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## *Skills in Applied Concept Mapping*

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# Applied Concept Mapping

Capturing, Analyzing,  
and Organizing Knowledge

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## INTRODUCTION

We begin this chapter with a widely held truism: Concept Maps are easy to make and use. Indeed, kindergarten-aged children have been shown to have not only the facility to make Concept Maps independently, but also to benefit from their impacts on learning and metacognitive control skills (Cassata-Widera, 2009). The basic steps for creating a Concept Map have been widely described (cf., Novak, 2010; Novak and Cañas, 2008):

1. Define a focus question
2. Identify the key concepts
3. Spatially arrange the concepts by some notion of inclusiveness or priority (“set up the parking lot”)
4. Create links
5. Revise spatial arrangement accordingly
6. Create crosslinks
7. Iterate

Crandall et al. (2006) describe what are essentially the same steps for when practitioners seek to help experts articulate their expertise. These steps hold true regardless of the medium, be it paper and pencil, white board and marker, or computer screen, keyboard, and mouse. Indeed, creating, sharing, and editing Concept Maps using CmapTools is an activity that children and adults throughout the world have found both easy and fun. These steps also hold true for collaborative Concept Mapping, i.e., situations in which one or more people co-create a Concept Map.

Were it not for ease of creation and use, we suspect the global use of Concept Mapping would not have grown over the past three decades, spreading from classrooms to boardrooms, migrating from butcher paper to the Internet. The ease of Concept Mapping is its greatest strength. The most powerful ideas are often the simplest.

And, yet, as practitioners with thousands of hours of Concept Mapping experience between us, our eyebrows are drawn upward when we hear the truism uttered. What we really hear is: “(Good, Novakian) Concept Maps are (*not so*) easy to (*efficiently and effectively*) make and use.” Moreover, facilitating others in making good Concept Maps is even more difficult. Concept Mapping is not just a procedure, it is a skill set.

This chapter pulls back the curtain on the process of Concept Mapping to reveal the otherwise surreptitious skills that reliably and efficiently yield good Concept Maps. By doing so, we believe Concept Mapping can be differentiated from other approaches to knowledge diagramming that use combinations of graphical and textual elements to represent or express meanings, but are neither theory- nor tradecraft-based. It is one thing to create a diagram or picture, it is another to create precise and integrated meanings.

Our context for the chapter is in applied settings; specifically in using CmapTools-based Concept Mapping to solve problems. We draw on our extensive experience in creating Concept Maps for many purposes, in using Concept Mapping to help others articulate and organize their knowledge and reasoning strategies, and in training others to become Concept Mappers and use CmapTools.

We begin by covering the hallmark features of good, Novakian Concept Maps. Next, we highlight the knowledge and skills that individuals need for Concept Mapping. We then discuss the skills that Concept Mappers must develop so that they can create a Concept Map as a team, i.e., one facilitator and one recorder. We close by briefly mentioning skills that enable Concept Mapping “on-the-fly” in brainstorming and other types of group sessions.

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## **THE FEATURES OF GOOD, NOVAKIAN CONCEPT MAPS**

Novak and Cañas (in Chapter 1) describe the basic features of Concept Maps by using a Concept Map. Crandall et al. (2006, pp. 51–54) expanded and refined this basic set to include several additional features that can be used to characterize Concept Maps as “good” and further differentiate Concept Maps from other types of diagrams.

Table 2.1 shows, in column 2, the five basic hallmark features, and four refinements of the basic features suggested by Crandall et al. in column 3.

Our experiences have led us to identify additional features of good Concept Maps, particularly in watching novice Concept Mappers create their first Concept Maps (these are shown in column 4). Unlike the five hallmark features, these additional features can be taken as heuristics, and used to assess the “goodness” of a Concept Map. Application of these heuristics is a key skill in Concept Mapping.

**TABLE 2.1**

Features of Good Novakian Concept Maps

<b>Features</b>	<b>Novak and Cañas</b>	<b>Crandall et al.</b>	<b>Moon et al.</b>
Elements	Concepts that are labeled with words and/or symbols	Straightforward expression, i.e., no tacit meaning in the elements of the Concept Map (e.g., using color or symbols to code meaning)	Properly formulated focus question, e.g., dynamic- (Miller and Cañas, 2008), functional- (Derbentseva, Safayeni and Cañas, 2006), process-, and/or declarative-inducing questions
	Focus question guides the generation of ideas and questions that the Concept Map is to explain.		
	Linking words and/or phrases that connect the concepts	Unrestricted semantics, i.e., no restrictions on what types of relations can be represented	Diversity in linking words and/or phrases
	Propositions, i.e., simple and meaningful expressions that are the concept-link-concept “triples”	Propositions can be read as “stand alone,” enabling propositional coherence (described in detail below)	Use of arrowheads to direct meaning and attention
Structure	Hierarchical structure	Explicit rationale for the “ <i>semi</i> -hierarchical” structure, i.e., the more general or most important concepts appear toward the top and provide the context or the “big picture” for the Concept Map, while the more particular concepts tend to appear toward the bottom, with the use of crosslinks	Minimally intersecting connections, i.e., no more than three intersections per Concept Map
	Crosslinks that show interrelationships		Balanced structure, i.e., mostly proportionate spatial arrangement Connection-necessitated distance, i.e., lines only long enough to make a connection
Usability and Aesthetics			Viewable and legible sizing of the Concept Map and its elements Content-appropriate aesthetics

Hoffman coined the term *propositional coherence* to refer to how well individual propositions stand alone as expressions, and, simultaneously, to what extent the entire Concept Map is comprised of such interconnected expressions. Thus, a concept–link–concept “triple” either is or is not a proposition. A Concept Map is or is not propositionally coherent; it is coherent if all triples can be read as propositions. This distinctive feature is important primarily for clarity in the Concept Map, and it also enables ease for linking in new concepts and propositions as the Concept Map expands. Moreover, it identifies “run-on” or “string” propositions as an undesirable feature, an example being:

This book → is about → Concept Mapping → in → applied settings.

Pulling apart the triples, we have as a second triple:

Concept Mapping → in → applied settings,

which is not a proposition. To make the string propositionally coherent, one would need to create two propositions:

This book → is about → Concept Mapping, and  
Concept Mapping → is used in → applied settings.

Of course, not every feature will apply to every Concept Map, and there are many reasons why a skilled Concept Mapper may choose to deviate from them when crafting a Concept Map. Indeed, as we describe below, one skill in Concept Mapping is the ability to know when and how to diverge from these features. Moreover, individual preferences may sometimes trump the heuristics. The use of arrowheads on connectors is a classic example. Some prefer them because they guide the eye and reinforce the order of reading the Concept Maps. Others do not because they believe the structural conventions are powerful enough to convey the order.

With all of these features of good Concept Maps in mind, we now turn to the knowledge and skills that proficient Concept Mappers bring to the task of creating them. First, we discuss the necessary knowledge about Concept Mapping. Next, we delineate the skills of an individual Concept Mapper, and then the skills in team Concept Mapping and Concept Mapping “on-the-fly.”

## **KNOWLEDGE ABOUT CONCEPT MAPPING**

The Concept Map practitioner must be, first and foremost, familiar with the research base underlying Concept Mapping. Gaining a deep familiarity is no small feat because the literature is vast and even summary reviews are extensive (cf., the reference list compiled by the Institute for Human and Machine Cognition (IHMC) at <http://cmap.ihmc.us/Publications/ReferenceList.php>). It is, at this time, an individual journey. There are a few academic programs that employ professors and instructors who are steeped in the research; however, most of these are focused on Concept Mapping in educational contexts. As far as we know, there is no formal academic training program on Concept Mapping or its applications. While we can imagine what such a program might entail and we routinely deliver workshops to train professionals in Applied Concept Mapping, it is difficult to conceive where an academic program would best be housed in the traditional academic department structure. The arts and sciences department, in particular, the social, psychological, and organizational sciences, seems appropriate. However, reasonable arguments could be made for engineering, business, and information technology departments.

In any event, exploration of the underlying theory of Concept Mapping, an introduction to the variety of methods and applications, and the architecture and features of CmapTools are available in the literature. A novice Concept Mapper would do well to review Novak's publications (especially Novak, 2010), the proceedings of the conferences on Concept Mapping ([cmc.ihmc.us](http://cmc.ihmc.us)), the homepage for CmapTools ([cmap.ihmc.us](http://cmap.ihmc.us)), and, of course, this book.

We turn now to the skills and knowledge of the individual Concept Mapper.

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## **THE SKILLS OF THE INDIVIDUAL CONCEPT MAPPER**

By individual Concept Mapper, we mean an individual practitioner who creates Concept Maps for many purposes. These purposes can include Concept Mapping one's own knowledge, working with another to co-create a Concept Map, transforming prose or some other format into Concept

Maps, analyzing a set of propositions culled from other sources, or creating a knowledge model for use as a presentation or Web site. We distinguish these purposes from Concept Mapping activities that are traditionally performed as a team, e.g., knowledge elicitation, and those done in group settings, e.g., idea generation. With these different purposes come different roles, task responsibilities, and thus skills, as we will discuss. In the next section, we reflect on some methods for gaining skill at Concept Mapping.

## **Gaining Skills**

As a novice Concept Mapper learns about Concept Mapping, practice in creating them plays a critical role. For many of the required skills, solitary practice in Concept Mapping is not only necessary, but nearly sufficient for mastery. One can learn a great deal about the utility of the heuristics simply by attempting to develop a Concept Map of what one already knows about the world, or what might already be captured in other forms, like text documents. Indeed, many of the heuristics were developed through our own trial-and-error practice sessions, using CmapTools to create Concept Maps that meaningfully expressed our intents. While practice without coaching or other means of feedback can be limiting no matter what the skill, creating Concept Maps while thinking through the heuristics can be a good means of gaining an appreciation for and even honing some of the critical Concept Mapping skills.

While solo practice is always beneficial, above we say it is “nearly sufficient” because feedback is crucial. Showing one’s Concept Maps to others, particularly those who are familiar with the topic addressed by the Concept Maps, can be invaluable for one’s skill development. There are few experiences more enlightening than showing someone a Concept Map and seeing the palpable signs of “map shock” on their face. Asking what makes sense and what is concerning the reviewer should always be the next step.

Solitary practice, however, will not afford the experience necessary to learn many of the particular skills, especially those necessary for co-creating Concept Maps. To learn these skills, a Concept Mapper must practice with others. It cannot be understated how different are the tasks of creating one’s own Concept Map, without the pressures of time and performance, and co-creating a Concept Map with another, i.e., the “knower.” The skills discussed in the following section are reflective of this setting, and many apply when creating one’s own Concept Maps.



Co-creating a Concept Map is different still than working in a team to co-create a Concept Map with a knower. The skills involved in these settings can only be learned through practice, preferably in low-risk situations. Our preferred approach for introducing these settings is to have teams of two or three practice with each other, each serving as the knower, while the others take on the role of Concept Mapper or a Concept Mapping team.

We turn now to the individual skills. We group them by categories for ease of discussion, but not to artificially separate them. Skilled Concept Mapping involves imparting these skills simultaneously and continuously. Indeed, doing so is the overarching skill of Concept Mapping.

### **Articulation**

This set of skills focuses on the abilities to clearly articulate the key elements in a Concept Map, i.e., the focus questions, concepts, linking words, and propositions. The formulation of the focus question establishes the initial direction of the development of the Concept Map. How it is stated can impact the way that the knower thinks to describe the knowledge, e.g., as dynamic or declarative, process or function (cf., Derbentseva, Safayeni, and Cañas, 2006; Miller and Cañas, 2008). Also, it is often the case that a Concept Map started under one focus question becomes a Concept Map about a different focus question, as the knower and Concept Mapper explore the knowledge. The skilled Concept Mapper must recognize when to refocus the question or start a new Concept Map with a new focus question, and judge whether to return to the original focus question.

Articulating, i.e., expressing distinctly, the key concepts in answering the focus question is the role of the knower, as is crafting the linking words and phrases. The proficient Concept Mapper, however, should be able to augment the knower's language capacity to express concepts and links in their clearest, most concise forms. Help from the Concept Mapper can take the form of suggesting synonymous terms, capturing a verbose statement in a quip, and sensing that the knower is thinking and allowing the thoughts to coalesce. CmapTools can assist the Concept Mapper in the suggestion of terms that might be added. The CmapTools Suggester (Cañas et al., 2004) analyzes the concepts in the map and searches the Web for pages that mention the same concepts. Additional concepts that appear on the Web pages but not in the developing Concept Map are presented in

a list to the Concept Mapper as concepts that could possibly enhance the scope of the map.

Related is the skill of recognizing that concepts are latently described in links, and vice versa. In the English language, many words can serve as both nouns (i.e., concepts) and verbs (i.e., linking words or phrases). The skill lies in seeing, for example, that there is a concept of googling in the proposition: “We → googled → Something.” The concept is “hidden” in the linking word and, thus, can be “pulled out” of the link, a process that opens up the prospect of linking the concept to other concepts:

We → used → Google,  
We → discovered → Something, and  
Google → can find → Something.

By pulling out Google as a concept, other areas of exploration become available. What else can Google find? Or do? Is there anything that Google cannot find?

This example also demonstrates the skill of thinking in propositions, which is probably the most challenging individual Concept Mapping skill to learn. Propositions are not sentences, they describe relationships. Above, we discussed the idea of propositional coherence. The Google example shows how a skilled Concept Mapper can translate a seemingly simple sentence of three *words* into a Concept Map comprised of three *propositions*. Many people who are new to Concept Mapping will attempt to write sentences by alternating words in concepts and linking phrases, creating “strings.” Experienced Concept Mappers will consider, and help the knower consider, the propositional representation of any given statement. This includes deciding how to express the intended meaning of the knower’s statements in concepts and linking words or phrases, while minimizing their verbosity and leaving open pathways for other extending connections to them.

Related to the skill of unpacking latent concepts is the skill of seeing invisible concepts that create opportunities for *differentiation* and *subsumption*. Differentiation is about distinguishing subconcepts and their relations; subsumption is about seeing how previously unrelated concepts actually fall under a higher order concept. Application of this skill is most necessary when spatially arranging the concepts by some notion

of inclusiveness, categorization, importance, or priority. Such notions may be proffered by the knower, or not. It may fall to the Concept Mapper to see that several concepts “fall under” categories, or lend themselves to a priority structure, or seem to be different than the others. The developing Concept Map can highlight when such opportunities arise. A concept with a “fan” of six or seven concepts linked by a common linking phrase will often be an indicator that there may be one or more intermediate concepts that should “sit between” the concepts and create new layers of abstraction. Ultimately, the knower’s schemes are what matters, and the Concept Mapper’s vision for the Concept Map can only be inspirational. However, the rewarding feeling of throwing light on hidden concepts can be enjoyed by both the Concept Mapper and the knower.

The next skill lies in executing the proper role in co-creating a Concept Map with a knower.

## **Role**

Highly functioning teams include members who not only know their own roles, but have a deep appreciation for the other roles and people on the team, and thus can adapt their contributions to the roles and styles of others. This skill is a must in professional Concept Mapping with a knower. The Concept Mapper must appreciate that his/her role is to help the knower create the Concept Map. To do so, the Concept Mapper must first orient the knower to Concept Mapping. The knower “must be helped to understand what will transpire in the sessions and why the process is carried out as it is. A briefing regarding the goals of the work, accompanied with a review of preliminary Concept Maps, can help the expert to gain this understanding” (Coffey, 2006, p. 3).

Throughout the Concept Mapping session, then, the Concept Mapper must continuously manage the attention of the knower, directing it to the Concept Map. At times, the process must be explained again. The Concept Mapper must coach but not impose upon the knower by providing instruction, feedback, and, most importantly, encouragement, about the process and his/her participation.

A distinction that we find challenging for novice Concept Mappers to make and maintain is that between the role of co-creator and learner. Many Concept Mappers get caught up in the knower’s knowledge, struggle to understand the nature of the knowledge, and shift into the role of learner.

This turns the focus on themselves and how well they understand what the knower is expressing. In the highly complex and technical domains in which we have worked, e.g., nuclear technology (Moon and Kelley, 2010; Hoffman and Moon, 2010; Coffey and Eskridge, 2008), this shift would have crippled our capacity to co-create. We are not nuclear scientists, yet our role has been to help nuclear scientists create Concept Maps of their knowledge, much of which they hold tacitly. A Concept Mapping session is not a training session, and the Concept Mapper is not there to learn.

Of course, we do learn quite a bit as a consequence of the Concept Mapping sessions, and it is always helpful in developing a rapport with the knower when we can demonstrate early in the session that we have a working understanding of the lexicon of their highly specialized field, or at least the experience of the knower. We rarely enter a session without having bootstrapped ourselves (Crandall et al., 2006, p. 38; cf., Coffey, 2006), at least minimally, in the domain and the organization in which the knower works. The professional Concept Mapper may create a few basic parking lots and/or Concept Maps prior to a session to aide in the bootstrapping process, and may even share these with the knower as a means of introducing Concept Mapping. But once the session starts, the focus must quickly, directly, and invitingly be shifted to the knowledge of the knower, and getting that knowledge into the Concept Map. The last thing a Concept Mapper wants to create is a Concept Map describing the knowledge they have of the knower's domain. A well-crafted Concept Map will bear the hallmarks of a good Concept Map, populated by the content of the knower.

The next skill is facility at using CmapTools.

### **CmapTools Facility**

With any specialized practice comes the need for skill at using tools. CmapTools has been developed to support creating and sharing Concept Maps by anyone. No special training is necessary to start Concept Mapping. Indeed, much like the home page for Google, the primary interface, i.e., the Concept Map itself, was designed for simplicity and supporting the sole function of creating Concept Maps.

The simple external interface of CmapTools hides significant underlying functionality that is available to increase the efficiency of Concept Map generation and enhance the effectiveness of the Concept Maps produced.

The most important reason for gaining facility with CmapTools is to know what options are available for reaching which objectives. CmapTools is a highly flexible tool, and for most desired outcomes, there are several approaches available. For example, there are a number of approaches to cluster concepts spatially. One can manually place them on the Concept Map in close proximity or in a vertical stack, or automatically align them using the style palette, or create a nested node (then arrange them within the nested node, or not), or create a box around them. Each approach can serve different purposes, e.g., visual or functional, and each comes with different follow-on requirements and options, e.g., ability to link to other concepts as a cluster.

Another important reason for gaining a deep understanding of CmapTools lies in being able to anticipate what CmapTools will do with the Concept Mapper's actions. While we cannot overstress the user friendliness of CmapTools, any tool can create surprises, particularly when a user is not highly practiced in using it. One example of a surprise we often see is when people attempt to link from one concept to another, and in the process cross over another concept. When the new concept-link-concept is created, the link seemingly is lost. In reality, however, it was created, but was placed behind the concept that was crossed over. Without a trained eye for such instances, a Concept Mapper may, at best, wind up repeating actions. At worst, the Concept Mapper may become frustrated in front of the knower, and feel helpless as the frustration spreads to the knower.

Low-risk, solitary experimentation with CmapTools is the best way to gain familiarity. One of the first discoveries that early Concept Mappers usually make is with the styles palette, which typically leads to aesthetic experimentation. Fonts, objects, lines, and Concept Maps are turned into all the colors of the rainbow. But a good Concept Map will have content-appropriate aesthetics, as a near-finished product. The most important consideration is that the entire idea of Concept Maps is to make meanings clear and explicit. Use of colors, shapes, and other features to "encode" meanings requires both a legend and a memory load for the person who is looking at the Concept Maps. As a rule of thumb, we never add any "bells and whistles" until we are certain that a Concept Map is nearly completed. Color is used very judiciously, perhaps using only a single color to make certain nodes stand out. Avoiding the temptations to introduce stylizations too early can be a time-consuming lesson to learn for the novice Concept Mapper, as color schemes that seemed to work early

in the session are overtaken by considerations for meaning. Thankfully, CmapTools includes the capability to quickly change styles, and a professional Concept Mapper can rapidly turn a boring Concept Map into a work of art, though this should not be done “before its time.”

Gaining a handle on quickly navigating around, then selecting, moving, and aligning the elements of the Concept Map is a finesse skill, but a highly critical one. Nothing destroys efficiency measurements more than fumbling around the Concept Map, continuously scrolling, and performing other types of place-finding. Such erratic behavior can at the very least irritate or confuse the knower. We often hear compliments following our sessions regarding the grace with which we manipulated CmapTools, and these are primarily aimed at the execution of this skill.

CmapTools includes a number of advanced tools, e.g., Autolayout, Merge Nodes, Presentation Builder, Compare to Concept Maps, that not only provide enhanced capabilities to the experienced Concept Mapper, but can be exploited for purposes beyond just building a Concept Map of a given knower’s knowledge domain (cf., Harter and Moon, Chapter 7; Moon et al., 2006).

Collaboration tools in CmapTools provide a means for participants to work together while being in different locations, and possibly at different times. In cases where in-person Concept Mapping cannot be done, either synchronous or asynchronous collaboration techniques can be used to work together. Synchronous collaboration allows the Concept Mapper and the knower to view and manipulate the same Concept Map at the same time, but on different computer screens. The participants can be in the same room, or across the world. While it is possible to collaboratively develop a Concept Map from scratch using synchronous collaboration, this approach works best as a follow-on activity. For example, we have found synchronous collaboration very useful for reviewing Concept Maps that have already been developed, where the Concept Mapper is walking the knower through the Concept Map, ensuring that it captures the knower’s point of view accurately.

A number of tools in CmapTools can support asynchronous collaboration. First are Annotations, which are the computer equivalent of the yellow sticky notes that adorn many computer monitors and refrigerator doors. Annotations allow others to highlight and comment on portions of a Concept Map, and have the Concept Mapper review them the next time the Concept Map is opened. Other asynchronous collaboration tools include:

1. A threaded conversation tool called Discussion Threads that attach e-mail-like conversations on particular concepts in a Concept Map.
2. Knowledge Soups, which are a way to share propositional information between Concept Mappers without sharing the entire map containing those propositions.
3. Import and Export tools that allow other programs such as text editors, outliners, and databases to be used to add or modify the Concept Map.

Skilled Concept Mappers use these capabilities where appropriate. The next skill deals with spatial considerations during Concept Mapping.

### **Spatial Considerations**

Crandall et al. (2006) have highlighted the “shape-meaning interactions” in meaning diagrams, i.e., the shape of the diagram interacts with the semantic and syntactic features. For the Concept Mapper, finding where to place crosslinks is the most obvious skill related to the interaction. Deliberate search for crosslinks is the means through which the skill is exercised.

There are other skills that Concept Mappers attribute to the shape-meaning interaction. One is in seeking and finding a balanced structure in the Concept Map. This often means spotting opportunities for using available space within one area of the Concept Map to house other sections. Concept Maps created in CmapTools are not restricted spatially—anything *can* be placed anywhere—which is a notable departure from many other diagramming tools that restrict spatial placement of elements. Such freedom, however, can induce free-wheeling use of space in early Concept Mappers. Many tend to have concepts or groups of concepts too widely spaced, which requires lots of unnecessary scrolling. On the other hand, concepts and links also can be placed too closely and become too “scrunched.” With experience comes the skill at using space, including scrunching and descunching concepts and propositions in the Concept Map.

Good Concept Maps should also have a balanced structure, i.e., mostly proportionate spatial arrangement. The proficient Concept Mapper strives for reasonable symmetry, knowing that exact symmetry is not always possible nor even desirable, by looking for ways to shift sections of the Concept Map into areas where whitespace is available. The need for work on the symmetry of the Concept Map is suggested by the presence of many

intersecting connections and multiple long connections, linking distant sections of the Concept Map. Balance in the Concept Map, whether in semihierarchical or another appropriate shape (cf., Safayeni et al., 2006, for notes on the use of cyclical Concept Maps), often requires some trial and error, guided by the Concept Mapper's efficient use of space and emergent visions of what the Concept Map will look like near completion.

Utilization of space is inextricably bound to size concerns in Concept Maps, i.e., the number of concepts and propositions. The more elements, and the bigger and longer they are, the more space is required to accommodate them. The more space required, the further away from the Concept Map one needs to be to review and engage with it. There are applications of Concept Mapping during which size does not matter in the course of a process (cf., Moon et al., 2006; Moon and Harter, Chapter 7). In most cases, though, the skilled Concept Mapper continuously seeks a "human-centered" size for the Concept Maps. In CmapTools, this can be handled by zooming, but delicately so. Our rule of thumb is to try as much as possible to avoid making Concept Maps that require scrolling, and certainly not scrolling in both the horizontal and the vertical. For most displays at most viewing distances, a "complex enough" Concept Map has about 35 and no more than 45 concepts.

Decisions about space also can include when and what to temporarily place to the side to create workable space, when to start a new Concept Map, and what elements to move into the new map. The order of the seven steps for creating Concept Maps mentioned in this chapter's introduction provides, among other things, guidance regarding spatial considerations. For example, one reason for not immediately creating links is to avoid the need to move concepts *and* links in order to make space. Once a Concept Map grows too large for viewing without scrolling, new decisions come into play regarding how to stitch together and navigate across numerous smaller Concept Maps. The graphical tricks are many, but each has tradeoffs. The skill lies in making these assessments, tracking the decisions, and advising the knower on the tradeoffs.

The next skill is about using resources.

## **Resourcing**

Adding resources, i.e., other digital files, to Concept Maps is easy to do in CmapTools. But the marks of a skilled Concept Mapper in dealing with resources lie in:



1. Knowing when and where in the Concept Map to refer to a resource.
2. Maintaining vigilance in looking for and helping the knower think about potential resources during a Concept Mapping session.
3. Being flexible in the numerous strategies available for incorporating resources.

To demonstrate the latter point, in some cases it may be best to use the contextual menu item “Add and Edit a Link to a Resource,” creating a hyperlink from the concept of reference to the desired resource. In other cases, though, it may be best to present the information, in its appropriate format, within the context of the Concept Map. Tables, figures, and lists are more often than not better shown as such.

The next skill is about working toward the big picture while Concept Mapping.

### **Maintaining the Big Picture**

As the theme of this book implies, all Concept Mapping is conducted for a purpose. The purpose for creating a Concept Map should be the basis for all of the actions of the skilled Concept Mapper. The purpose of the Concept Map can refer to the purpose of the Concept Mapping session and/or the purpose of the Concept Mapping product. Both of these purposes can apply on the individual Concept Map level and on higher order levels, such as the purpose of the overall project in which Concept Mapping is being used.

The purpose of the Concept Mapping session plays back onto the decisions the Concept Mapper makes with regard to, for example, which knowledge domains will be addressed, how deep and detailed the Concept Map must be, how refined the Concept Map should look by the close of the session, and where and how the Concept Map might be revised after the session. We have held many Concept Mapping sessions during which we only captured the key concepts and started to spatially align them; in these cases, the purpose of the session was to spend a compressed amount of time with a knower and elicit as much information about the focus question as possible. Afterward, we completed the Concept Mapping by listening to an audio recording of the session and working with the unlinked concepts (the “parking lot”) developed during the session.

Of course, there are other ways that postsession processing play out. Concept Mapping should always be regarded as an iterative process. Revisiting Concept Maps with a knower at some near-term, later date can be a valuable exercise for gaining even greater precision of meaning and identifying omissions. It also can be fruitful to have other knowers, steeped in the represented knowledge, review the Concept Maps. Some evidence exists (Hoffman, Coffey, and Ford, 2000) that the changes made by a different expert than the one from whom the Concept Map was originally elicited are relatively minor; perhaps on the order of 10% of the concepts and linking phrases might be wordsmithed. These differences can open up new doors of exploration for the organization. They may be the seeds for new innovations, or suggest changes to organizational structure or procedures.

The purpose of the individual Concept Map product involves assessing who might see or use it, and for what purpose. It may involve considering if and how the Concept Maps might integrate with other corporate products. It certainly involves assessing what elements can support different visual or search or collaboration strategies and what impacts might result. A good example of the latter assessment lies in the use of images as concepts. The mechanism for turning a concept into an image in CmapTools is simple—drag and drop the image from where it is stored onto the concept, and CmapTools does the rest. If the purpose of the Concept Map is strictly visual, for instance, to create a sales pitch or capture a manufacturing process using images of the shop floor, the work is done. If, however, the purpose of the Concept Map is to display the sales pitch on the Internet, or make the manufacturing process available on an internal Concept Map server so that new hires to the shop floor can be trained, attention must be given to the concept into which the image was dropped. Specifically, the concept can serve as a caption (made visible) or keyword list (hidden from view) for the image so that it can be *discovered by search engines*. The image itself can be synonymous with the concept label, or it can be an amplification of the concept, meant to convey the more detailed meaning possible with an image. The skilled Concept Mapper appreciates the purpose of the Concept Map, and understands the implications of the actions taken on the intended purpose.

The purpose of Concept Mapping products in the context of the overarching project and organization also influences how the Concept Mapper

works. Invariably, this purpose evolves over the life cycle of the effort. While certainly not predestined, we typically see a four-phase pattern emerge when we work with clients: the picture phase, the utility phase, the extended utility phase, and the deployment phase. First is the *picture* phase: The client wants help creating Concept Maps, and thinks only of the Concept Map product. Next comes the *utility* phase. As Concept Maps are developed, the client starts to see implications for where and how the Concept Maps (as pictures) can be used. This may include augmenting training materials or as briefing slides or simply hung in the lab or pinned to the cubicle as a reference. As the client begins to appreciate that we are not only creating pictures, but also building a database of concepts, links, and propositions, the light bulbs begin to turn on and we move to the *extended utility* phase. Here the client moves from Concept Maps as pictures to Concept Maps as information resources that can be linked to other information resources that we already have and need to organize the scheme for which is already in the head of the knower and could be represented in Concept Maps and organized as a Knowledge Model. As this epiphany sets in, and hurdles are crossed (cf., Desnoyers, Chapter 16), the client moves to the *deployment* stage, launching CmapTools (clients and server) into the organization and realizing the genuine and intended purpose of broad-based, large-scale knowledge management. As Concept Maps are developed, increasing numbers of Concept Mappers search other Concept Maps, resources, and the Web for related and insightful information. Individual Concept Maps become linked to other Concept Maps, perhaps built in another department within the same organization, but for complimentary purposes. Heretofore undiscovered crosslinks are made across two Concept Maps that have been integrated into one, resulting in new and innovative product and service ideas. Importantly, the Concept Maps that are being generated across the organization do not come to be regarded as fixed artifacts. Rather, they are regarded as “living” representations rather than finished “things,” to be updated and revised as the organization, its people, and its knowledge evolve.

This is a vision that the skilled Concept Mapper must foresee, and guide the knowers and clients toward. By anticipating these phases, the skilled Concept Mappers can create Concept Maps that build toward the ensuing phases. While some clients may already see it and be working toward it, the Concept Mapper can present the vision at opportune times during any given Concept Mapping session or the course of the project.

## **Facilitation**

In addition to the skills involved in Concept Mapping, Concept Mappers who work with knowers must also be highly skilled facilitators. They must be able to forge a positive relationship with the knower, accomplished in part by fostering a sense of shared purpose in undertaking the task at hand and also by projecting a collegial disposition. They should be capable of gently drawing out a knower possessing lesser verbal acuity, or even perhaps a knower who may be less inclined to cooperate with the Concept Mapping session for one reason or another. When working with highly experienced knowers, an overarching set of unique circumstances may come into play related to their deep experience and even personalities (Moon, 2010). The experienced Concept Mapper anticipates these situations and introduces mitigation strategies while never losing sight of the big picture.

These sensitivities must be balanced with excessively leading or prompting the knower. Continuous assessment of the knower's state of mind (thinking? stumped? not understanding the purpose? tired? worried about the call that just came in on the cell phone?) must be made in order to gauge the knower's level of interest and connection with the session. Such assessments suggest to the Concept Mapper what sorts of controls on the tempo of the session need to be imposed: Should we slow it down? take a break? try to get through this Concept Map or risk losing a train of thought? let the knower talk or tell a story, leaving the Concept Map aside for a bit?

The final set of skills that mark a proficient Concept Mapper are reflected in the avoidance of novice errors.

## **Error Avoidance**

We have already mentioned many of the novice errors we have seen new Concept Mappers make, most of which we made ourselves. Experiencing these errors a few times is a valuable learning experience, making it really possible to avoid them and introduce a level of true professionalism into Concept Mapping. The errors include:

- Rushing or skipping altogether the introduction to Concept Mapping for the knower.
- Writing sentences or verbose phrases into concepts.

- Complacency in capturing the concepts as the knower expresses them.
- Incessantly moving elements in front of the knower.
- Jumping too quickly into creating links between concepts.
- Banally repeating linking words.
- Restructuring the Concept Map outside of the view of the knower.
- Incautiously setting up links to temporary resources or resource locations.
- Neglecting to include a legend where obscure or parochial meaning was imparted on elements.
- Using acronyms.

Having defined the skills of the individual Concept Mapper, we turn now to the skills that teams of Concept Mappers must develop to work synergistically with a knower.

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## THE SKILLS IN TEAM CONCEPT MAPPING

Each Concept Mapping team member needs those skills described in the previous section, but the team Concept Mapping approach introduces new skill requirements. It is ideal when each team member is an accomplished individual Concept Mapper.

### Roles

Team Concept Mapping is an approach to Concept Mapping during which one teammate plays the role of the “facilitator,” guiding the conversation with the knower, and the other teammate plays the role of the “recorder,” working with CmapTools to record what the knower says in Concept Map form. It essentially splits the duties of the individual Concept Mapper in two. The primary advantage of the arrangement lies in enabling the facilitator to more directly engage the knower. By relieving the facilitator from most of the spatial and CmapTools skills, his or her focus can be more readily maintained on articulation, facilitation, and the big picture. That said, the facilitator is not entirely relieved of the spatial and CmapTools skills. Indeed, the facilitator must also work with the recorder in such tasks as what concepts to record, where to place them, what links to make

between which concepts, when to make space and move sections of the Concept Map, when to pause and reinitiate the recording, and when to start new Concept Maps and for what purpose.

The experienced recorder, meanwhile, must follow these directions while listening to the knower to capture concepts and, at many points, take direction directly from the knower. Actions may also occur to the recorder, and it is well within the bounds of the recorder role to speak up, ask questions, and make suggestions. At some points, the facilitator may also take over the reigns on CmapTools, as a vision for spatial organization may be more efficiently imposed directly by the facilitator than directed to the recorder. The well-practiced Concept Mapping team will fluidly demonstrate the ensemble nature of this relationship, each playing the proper roles while complimenting the other.

## **Choreography**

The ensemble also must choreograph its actions in the process of creating Concept Maps. To do so, the Concept Mapping team must start with a shared sense of the Concept Mapping process, which enables them to anticipate where the session needs to go next. They must use verbal and nonverbal communications to help each other gauge and manage the pace of the session. One example of this can be observed as a facilitator, who is deeply engaged with and looking at the knower, listens to the tapping of the keyboard by the recorder, indicating that the recorder is either keeping up with the engagement or not. Neither teammate should push the other; each must show patience to allow the process to unfold while simultaneously unfolding the process for the knower. And both must be prepared to be guided by, and guide, the other.

Our discussion of skilled Concept Mapping now turns to yet another context, the skills in Concept Mapping “on-the-fly,” i.e., co-creating Concept Maps with groups of people doing some sort of collaborative work.

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## **THE SKILLS IN CONCEPT MAPPING “ON-THE-FLY”**

Concept Mapping during brainstorming or in other collaborative work sessions is another skill-dependent practice. The biggest challenge lies

in the fact that the Concept Mapper must work with multiple knowers simultaneously, in many cases without the benefit of a group facilitator. Sometimes, the Concept Mapper becomes the de facto group facilitator, as the artifacts being generated by the Concept Mapper are discovered to be the most useful, and sometimes only, record of the proceedings. We have created Concept Maps both in and outside of the view of the groups with whom we are working. Showing the group the Cmap that is being developed almost always leads to the Cmapper taking on some facilitation role.

The difference between individual Concept Mapping and Concept Mapping on-the-fly is one of degree, not nature. The Concept Mapper must muster and amplify all of the individual skills, often for an extended duration. While the task can be exhausting, the advantages of the output of the session are clear. Concepts expressed by one participant are directly related to another. Priority and order can be brought to unorganized thoughts. Different, even seemingly conflicting, perspectives can be integrated or merged. Differences in beliefs and meaning that had been tacitly held can emerge (cf., Hoffman et al., Chapter 9). The simultaneous viewability of all of the propositions enable otherwise hidden crosslinks to emerge into new ways of looking at problems and solutions. Previously disparate propositions can be clustered into meaningful groups. Resources that were promised to be retrieved after the session can be immediately linked during the session. It is the role of Concept Mapper to ensure that all of these potentials are realized, where they become available.

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## CONCLUSION

In this chapter, we have detailed the features of good, Novakian Concept Maps, and explicated the skills required to make them. In doing so, we hope to inspire others to join the growing class of professional Concept Mappers, and to encourage professionals working in applied settings to employ *skilled* Concept Mapping to solve problems.

An old adage says that when you have a hammer, everything looks like a nail. Concept Maps, in particular those developed using CmapTools, do start to feel a lot like a hammer to the incipient Concept Mapper

and many topics of knowledge begin looking like nails. Each of us have seen the eyes of our colleagues roll when we have suggested (yet again) that a Concept Map might be a good way to represent or share meaning. In some cases, we have pushed forward with the Concept Map, and in the end demonstrated the value that we knew was possible all along. As skilled Concept Mappers, we also know when to restrain from Concept Mapping, and when to turn to other means of expression as the most efficient and effective way to encourage meaning making. After all, we did *write* this chapter.

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