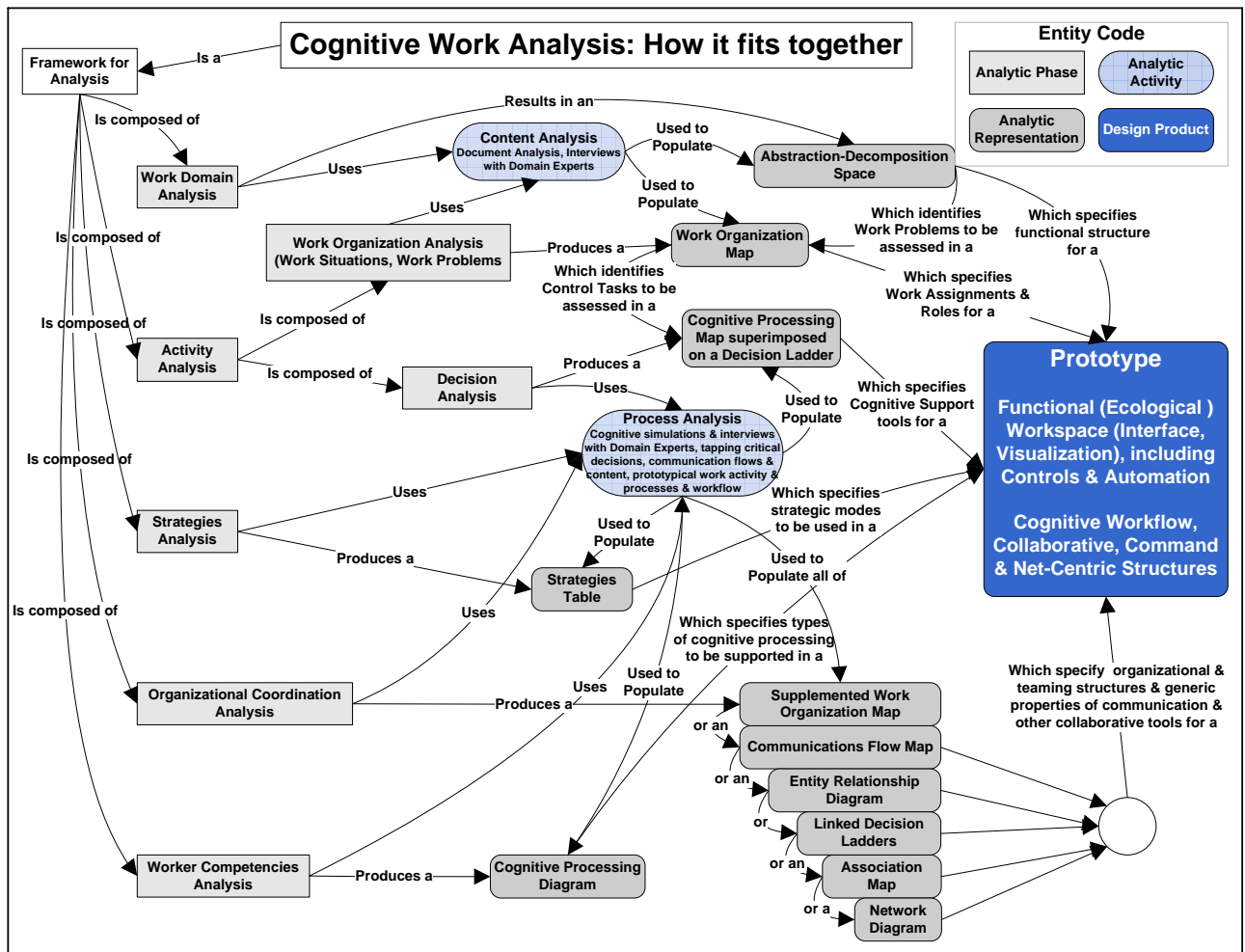


Figure 1: The Entity Relationships within Cognitive Work Analysis

Because of the large number of entities that had to be included, the elements of the figure and text are smaller than is desirable in this document. A JPEG version is available on the Cognitive Systems Design website ([www.CognitiveSystemsDesign.net](http://www.CognitiveSystemsDesign.net)), which can be printed out in larger size.

Please note that this remains a work in progress. My colleague, Catherine Burns (Cognitive Systems Engineer, University of Waterloo, Canada), has suggested some additions that I have not yet implemented. If you send a request through the Cognitive Systems Design website, I will advise you when a new version of this tutorial and the figure are posted.

The Entity Relationship Diagram is shown in (Figure 1). In the remainder of this tutorial, I will offer a description of what it reveals. Note that some of the terms used here differ from those used by other authors such as Vicente (1999) and Rasmussen, Pejtersen and Goodstein (1994). I have been concerned for some time that many of the terms used in Cognitive Work Analysis do not clearly signify the intention for them. Where I see the possibility of introducing terms that more clearly signify the intent I do so although this adjustment is not a result of disagreement with the nature of the concepts.

### **Narrative Description of Entity Relationships**

As stressed by Vicente (1999), Cognitive Work Analysis is a framework and is not a method. It is composed of five analytic phases, Work Domain Analysis, Activity Analysis, Strategies Analysis, Organizational Coordination Analysis, and Worker Competencies Analysis. One particular phase of analysis, Activity Analysis, has the sub phases of Work Organization Analysis and Decision Analysis. The reason that these are sub phases rather than two main phases in an overall system that would then have six main phases is more likely a matter of the historical evolution rather than of logic or imperative.

Treatments of Cognitive Work Analysis (e.g., Vicente, 1999; Rasmussen et al., 1994) do not provide much discussion of Knowledge Acquisition methods. The emphasis is rather on forms of representation. Nevertheless, some methods must be employed to populate those representations. Work Domain Analysis and Work Organization Analysis emphasize content for which Document Analysis and interviews with domain experts can be suitable. Decision Analysis, Strategies Analysis, Organizational Coordination Analysis and Worker Competencies Analysis emphasize process for which cognitive simulations and interviews with domain experts can be suitable. Almost any book on Cognitive Task Analysis will offer excellent strategies for Knowledge Acquisition. My personal favorite is Seamster, Redding and Kaempf (1997) but there are many others that also cover this topic well. I suggest, however, that the many books on Cognitive Task Analysis that are made up of chapters by a number of different authors do not provide comprehensive coverage and will not serve you well if you are seeking to familiarize yourself with basic Knowledge Acquisition techniques.

Each of the analytic phases (and sub phases) has an associated knowledge representation.

- Work Domain Analysis results in an Abstraction-Decomposition Space. See my tutorial on Work Domain Analysis for an explanation and tutorial examples of this representational form.
- Work Organization Analysis results in a Work Organization Map. See my tutorial on Activity Analysis for an explanation and tutorial examples of this representational form.
- Decision Analysis maps activity trajectories onto the Decision Ladder template. See my tutorial on Activity Analysis for an explanation and tutorial examples of this representational form.
- Strategies Analysis results in a strategies table. I have not yet developed a tutorial on Strategies Analysis but tutorial examples may be found in my workshop presentation on this topic, available from [www.CognitiveSystemsDesign.net](http://www.CognitiveSystemsDesign.net).

- Several options are available for representing the information collected by Organizational Coordination Analysis. Tutorial examples may be found in my workshop presentation on this topic, available from [www.CognitiveSystemsDesign.net](http://www.CognitiveSystemsDesign.net).
- Worker Competencies Analysis results in a Cognitive Processing Diagram. Tutorial examples may be found in my workshop presentation on this topic, available from [www.CognitiveSystemsDesign.net](http://www.CognitiveSystemsDesign.net).

Each of the representations specifies a different type of information that can assist in the design of a complex, socio-technical system. It is prudent to develop prototypes of a future system and to then use those prototypes as the design basis for an actual system, rather than using the representations from your analysis as the design basis for an actual system. Thus the Entity Relationship Diagram shows how the various representations contribute to the design of a prototype.

The goal of Cognitive Work Analysis is to inform the design of some sort of human-centered work system. As shown in the Entity Relationship Diagram, the specifications from the analytic artifacts might be used to design a prototype of a functional (ecological) workspace (interface, visualization) that would include any useful technological devices or subsystems for support of cognitive work. Another form of prototype could model cognitive workflow for collaborative, command and net-centric structures. Naikar Pearce, Drumm and Sanderson (2003) have used Tabletop Analysis (also described in Kirwan and Ainsworth, 1992) to model cognitive workflow. I have used the Brahms simulation environment for that purpose (Lintern 2005, 2006). The Brahms simulation environment (Clancey, Sachs, Sierhuis & van Hoof, 1998) is available as a free download from [www.agentisolutions.com](http://www.agentisolutions.com).

### **The Problem of Synthesis**

The term analysis refers to the process of searching for important details. Inevitably, analysis becomes a process of pulling the system apart to identify its constituent elements. In design, we have to put all of those elements back together. The more we pull it apart, the more of a challenge it is to assemble those elements identified in analysis into a cohesive and effective system. Nevertheless, the more extensive and more complex the desired system is to be, the more it is necessary to analyze it.

With its multiple representations, Cognitive Work Analysis breaks the system apart to a greater extent than other forms of cognitive analysis although not nearly to the degree of some approaches to Systems Engineering, for example the Department of Defense Architectural Framework, which results in upwards of 35 representational artifacts.

Nevertheless, the challenge within the Cognitive Work Analysis framework remains to assemble the information from its representational artifacts into a working system. Vicente (1999) has mapped the various contributions of these artifacts into a table. This is, however, a difficult problem and I like to believe that my Entity Relationship Diagram will also help to clarify the contributions of each of these artifacts to the design of a prototype.

### **References**

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