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ABSTRACT

The revolution in digital communication is bringing about profound changes in the ways people live, learn, and work. Three topics that address these changes are discussed. First is a set of ideas about the nature of information and information processing. Second is an Australian National Framework for competence in language, literacy, and numeracy that has recently been developed; and third is a set of ideas about productive diversity that are the focus of some recent explorations for the Australian Human Rights Commission and the Office of Multicultural Affairs. Nine elements of information processing are identified and discussed as follows: (1) configuration; (2) location; (3) concentration; (4) organization; (5) replication; (6) representation; (7) distribution; (8) scale; and (9) transformation. The newly developed framework offers a complex picture of competence as something occurring at three stages of skill (assisted competence, independent competence, and collaborative competence) across six communication domains. Exchanging information across cultural, gender, class, and ethnic boundaries brings many problems. Individuals without information fluency skills and the motivation to use them will be at a disadvantage as will their employers. Eleven figures and four tables illustrate the discussion. (Contains 28 references.) (SLD)

Working in a Wired World

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Presentation for the seminar "Information Literacy at Work"
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Throughout the whole of [its] human history ... [Aboriginal p]eople's major tool in occupying and managing the Australian continent was knowledge.

Deborah Bird Rose, (1991, p. 8)

During my lifetime our planet has become a wired world. Actually, the process began in the lifetimes of my great grandparents with the invention of the telegraph. When European Australians built the telegraph line from Adelaide to Darwin and when the cable was laid from Sydney to Aukland during the lifetime of my grandparents, the world-wiring was well along. What has happened since the end of 1939 is the extension of the process to microwave and satellite technology (topics of some interest in Australia these days). With satellites and microwaves, and with fibre optic cabling and laser beams, we have moved from literal wiring to virtual wiring. The contemporary equivalent of the telegrapher's dots and dashes now span the globe in an instant. You can zap the full text of Macbeth into your computer in minutes from thousands of kilometers away.

What moves through the wires, glass fibers, and microwave channels of the world is information, digital information. Everything is transmissible, or rather, everything that can be rendered into ones and zeros is transmissible, with astonishing speed almost anywhere on the planet. Everything transmissible can be sent off the planet as well as around it.

This revolution in digital communication is bringing about profound changes in the ways we live, learn, and work. Here I want to examine three topics that integrate with these changes. First is a set of ideas concerning the nature of information and information processing. If we are in an information age, it behoves us to be clear on what that age is about. Second is an Australian National Framework for competence

in language, literacy, and numeracy recently developed by my colleagues at the Centre for Workplace Communication and Culture for the Australian Office of Training and Further Education. Many educational agencies are under a mandate to develop sets of training competences and the National Framework is intended to guide and direct their work in this area. The world's wiring has a significant impact on training for competence. Third is a set of ideas about "productive diversity" that are the focus of some recent work for the Human Rights Commission and the Office of Multicultural Affairs carried out by our Centre. Difference among and between workers, managers, clients, and customers has caused problems in the world of work as it has in other social, political, and economic realms. Productive diversity is a way of thinking about diversity that recreates difference as an advantage and an opportunity. Because the world is wired, we are closer to different others than ever before, and they are closer to us.

The Elements of Information Processing

Once upon a time I was to speak on a panel concerned with computer literacy. Wondering what the term might mean, I looked up "literacy" in the dictionary. Not surprisingly, it meant being able to read and write. That is, teaching children to read and write was a matter of attaching new input and output skills to a central process they already had, being able to speak their native language. First comes fluency and then comes literacy. If reading was adding visual language to a system already fluent in spoken language, then what would be the computer literacy parallel? It would still involve a kind of reading, though the thing to be read would be computer screens and printouts. It would still involve a kind of writing, but using a keyboard (before the days of Macintosh, Windows, and mice) instead of a pencil or pen. What would be the part in between? What are the basics of information processing? Children come to school fluent in spoken language but not with a full kit of information processing skills.

A computer is only a kind of information processing power tool, an information equivalent of an electric drill, an automobile, or a food processor. "Computer literacy" is a misleading term. We should not focus on the tool but on the work to be done with it. In other words, what people need in a wired world is *information fluency*. They also need a variety of literacies: linguistic, information, technological, perhaps computer. This list of the elements of information fluency derives from several earlier versions (Stavely, 1989) and integrates smoothly with the published

principles of information literacy (American Library Association, 1993; Breivik, 1992; Burnheim, 1992a).

The table that follows details nine interrelated elements of information fluency. They are shown as independent of one another, though a more rigorous analysis might establish some of them as subcategories of others. However, this presentation emphasizes the particular characteristics of each element. Although the present concern is information, the elements apply to physical objects and materials as well.

This approach to information has its roots in the Gestalt notion of figure and ground and in an observation by S. S. Stevens that judging sameness or difference is the most basic cognitive operation. It also has roots in computer science where it is common to refer to "information objects." That is, in a computer's working memory an object is a particular delimited set of binary numbers currently stored in a particular place. The "object code" of a computer program is the actual set of machine language instructions guiding the activities of the central processor. Our universe is composed of matter and energy. Each thing into which the universal matter and energy can be divided has a particular shape and a particular location. Thus begins the list of elements.

Nine Elements of Information Fluency

Element	Activities	Knowledge, Skill
Configuration	recognize, identify, detect pattern	breadth of experience, curiosity
Location	search, retrieve	search strategies, sense of direction, knowledge of maps, guides, bibliographies, etc.
Concentration	collect, hold, store	tools and technologies of storage
Organization	sort, arrange, rearrange, structure, create pattern	awareness of and experience with storage and retrieval schemes, deep knowledge of the material being arranged, creativity
Replication	copy, record	mastery of replication technics, e.g. writing, photography, sketching
Representation	encode, decode, map, describe, simulate	replication and organization skills, languages, knowledge of codes and their use
Distribution	communicate, deliver	knowledge of distribution channels and networks, skill with relevant technics
Scale	zoom	understanding of the complexity and structure of the material
Transformation	calculate, compute, make	mastery of the relevant technics, e.g. arithmetic, algebra, grammar, genre, programming language

The following paragraphs discuss these elements in more detail and offer examples of their functioning. Taken together, they constitute what is done with information, and with everything else: all life processes things.

Configuration

Everything that exists has a shape. At some level of examination, each thing above the scale of a molecule is distinguishable from every other thing by variation in shape or configuration. Each thing, thus, has an *identity*. The shape or identity of a thing is the information it bears (Young, 1987). In Shannon's mathematical theory of communication (Shannon & Weaver, 1949) information is defined in terms of uncertainty, in terms of the reduction of uncertainty, and this approach has been carried on by others (e.g., Jumarie, 1990; Stonier, 1990; Dretske, 1981). Of the possible signals one might receive at a given moment, the more unlikely a signal turns out to be the more information it carries.

It is poetic to define information in terms of uncertainty. The more confusion to be found in a situation—the more uncertain it is—the more information there is to be obtained, the more there is to be learned. We so often think of information as part of the sequence data–information–knowledge–wisdom. To say that the information available equals the uncertainty one has is, on first examination, to go off at right angles to the line that leads to wisdom. More careful examination shows Shannon's insight to be accurate, however. Uncertainty reduction: "What thing have I encountered? I am uncertain. Ah ha! It's that one; I recognize it now." In*form*ation: the very word spells shape.

"Uncertainty" implies an observer who is uncertain. The information obtained by someone or something from the identification of a configuration depends on the information already in hand (Jumarie, 1990; Dretske, 1981). Without being able to prove it, I would suggest that the amount of uncertainty I or anyone else has about the universe is infinite. No matter how much I succeed in reducing my uncertainty about something, there will be an unlimited amount of information left to learn. No threat to the policy of life-long learning here.

The idea of information as distinctiveness, distinguishability, started early in the history of life on earth. Individual bacteria have mechanisms to distinguish features of their chemical environments. At the other extreme, when human beings invented writing what they did was devise a set of distinguishable marks they could

make on flat surfaces to represent language elements. And, before there was visible language there was, of course, audible language. Speech communication consists of distinguishable bursts of sound. Language learning consists of coming to recognize the particular sound-chunks that are meaningful in the tongue and to generate and organize those chunks and not others.

As we will see in the description of the other elements of information processing, the finding, copying, storing, retrieving, and utilizing of the information carried by the shapes of things constitutes information processing. Information is configuration and information processing starts with recognition and distinction, with identity.

Location

Everything that exists exists in some place. Information cannot be processed until first it is found. A central requirement for an information user and processor is a set of strategies for finding what you need when you need it. Anangu people in the Centre of Australia have strategies for finding water in the desert. Taxpayers are lucky if they have good strategies for finding the many bits of paper needed to document their tax returns. Library users learn strategies for finding things in the stacks. Each setting requires particular strategies, and although there are often similarities from one to another, there is also a great degree of particularity about it. One must learn the ways of each situation and be able to call up the knowledge when it is needed.

In social settings, one transferable strategy is to ask another person where the thing you seek might be. I suppose there are even strategies for determining which people are the best candidates for such a question. In the library, of course, it often helps to ask a librarian, or it certainly should. On the other hand, the joke exists in many places in which a tourist asks a local how to reach a certain town. After thinking about it a while and making several false starts, the informant, often an old farmer, concludes, "Yuh can't get theah from heah."

Another universal strategy is to look everywhere. If nothing else works, and if one has enough time and patience, it is possible to begin at the upper left-hand corner (for us readers of English and similarly arranged languages) and examine every centimeter of the space. Because this strategy gobbles up time and other resources, the specific knowledges just discussed are valuable.

This analysis may help us understand better what it means for something to be lost. If information exists as the configuration of objects (or of energy packets) and if objects (and energy packets) have as a basic property some location, then information about location—map coordinates, call numbers or whatever—is valuable. If a seeker lacks that sort of data, an object is lost, short of a look-everywhere search. When I was a child and couldn't find my socks or a favorite toy, my mother would say, "Look where you don't expect to find it." With my child's understanding of the world, her suggestion made me angry; I was sure the lost object was to be found where I was looking—that was why I was looking there. Now I realize that all she was doing was restating the definition of "lost." If the thing was where I wanted to look for it it wouldn't be lost.

Concentration

To process any appreciable quantity of information, the items making up that quantity must be collected in one place. When I fill out my tax return I have to gather in one place all those bits of paper, printouts, and spreadsheet files that document the year's income and expenses. Given the ability to recognize what is wanted and the resources to search it out, concentrating it together in one place follows directly. When a scholar enters a library with a topic in mind she eventually leaves, if all has gone well, with a set of notes and bibliographic citations. The material was spread throughout the library (or now, throughout the world computer network). After her research, copies of selected items are concentrated in the scholar's papers.

There are technologies for the concentration of information, as there are for the concentration of objects. It is striking how similar an auto parts store and a library really are. A bowl in the kitchen allows the concentration of the components of a bread recipe and then their processing to the point of kneading. Index cards, ring binders, and database programs store verbal information. A chest of drawers stores shirts, underwear, and socks. Even frozen orange juice represents the element of concentration: the non-water orange material gets separated from much of the fruit juice's water, packaged, and frozen. Autumn in the American northeast means millions of dead tree leaves to be raked and composted. Crucial technologies have developed over many centuries to separate things from each other, including distiling, raking, screening, smelting and Boolean searching. Concentration is assembling together what you want and leaving behind what you don't.

Organization

Once you have assembled a collection of information objects, it may be helpful to arrange them in some order or to sort them into categories. Doing so facilitates retrieval. Finding the item initially may have been difficult, having to struggle to find it again is really a drag (take for example the lost bit of tax information 4/5ths of the way through completing the return). We alphabetize lists of names and many other items to facilitate locating them later. Chronological ordering and ordering by size, price, population, or any other numerically increasing or decreasing sequence is common. The key here is knowing the scheme: alphabetizing in Cyrillic order wouldn't help me as much as alphabetizing in Roman order.

Beyond linear sequences there are innumerable organizing schemes. Hierarchical structures are common in Western culture. Children were once taught to outline their school writing projects hierarchically with Roman numerals, capital letters, arabic numerals, lower case letters, and so forth. The taxonomy of biological names for plants and animals is a famous example of a hierarchy. Library numbering systems are more or less hierarchical, with certain types of information found within a certain range of numbers and the numbers growing longer as the category subdivides. But hierarchy doesn't exhaust the possibilities for complex organization of information sets. There is the classical mnemonist's method of *loci*, chronological order, musical structures of melody, harmony and rhythm, genre and story grammars, and so forth.

Talking about organization opens the way to talking about disorganization also. Randomness is the opposite of order. In this context "random" means that every configuration is equally possible, every sequence of configurations is equally possible. A random sequence of objects or events will certainly lack familiarity as a pattern, yet it will be itself and not some other. That is, it has its particular identity (particular configuration) and as such carries that much information. At this moment in the USA and elsewhere people are recording and searching cosmic radio waves searching for signs of extraterrestrial intelligence. Computer programs conduct complex manipulations of the interstellar signals searching for nonrandom patterns that might be communications from other societies. Question: How can you look for order constructed by creatures utterly different from yourself? SETI scientists are testing possible answers. And, since we're talking about order and chaos, what about codes? Coded messages do the best they can to hide their

organization. They're meant to *look* random while actually containing a meaningful communication that you can extract if you have the right key. Randomness is tricky stuff.

Replication

In a way, the purpose of life is copying onesself. The geneticist J. B. S. Haldane is supposed to have said that the hen is the egg's way of making another egg. That is the information in the egg tells how to create an object capable of laying another egg. And that reproduced egg carries copies of half the genetic information in the original egg, a random half. Another new egg from the same hen carries a different random half. For purposes of concentrating an information set and for the purpose of making of information portable, and for many other reasons, copymaking is important.

The technologies of copying information represent a major axis of the history of technology in general. Consider this rough history of copying: clay tablets, papyrus scrolls, illuminated manuscripts, printed books, lithography, photographs, phonograph recordings, silk screen prints, motion pictures, mimeographs, tape recordings, videotapes, photocopies, floppy disks, compact disks. Since the invention of money there has been money to be made from increasing the accuracy and lowering the price per copy of information objects. Looking at this list of technologies, one can see that society itself has been transformed as a result of the introduction and distribution of new, effective means of producing copies of information.

Representation

Representation of information in this list is meant to stand for a change in the form of information that approximately preserves its meaning. "Translation" and "transduction" are two synonyms. I say "approximately preserves" rather than just "preserves" because as the saying goes, *traduttore, traditore,* the translator is a traitor who undermines the original meaning in the constructed representation. Nevertheless, to represent one thing in another form is often enormously useful, as, for example, representing the terrain over which one intends to travel on a highway map. In representation something is always lost—which is the reason why the translator must betray the source material. The highway map is not at all like the territory except in the crucial area of road directions, distances, and junctions.

In human history, the invention of spoken language constituted a profound change in the ability to represent one thing in another form. When one person's perceptions and conceptions could be represented in language and communicated to another with a richness of detail and nuance, culture was transformed. When written forms of representation eventually appeared, time and distance became far less of a barrier to communication. Furthermore, the individual who could write could feed back into his thought process a significantly larger quantity of ideas at one time, thus becoming able to perceive more abstract patterns in the information and obtain deeper insight and understanding.

Before spoken language, according to Merlin Donald (1991), protohumans communicated mimetically. That is, they represented and expressed their conceptions and feelings by gesture and movement. He suggests that knowledge can be communicated in this way, enabling communities to maintain a culture and carry out complex collaborative tasks such as group hunting of large game. Spoken language added considerably increased people's ability to represent information, to be sure, as has written and printed language; but facial expression, posture and gesture are still important. Humans have not stopped dancing just because they can now tell a story with words.

Represented information has a shelf-life. When a representation and the thing represented are separated from one another, they become independently susceptible to modification. In other words, change will strike each differently. We no longer look like our high school photograph. Every data base contains inaccuracies because some of its contents are out of date. The problem of keeping disparate copies of the same file current is not small, especially in large organizations and even when all the copies reside in the same computer network. Gauss taught us almost 200 years ago that all data contain error. The longer the time since a copy was made of a data set, the more likely it is to have become stale.

It is worth considering human memory in this regard. Far more than a floppy disk or hard drive, human memory is dynamic. Remembering something is an act of reconstruction; the memory is made up at the time of remembering (see Loftus & Loftus, 1976). What gets made up depends on present motivation and expectation as well as what representation of events was stored to begin with. Guaranteed, we never remember with total accuracy.

A crucial thing about represented information is the paradoxical relationship between precision and accuracy. The more one strives to be precise in simulating, or modeling a complex and changing reality the more one will become inaccurate in the long run. The more one strives for accuracy in painting the big picture the more imprecise one must be concerning details. For a given information processing situation one must balance these two considerations. Karl Weick has emphasized this paradox in his *The Social Psychology of Organizing* (1969). Additionally, recent research has demonstrated that when communication within an organization is too clear the organization is ill-prepared for unexpected changes in its environment as compared with an organization with less clear communication, i.e. one with a number of contradictory messages. The point is that alternative versions of reality stay alive in the less-precise representation and are available later on when reality has turned back on itself to approximate a different model than it had formerly.

Representation interconnects with organization and configuration. When organizing a set of information objects one may invent categories in which to sort items sharing similar properties. "Similar properties" is a matter of configuration: two things are similar if they share certain configurative features. Representation comes in when the category is named or identified with a symbol of some sort. For purposes of further information processing, the *name* can be used in place of the objects themselves. As needed at some other time or place the objects in the category can be unpacked from the name. In the meantime, great economy and efficiency is achieved by the substitution. A powerful example of this phenomenon for each of us is our personal identity (Erikson, 1951). The main task of adolescence (at least for male adolescents) is establishing a sense of one's own identity. Only with a reasonably clear sense of their own psychological shape and boundaries can people move ahead and deal effectively with others and the world. In education the same general consideration shows up in the concern for metacognition. Children need ways to think about their own thinking in order to be more effective as active learners (Papert, 1980).

The dark side of representation is the use of false categories. Thanks to the flexibility and creativity that language allows, one can invent any names one likes. *Slithy toves* playing in the *wabe* are benign examples of false categories. But "race" is a nasty one that has burdened humanity for hundreds of years. Race, as color, has no existence in biology but a powerful existence in the ideology of racism. Reification of

category names is an everpresent danger. In our neverending quest to understand—represent internally—the world around us we constantly look for patterns and types in the behavior of people and things, especially in the behavior of other people. It is a central tenet of social science that shared beliefs about categories have a self-fulfilling quality. "Things believed to be real are real in their consequences," as Thomas and Znanietzki wrote about 70 years ago. Some protection against the harm false categories can do is available in scepticism and the repeated testing of one's ideas and beliefs. "I'm from Missouri; show me," is an old saying in the United States. A useful rejoinder to the assertion of a purported truth is, "Compared to what?" Also, it doesn't hurt to familiarize oneself with the known logical fallacies. Moves afoot in Australia to include critical skills in the school curriculum are a good idea in this respect, to the extent that a true ability to criticize all arguments is learned and not a particular theory and ideology of critique.

Looking back on the bright side of representation, it is worth a moment to take note of simulation as an information processing activity. Scientific, social scientific, and educational theory often make use of mathematical, metaphoric, and mechanical models to represent the reality the theorists seek to understand. Watson and Crick waited on tenterhooks for days until the machinists at the Cavendish Laboratory could complete the pieces of their model DNA molecule (Watson, 1968). Without the physical model they couldn't be confident that their theory of the genetic code was correct. More recently, oceanographers have put "the billion-plus cubic kilometers of the world ocean into a box about the size of a telephone booth" (Kerr, 1993, p. 32). They have for the first time managed to simulate the entire ocean in a supercomputer So far the world atmosphere still eludes computer simulation because of the much larger quantity of data that must be manipulated.

Distribution

As mentioned, the ability to represent a set of information items in another form facilitates its communication. To be able to deliver multiple copies of a set to many destinations more or less simultaneously has many advantages. A history of information distribution technology would be quite similar to the list of replication technologies mentioned above. Many of those were invented to facilitate communication. Historically, libraries served an important social function as information-distribution points. When printed information was rare in homes and communities, libraries were like the town well. Modern broadcast technologies

deliver huge quantities of picture and sound over vast areas quite cheaply. CD-ROM technology wedded to PCs permits the distribution of application software, data bases, and even type fonts in mass quantity. The library's job has added information access and management to information concentration and organization (Hannabuss, 1987).

The creation of distribution networks for information as for any other commodity has been both the consequent and the cause of social change. Automobiles aren't much good without highways; personal computers increase exponentially in usefulness when they are attached to local and wide-area networks. To buy a PC without a telephone modem or a network port is to cripple the machine in terms of its potential as a sender and receiver of information.

Information distribution interacts with information organization. If you want to target messages to particular locations it helps a lot if the organization of the destinations is known. In the United States, most streets and avenues are platted on a grid and the blocks are sequentially numbered. Mail delivery is simplified. I haven't figured out how they do it in Tokyo where there are no street addresses. The Japanese postal system, however, knows the scheme.

Scale

Everything that exists can be viewed from many standpoints. Every object can be examined with a microscope, the naked eye, or a telescope, so to speak. My favorite metaphor in this regard is the zoom lens. In close, we see a lot of detail within a narrow range. Zoomed back, we see a larger scene, the big picture, without as much fine-grain detail.

What makes scale important is the ability it gives to resolve patterns in the information set under investigation. By changing the scale, different patterns are visible. An aerial photo of Brisbane will show the Brisbane River while a blow-up of the photo might let you see into someone's back yard. If you had the complete set of blowups you probably couldn't find the river unless you assembled the pictures like a puzzle and then hoisted yourself up in an industrial crane to get the necessary perspective.

Scaling is an aspect of information processing that is little understood, I believe. We get into trouble when struggling to understand something if we use concepts that

mix different levels of analysis. Learning what goes with what at the same level and what goes at higher and lower levels is valuable learning indeed.

Transformation

This list of information fluency elements began with pattern recognition. It ends here with symbol manipulation. Acts of transformation in information processing involve subjecting one information set to a series of treatments that change it in some particular way. In mathematics, transformation is what functions do. For a given function in X, when you supply a value for X the function returns a value for Y (assuming you know how to perform the necessary calculations). In cooking, transformation is what recipes do. For a given set of ingredients, the application of a specified series of cutting, mixing, shaping, and cooking produces an apple pie or a meatloaf. Statistical analysis takes numerical information (numerical *representation* of some source data) and produces means, medians, standard deviations, *t*-statistics, correlation coefficients, probability values, and so forth. Even qualitative research requires transformation of information. Content analysis takes a set of verbal material and produces the count of each category of statement found therein.

Transformation, unlike representation, produces a result different from its original ingredients. In principle a representation can be reversed, though in practice it is at least expensive to do so, as, for example, recreating a landscape from a photograph. You cannot get water, yeast, salt, and flour back out of a loaf of bread; the materials have been transformed. You cannot unpack the original figures out of an average for the same reason.

Besides calculation and computation, consider games and battles. In the beginning the sides have certain information and certain material and nonmaterial resources. The issue is in doubt and the play of the game, the fight of the battle, will decide the result. Afterwards people may argue what might have happened if this or that had been different, but with the actual winning and losing the initial uncertainty is transformed into a specific outcome.

Thinking of games and fights as computations points to another feature of transformation: parallel processing. In team sports and warfare, many people are making choices and taking action simultaneously. In parallel processing several or many actors cooperate, coordinate, converge to determine a result; there is not a single A B C sequence of actions leading from initial conditions to final outcome.

Parallel processing is an area of intensive research in computer science right now. Much remains to be learned about how to program "massively parallel" machines (Sabot, 1988) but the hardware is developing rapidly. Work groups, committees, organizations, even whole societies are parallel processors of information.

But wait

The structure of information processing elements here outlined owes its existence to a particular culture and a particular view of reality. The Western Enlightenment and its atomistic, objectivistic conception of the universe and all its living and intert contents stand behind this approach to information fluency. Michael Christie (1993a, 1993b, 1990) has described the possible limitations of traditional Western approaches to understanding and the importance of entertaining alternatives. He outlines how the Yolngu people of Arnhem Land in Australia's Northern Territory offer a sample alternative science. In Yolngu understanding reality is not divisible into separate abstract boxes. Every person and thing has several names, each appropriate to a particular context, each signifying a particular set of relationships to other persons and things. Complex and extended lines of connection characterize Yolngu science. Knowledge of all the identities and connections that things have is acquired over a lifetime of participation in song, dance, and story and is negotiated interactively with other knowledgeable members of the community. Christie observes that both Western science and Yolngu science carry out their knowledge-building by means of metaphor.

> Developing a metaphor involves selecting a particular picture of reality and fitting our data into that picture. The Western scientific system, like the Aboriginal system, ignores some obvious differences between elements and focuses upon those aspects which are found to be congruent according to the chosen metaphor. An obvious example of this metaphor building in Western science is the process of quantification. When I say there are two hundred people in this room, I am making in some ways a rather bizarre leap, by assuming that in one sense, we are all identical, and therefore can be included meaningfully in a set of '200 people'. We are in fact, all quite different, so different that it would be impossible for me to actually define what a person is, but my scientific system allows us to assume that in some sense we are all alike, and to that extent, counting people is a meaningful scientific process.
>
> Aboriginal scientists refuse to make such a huge metaphoric leap. They know each person is an individual, from a certain family, from a certain part of the land, from a certain totem, related to each other in particular ways. It is in their relatedness and their affiliations which are significant in the Aboriginal system, and to quantify people would force us to ignore those other metaphors which define our various modes of connectedness with the world and each other. A Yolngu gathering of two hundred people say, at a funeral, would be seen by Yolngu scientists in terms of a variety of roles and dimensions specific to the context. They would see the close relatives of the deceased, people who are the managers for the totems of the deceased, people in the correct relationship to do the ceremonial singing, or the painting, people whose land forms

> part of the dreaming track chosen to return the spirit to its home, and many others. Aboriginal science ignores, in this instance, the common humanity shared by the 200, and perceives and labels them according to different metaphors appropriate to the context. In the Aboriginal context, the fact that there are 200 people present is useless information. Western science on the other hand, ignores the reality that all elements are given meaning by their context, and cultivates a metaphor in which they can be manipulated as abstractions without reference to context (Christie, 1990, pp.58–59).

I believe that the Yolngu system of knowledge could be mapped onto the description of information and information processing I am presenting here. However, I would want to approach the task cautiously. I have much more to learn about the epistemology and ontology of cultures other than my own. For the present I think it is important to remember the cultural rootedness of the ideas I am presenting.

Information and Competence

As part of Australia's integrated industrial and educational restructuring, my colleagues at the NLLIA Centre for Workplace Communication and Culture, in collaboration with a team of other educators, have developed a new "National Framework of Adult English Language, Literacy and Numeracy Competence" in a report entitled *Communication, Collaboration, and Culture* for the Office of Training and Further Education in Canberra (Cope, Kalantzis, Luke, *et al.*, 1993, Cope, 1993). Schools and workplaces have always been about information, and in this "information age" the information content of education and work takes on new dimensions.

Six Types of Communication

The report identifies these six ways of communicating about activities in the workplace, each with its associated domain of application and some typical examples. The following table, drawn from Cope (1993), shows the workplace communication types and domains and offers some examples.

Domains of Workplace Communication

Type	Domain	Examples
Procedural	Task	instructions, suggestions, orders, commentaries
Technical	Technology	instruction manuals, technical reports, mathematical expressions
Personal	Identity	heart to heart talks, discussions of personal motivation, negotiation of different attitudes and expectations
Cooperative	Group	collation of written and numerical data, negotiation of different interests, engaging in group discussion, producing substantive reports
Systemic	Organization	creating and reading flow charts and organizational diagrams, negotiating up and down the hierarchy, dealing with industrial relations issues, participating in committee work
Public	Community	handling aspects of client relations, public relations, advertising, or marketing, representing the organization to suppliers, distributors, or government agencies

Perhaps the first and most obvious connection between the communication domains covered in the framework and the previous discussion of information fluency is the element of information distribution. Communication competence requires the construction and delivery of information sets from one person to one or more others via diverse media. Skillful and effective communication in the workplace requires creative and effective finding and identifying, collecting and organizing, representing and processing, and copying and distributing of information—all the while being mindful of scaling factors by zooming in on details and out to varying sizes of the big picture as appropriate. Specific skills for each element of information fluency will differ depending, among other things, on the task involved, the form the relevant information takes, the communication technologies available, and the cultures of the people and the workplace. Training needs to concentrate on the acquisition and refinement of skill across the whole spectrum of information fluency.

One key feature of refined skill here is recognition of the tentativeness of information representations. Newly minted understandings of a state of affairs are certain to be inaccurate and quite likely to be misleading as well. The ability to return to the sources of data again and again to search for disconfirming information and otherwise to test one's conceptions is essential.

Scaling considerations are also fundamental. The framework's domains constitute a triangular constellation of task, technology, and identity within concentric circles of group, organization, and community. In the contemporary workplace one must be able to shift focus rapidly and smoothly among task, technic, and self and to zoom in and out as necessary in order to include any two or all three at once. This kind of attentional mobility must be available not only at the level of one's own specific job but also at the level of one's participation in working groups, the overall organization, and the organization's lodgment in the larger community.

So far I have been discussing the information processing function of individuals. With only the rarest exceptions, however, individuals almost never work alone. The framework recognizes the cooperative, collaborative nature of the workplace as follows:

> The *National Framework* is not about isolating out 'the illiterates', or people who would otherwise fail standardised tests. Rather, it is about two important approaches to workplace communication:

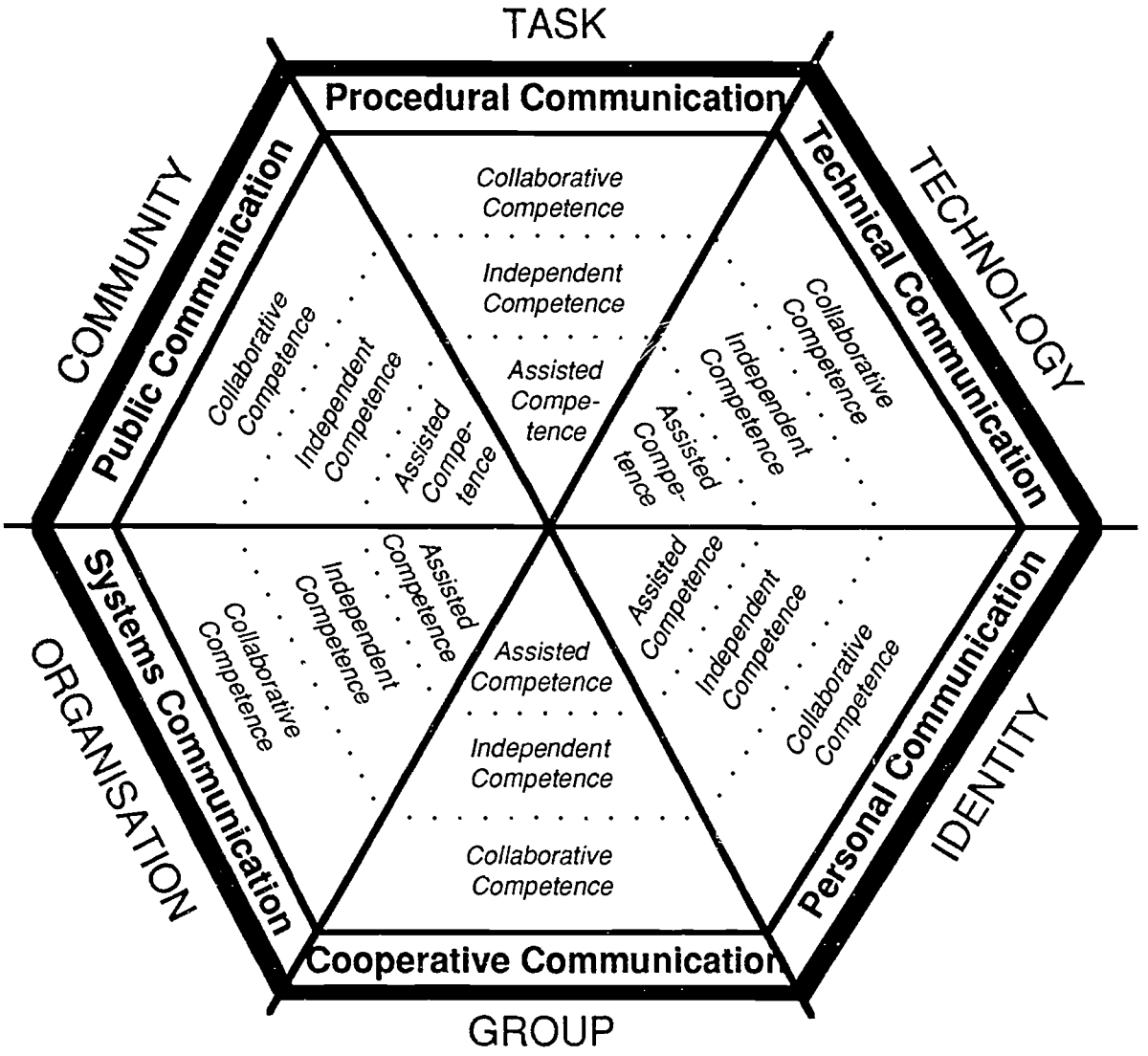
- **Complementarity**: People bring to work different communication skills. These need to be identified, valued and used as a resource for the organisation. The *National Framework* attempts to identify the range of communication skills needed at work so that the different linguistic and cultural resources of all the members of the organisation are used to complement each other.

- **Repertoire**: All members of an organisation should always be striving to extend their repertoire across all six forms of communication described by the *National Framework*. This should involve negotiation, exchange and continuous learning for all members of the organisation, from the bottom to the top (Cope, 1993).

At the level of the organization, complementarity and repertoire must be recognized and nurtured. At the level of the individual, the framework describes how competence in workplace communication grows through three stages. Individuals demonstrate assisted competence at some tasks, independent competence at others, and collaborative competence at yet others. Training, on the job, in worksite courses, and in offsite courses, must support learners in growing through these stages toward the goal of collaborative competence across as many tasks and technologies and at as many organizational levels as possible.

Three Stages of Competence

The *National Framework*, then, offers a complex picture of competence as something occurring at three stages of skill across six communication domains. The diagram below (Cope, Kalantzis, Luke, *et al.*, 1993) presents the full structure in a ring configurationwith the domains of communication in contact with one to another.



Domains of Communication and Stages of Competence

Representing the framework in this ring configuration means that when a given individual's competence is mapped onto it she or he would be found near the center for some work situations, near the middle for others, and near the outside for still others. The picture makes it hard locate an individual at a precise point and suggests that the goal of training is to encourage a flow away from the center. To illustrate that different representations are useful for different purposes, consider the following diagram (Cope, Kalantzis, Luke, *et al.*, 1993) showing the framework as a grid.

An Example: English in the Workplace Program—AMES

Task- *can independently use procedures and strategies neede to complete a range of tasks*
- needs assistance to extend and build on knowledge and skills relevant to performing tasks.

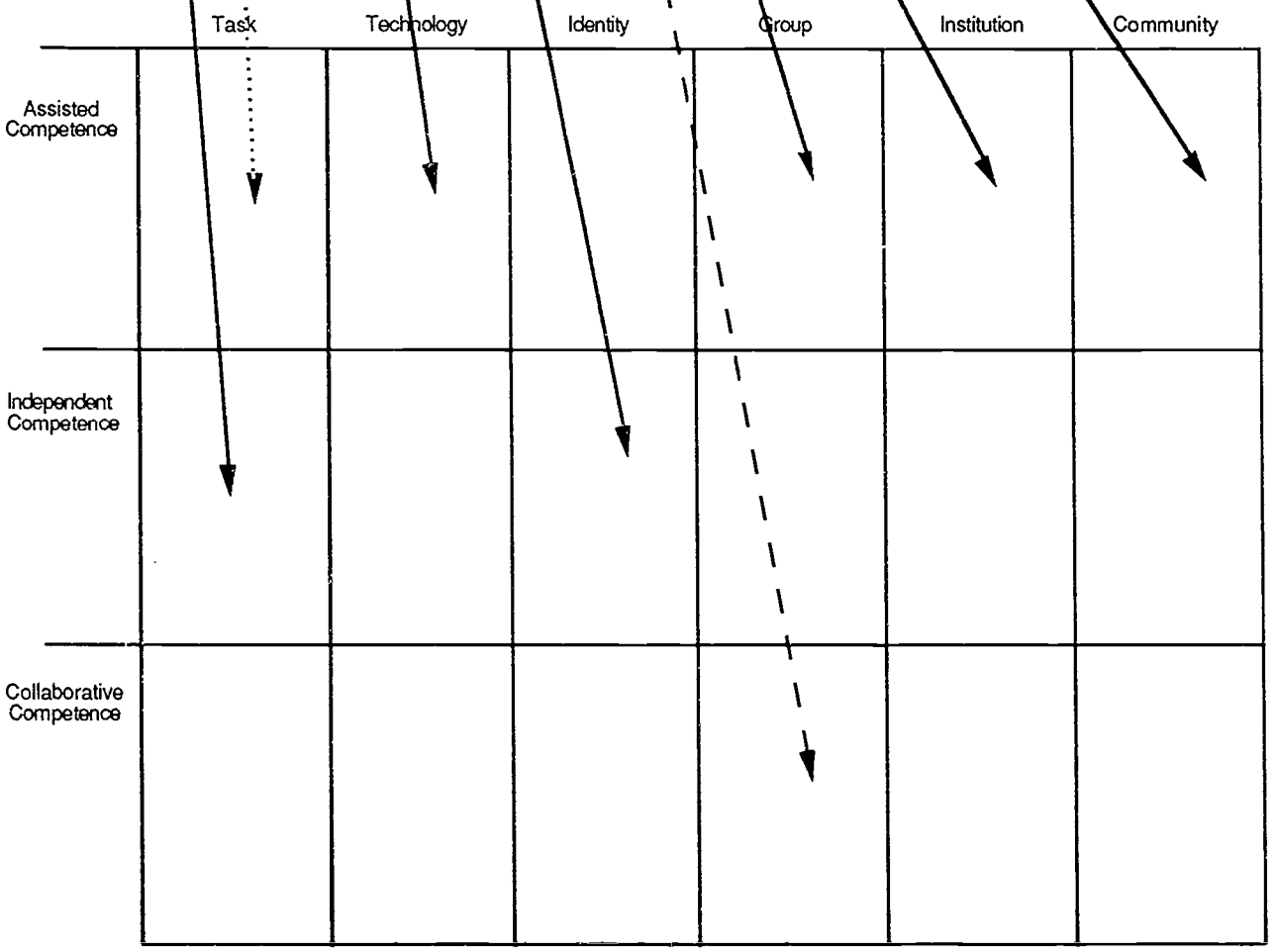
Technology —*needs asistance to use language, literacy and numeracy with a new technology*

Identity—*can independently use language, literacy and numeracy to develop knowledge resources that arise from personal identity for participation in a range of contexts*

Group —*can collaboratively use language, literacy and numeracy to participate in teams in familiar contexts*
—needs assistance to participate in unfamiliar contexts

Institution —*needs assistance to participate in an institution in accordance with its goals and structures*

Community —*needs assistance to participate in community structures and activities*



The diagram indicates that a particular AMES class, as a group, was skilled at different stages in some areas of competence in different communication domains—in fact, they were skilled at different stages depending on whether the task was in the familiar range or required an extension to new tasks or whether the teamwork context was familiar or unfamiliar. "[A]dults require a repertoire of performances depending on the circumstances they face at any particular time and place" (Cope, Kalantzis, Luke, *et al.*, 1993). With competence, as with information fluency, flexibility and multiconnectedness are central themes.

Australian trainers and adult educators are already familiar with the topic of key competencies due to the work of the Mayer Commission and its predecessor the Finn Commission (Burnheim, 1992b). The new National Framework reapplies the fundamental concepts introduced by the Mayer Key Competencies. In the following table (Cope, Kalantzis, Luke, *et al.*, 1993) the Mayer concepts have been reorganised to meet the particular needs of this framework as it focuses on language, literacy and numeracy development showing the fundamental points of commonality between the framework and Mayer.

Comparison of the National Framework with the Mayer Key Competencies

This Framework > Mayer V	*Task: Procedural Communication*	*Technology: Technical Communication*	*Personal Resources: Personal Communication*	*Group: Cooperative Communication*	*Organisation: Systems Communication*	*Community: Public Communication*
Collecting, Analysing and Organising Information	X	X	X	X	X	X
Communicating Ideas and Information	X	X	X	X	X	X
Planning and Organising Activities	X	X	X	X	X	X
Working with Others and in Teams				X		
Using Mathematical Ideas and Techniques	X	X	X	X	X	X
Solving Problems	X	X		X	X	
Using Technology		X				

As information, the Australian education and training agenda is undergoing a continuing transformation as new elements and interpretations are added to earlier structures. The whole is subject to alternative and sometimes contradictory

representations. Perhaps this framework will assist in organizing many different efforts into a coherent pattern.

Information and Productive Diversity

This discussion began with the observation that the world is wired together as never before. Also as never before in the world people of diverse backgrounds, cultures, and interests have been brought together, virtually if not actually, to live, learn, and work in concert. As with musical concerts, there can be consonance and dissonance in the process. The dissonance can lead to resolution or to outright dischord. Many compositions are possible. Many interpretations of a composition are possible. What ultimately transpires is a function of all people involved acting together.
Throughout the twentieth century there have been huge numbers of people on the move, both socially and geographically. Now more than ever before people of different ethnicity, gender, culture, and orientation find themselves needing each other to get their jobs done, to carry on their daily lives, to pursue their personal goals.

Culture

"Culture" has become a buzzword in the literature of management. Concern is shown for the "culture of the workplace," for the "company culture" and for workers to clone themselves to the corporate model of culture. The basis of culture is human needs. People have material, emotional, and spiritual needs, and human cultures have evolved as ways for people to meet their own and each other's needs (Kalantzis & Cope, 1983). The subject is usually discussed in terms of language, beliefs, values, tools—what one might call "the furniture of daily life." These aspects of culture are the systems by which culture makes possible the meeting of needs in an ongoing fashion. In the context of information fluency, we can say that culture is a particular way to identifying configurations in the social and physical environment, a particular set of structures with which to organize information one gathers, a particular set of representations commonly applied to the information one possesses, and a particular set of transformations preferred for acting on the information available. Communication and collaboration across cultural boundaries is bound to encounter problems. Contemporary workplaces, in Australia, the United States, and all around the world are becoming increasingly culturally diverse.

The Productive Diversity Model

Converting this diversity from one of difficulty to one of opportunity is the subject of a CWCC report *Productive Diversity: A Report to the Human Rights Commission on the Piloting of its* Diversity Makes Good Business *Program*. The report concludes with these paragraphs:

> Not only Australia, but all over the planet people of different backgrounds are living and working side by side. In some places, notably ones where different groups have lived together for generations, savage warfare is taking place. In some places racist attitudes and discriminatory practices mar the lives of both mainstream and marginalised groups. Early in the Twentieth Century cultural difference was used by management in large industrial organisations as a tool to speed the assembly line and maximise production. More recently, cultural difference came to be treated as something to be reduced and replaced by a loyalist corporate culture. As has been argued in this report, both of these approaches to diversity are worse than unsatisfactory today.
>
> Today when people work in collaborative teams, take responsibility for production decisions and product quality and have to master the seeking, finding, processing, and communicating of information more than ever before, cultural understanding and accommodation are essential. Justice and fair treatment as human rights now converge with productive diversity as an economic necessity. Diversity can make good business and will when people and their organisations embrace it and make it their own (Cope, Kalantzis, Solomon, *et al.*, 1993).

Industrial management in the twentieth century has passed through two phases and can be nudged into a third, according to the *Productive Diversity* report. Scientific Management ("Fordism") represents the first phase, Restructured Enterprise is the second phase which has recently replaced Scientific Management in many corporations. Research into the best practices for managing diversity in the workplace has demonstrated the outlines of a third phase which the report calls Productive Diversity. The table that follows (Cope, Kalantzis, Solomon, *et al.*, 1993) compares these three models of management across nine features of the work and the workplace.

Comparing Models of Management

	Scientific Management	Restructured Enterprise	Productive Diversity
production model	mass production for a mass market	flexible specialization for niche markets	enhanced flexibility of specialization
worker skill	subdivision of tasks and deskilling of workers	assignment of tasks to multi-skilled teams of workers	not standardized across workers, crosscultural communication skills valued, difference utilized as a productive resource
pace of work	relentless production line designed by management engineers	driven by workplace culture emphasizing sense of community and allegiance to enterprise mission	culture-driven with encouragement of difference rather than pressure toward a monoculture
induction into the workplace	minimal; workers given a place on the production line and left to do the job	managerial and peer pressure to conform to a monolingual, monocultural setting	two-way cultural exchange, both workplace and worker accomodate difference
management structure	authoritarian hierarchy	flattened hierarchy emphasizing participation, collaboration, and negotiation	flattened hierarchy emphasizing participation, collaboration, and negotiation
locus of decision	management engineers perform time and motion studies to define tasks and carry out quality control	every worker brought into decisions about task allocation, work design, and quality assurance	every worker brought into decisions about task allocation, work design, and quality assurance
lines of communication	vertical only	horizontal as well as vertical	across sociocultural lines in all directions
industrial relations	confrontation between centralized management and centralized unions	participatory and consultative industrial relations involving win-win bargaining, enterprise bargaining, and broad worker participation	participatory and inclusive of the socioculturaly diverse informal networks to acknowledge different needs for different groups
marketplace	uniform mass market based on the language and culture of the dominant group for all clients and customers	market diversified by age gender, ethnicity, sexual preference, style allegiance, etc.	locally and globally diverse, made accessible by respective diversity of the workforce

Here is an example of the productive diversity model at work in the client relations section of the Australian Taxtation Office (ATO) in Dandenong, Victoria.

> I go and give talks to farmers in Gippsland. Coming from an Italian background helps me a lot. Culture is not just nationalities, but the man on the land compared to the man in the city, and so on. So, I go to the field days dressed casually. I also speaks from personal experience. I know Italians and farming. There's an expectation among many Italian and Jugoslav farmers that the government will help them. I tell them that you need to appreciate that this is not Italy 40 years ago. Even if they go away grumbling, at least they know.
>
> Advising officers have lots of contact with clients. I use my cultural background as a resource. Clients write in and say really nice things about how well I do my job. I know about the outside world. I take a tremendous interest in taxpayers' affairs. There's a tremendous appreciation for what I do. But I can contribute a lot more than I am able to at this level. Clients often expect the tax office to be overbearing. But we're here to serve; this is my cultural view; make sure the customer is satisfied and deliver in a way that is not threatening. The ATO must have compassion and stress the service it provides. It must not be condescending. A customer may have $2 million to invest in Victoria, which they might take to Hong Kong instead (Cope, Kalantzis, Solomon, *et al.*, p. 49).

Cultural sensitivity takes time to build and vigilance to maintain, and the effort is worth it.

Beyond Conflict

The daily news abounds with examples of diversity giving rise to dispute conflict, and worse. Although I have observed face-to-face confrontation more often in Australia than I usually do at home, I think it is safe to suggest that the dominant middleclass Anglo culture of Australia joins its parallel version in the United States in encouraging its members to avoidance overt confict. One strives to make nice, not to make waves, to ignore or minimize difference.

The cost of this social appeasement policy is that information about difference is seldom in the forground. As a result, it is often not recognized, collected, represented, or processed. To the extent that culture gives people a set of filters to let in certain forms of information and screen out others, it blinds them to portions of their world. To the extent that culture gives people a set of categories and story structures to represent and process information, it simultaneously enables and disables their understanding depending on how closely current events match the available schemas. At the level of workplace and organization, blindness to certain realities and inability to understand can be costly. By establishing communication and negotiation links among people of different cultures within the organization gains the ability to represent within itself greater complexity in its environment (Weick, 1969). A diverse workforce multiplexed into shifting teams and task forces taking on ad hoc missions in an everchanging environment offers the best

possibility for successful enterprise performance. Members of that workforce must maintain a continuing dialogue with subordinates, peers, and superiors so that the information they individually and collectively encounter from the outside world and from the lively life within the organization is properly evaluated and digested.

Because the world is now so well wired, enormous quantities of information are literally a keystroke away. Serious questions arise, however, concerning what information is truely needed, which is out of date, and which is leading down a blind alley. The organization's internal representations must constantly grow and adjust. Mistaken and out of date information must be discarded and replaced with more correct and up-to-date material—though as the foregoing discussion shows, "mistaken" and "correct" are relative terms and the extremes of precision may be harmful to organizational health. Individuals and social systems are in constant contact with uncertainties. The human ability to make judgments about these uncertainties extends far beyond the competence of forseeable computing machines. Information fluency combined with a kind of "cultural fluency" to speed the flow of fact and speculation from person to person will put an enterprise on the path to Productive Diversity, whether its present management structure is Scientific or Restructured.

Exchanging information, both factual and speculative, across cultural, gender, class, and other boundaries has its problems, of course. People disagree. The heat of their disagreement is proportional to their commitment to their own goals (which may be shared with others in their work group and the organization) and to the overarching goals of the enterprise. It is also proportional to the threat to their own self esteem and future prospects they perceive in the positions taken by others they are interacting with. This is negotiation. though it is often thought of as something carried on by company representatives, diplomats, lawyers, and industrial relations representatives, in fact people negotiate with each other all the time. e.g., over who will go out for coffee or which movie they will attend as well as over more weighty matters. Negotiation means taking a stand, expressing it, and listening to another's conflicting expressions of a a stand. It can get very hot indeed. In workplaces of diversity, the ability to negotiate personal identity, goup identity, and work and organizational issues is crucial. All must be able to stand the heat and forge agreements.

Living, Learning and Working in a Wired World

Far more than any previous time in human history, the present moment is awash in represented information. More people than ever in history have an awareness of the entire planet as an interconnected system. Individuals are daily faced with the daunting task of making sense out of quantities of changing data far beyond the amounts served up to their pre-urban ancestors. Information is defined in terms of uncertainty. As the last section shows, uncertainty is the name of the game in contemporary workplaces. Individuals without information fluency skills and the motivation to use them will be at a disadvantage. Employers of such individuals will be at a disadvantage too.

Competent individuals work to increase their internal complexity, gladly receiving assistance to gain independence and to collaborate more effectively. Productive enterprises employ competent individuals of many backgrounds and support a continuing dialogue among them to further increase their information fluency and the scope and texture of their communication. Both individuals and organizations grow by differentiation and then the integration of parts. On a large scale, information fluency is a cycle of differentiation and integration. Fluency, competence, productivity: these are all key features of lively and successful systems.

Living organisms depend on information every bit as much as they depend on direct and recycled solar energy. Plants and animals consume matter and energy for metabolic and reproductive purposes. They cannot, however, carry out their life cycles without information about the state of their external and internal environments. The more rich and complex the organism the more rich and complex the world it lives in. The world's complexity is a function of the organism's. Our bodies turn breakfast into energy and action. Our minds turn the morning newspaper into ideas and choices. It's all nourishment.

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