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CONVERSATION THEORY

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The object of the game is to go on playing it.
—John von Neumann (1958)

Is it, in some good sense, possible to design a character, and hence to generate some one kind of immortality? The fact of immortality is essential. Further, without this fact, our fine talk (as of societies and of civilizations and of existence) would be so much hogwash.
—Gordon Pask (1995)

8.1 OVERVIEW

Gordon Pask's Conversation Theory (CT) is based on his model of the underlying processes involved in complex human learning. As such it can be read as a radical cybernetic constructivist account of human cognitive emergence, a kind of ontology of human being. Conversational learning is taken to be a natural imperative, an "ought that is." So its elucidation in Pask's Conversation Theory can apply normatively to schemes for designing and evaluating technology-supported human learning. CT is relevant to the development of quasi-intelligent tutoring systems which enable learners to develop nontrivial understandings of the complex real underlying systemic processes of ecosystems and of themselves as multiactor systems. CT portrays and explains the emergence of knowledge by means of multilevel agreement-oriented conversations among participants, supported by modeling facilities and suitable communication and action interfaces; hence it is also very much an applied epistemology. When used for instructional system design, CT prescribes learning systems that involve at least two participants, a modeling facility and at least three levels of interaction: interaction with a shared modeling facility, conversational interaction about how to solve a problem, and conversation about why that method should be used. Higher metacognitively critical levels of learning conversation, about the implications of carrying on robotically, are necessary to overcome the "cognitive fixity" arising when only two languaging levels are employed by a learner. In especially beneficial educational ventures, multiple participants and many levels of discourse are involved, and here CT is almost alone in providing a framework for developing multiactor multilevel networks of human–machine discourse.

Conversation Theory, when considered in depth, offers a critical transformative challenge to educational technology by deconstructing the conventionally understood psychology of the individual. The supposedly continuously present stable autonomous integrated individual learner is reunderstood rather as a collection of psychological individuals (P-individuals) whose presence is variable and hetrarchical. CT asserts that what it is we are mainly helping educate and self-construct is not simply one person but rather a wide variety of interwoven competitive P-individuals, some of whom execute in distributed fashion across many bodies and machines. Such a task is more complex and micropolitical than educational technologists usually assume to be their job.

This chapter provides a skeletal description of the theory, some practical explanations of how to use it, and a brief historical account of its evolution and future prospects. Pask's Conversation Theory has proven useful for designing, developing, evaluating and researching many sorts of partly

computerized, more or less intelligent, performance support and learning support systems. The CT way of viewing human learning has very wide application and often has led to important new insights among those who have used it.

8.2 INTRODUCTION TO PASK'S CONVERSATION THEORY (CT)

8.2.1 Conversation for Responsible Human Becoming

The Conversation Theory (hereafter referred to as CT) conceived and developed by Gordon Pask (between 1966 and 1996) is primarily an explanatory ontology combined with an epistemology, which has wide implications for psychology and educational technology.

The object of THE game is not merely, as John von Neumann (1958) said, just "to go on playing it," but rather to go on playing it so as to have as many shared enjoyments and intimations of such Earthly immortality as are possible. Let us first look at an example of people attempting to teach and learn responsible and delightfully propitious habits of awareness and action. Subsequently we will look at ways to model and facilitate what are probably the real underlying processes that generate and propagate responsible human being and becoming.

In Mount Royal Park last week, Larry, aged eight and standing beside me, was watching his brother Eddy and Marie, a gentle young girl visiting them from Marseilles, crouched a little way down the hill trying to get near to a gray squirrel without frightening it. Suddenly, Larry clapped his hands as hard as he could; the squirrel scampered up a tree. I said, "Don't do that. You're spoiling their fun!" He said, "That's my fun!" I said gruffly, "Hey, wait a minute, Larry. They are really part of you, and you will go on suffering their dislike for a long time to come if that's how you get your fun." He just looked away. I strode off toward the lookout.

Possibly that event was both people-marring and an attempt at responsible peoplemaking through action-situated conversation. Was it a real learning conversation? Here we had two participants, both of whom had their attention fixed on an immediate concrete experience as well as on each other. On my part there was an intention to teach; Larry's obvious intent was to show how smart he was. Was there an intention to learn on both our parts? That is uncertain. The conversation was situated in an emotively meaningful way, and it was connected to direct actions and the cocausal interpretation of observations, and we will both remember it. However, we failed to come to an agreement as to how the acts should be named (just clever fun vs. gratuitous nastiness) and valued.

8.2.2 The Cycle of Conversational Coproduction of Learning

The essential activities of constructing knowledge through grounded conversation are pursued through cycles similar to A. N. Whitehead's (1949) description of learning through cycles of: Romance > Definition > Generalization > and so on again. . . .

After the first touch of romance, a CT learning venture begins with the negotiation of an agreement between participants to learn about a given domain, and some particular topics and skills in that domain (see Fig. 8.1). One participant (A) who has some inkling of a topic starts by using the available resources to make a modeling move, to name it, and to explain why it is being made. Another participant (B) either agrees to try to do the same thing and compare it with what A did or disagrees

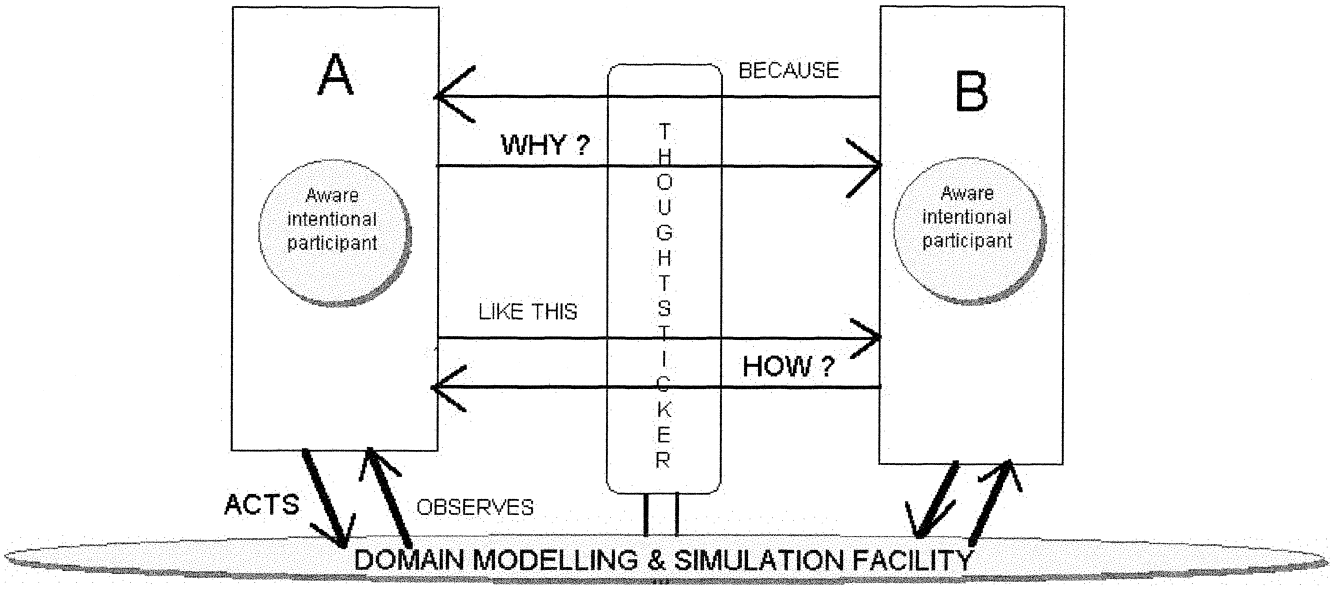

FIGURE 8.1. The simplest possible model of conversational learning.

with that foray and tries to make another start by acting on the model, naming the new act, and explaining why it is better. If there are other participants, they join in. If the modeling efforts are judged, on close investigation, to be different, they will be labeled differently and some relation will be constructed between them and will be appropriately labeled. If the two (or n) efforts are judged to be the same, they will be coalesced into one chunk of the domain model with one name.

Each chunk, or concept, of the model should consist of executable procedures that reconstruct relations among more elementary constituents, and possibly among other complex concepts. Various conjectures are made as to what a good extension, and/or predictive capability should be, and the participants attempt to extend and debug the model to achieve such. If they fail, then they reject the supposition as being incongruous with other parts of the domain knowledge and skill development endeavor. Each conversational learning cycle adds more agreed coherent well-labeled complexity and more autopoietic, predictive capability to the model.

8.2.3 Conversation Theory as an Explanatory, Also a Heuristic, Research and Development Framework

Pask's Conversation Theory is not yet a fully worked out conventional axiomatic-deductive scientific theory. What it offers is a framework for thought and a plausible model mechanism to account for the emergence of the domain of human conceptual knowledge, which Popper (1972) named "World 3." It is also a kind of Artificial-Life theory of human-becoming, which models the emergence of conscious cognizing human beings as essentially a matter of multilevel multiactor intercourse (CT conversations). This is carried forward among software-like actors called P-individuals, continually executing in biological processors or a combination of biological and hardware computer-communication systems, which are called, in general, M-individuals.

The physical world as we have learned to know it (including biological individuals) and the social world we have made together are both understood as being generated largely by contextually situated, multilevel conversations among our P-individuals who interpenetrate both. It is asserted that the reciprocal conversational construction, of active concepts and dynamic memories, is how psychological participants and perhaps indeed human beings arise as coconstructions.

Conversation Theory along with its child, Interaction of Actors Theory (IAT), amount to a sort of Artificial Life theory. They propose that, when employing the appropriate relational operators, a Strict Conversation, eventuating in appropriate agreements among its originating P-individual participants, can bifurcate and result in the emergence of a new Psychological individual (one able to engage in further broader and/or deeper conversations with others) and so on and on, constructing ever more complex extensive local and distributed P-individuals.

Pask's CT and IAT are, I believe, founded on a larger and deeper view of humanity than are many cognitive science theories. The underlying question is this: How do we together generate creatively complex psychological participant individuals that can interact to have plausible intimations of cultural immortality?

Conversation theory is a really radical psychological theory in that it places the understanding-constructing P-individuals and their world-reconstructing discourse in first place, ontologically. The biological individual persons are not the primary concern.

8.2.4 The Very General Ontological and Epistemological Nature of Conversation Theory

Gordon Pask's main premise is that reliable knowledge exists, is produced, and evolves in action-grounded conversations. Knowledge as an object distinct from learner–teachers does not exist. Learners always incorporate internalized teachers, and teachers always incorporate internalized learners who help construct their knowledge. We all incorporate all three, and our knowledge, as executable models of the world, in our physiological M-individual bodies and personal machines.

Conversation Theory, as well as being an ontology of human being, is also developed as a prescription for designing constructivist learning support systems. In going from "is" to "ought" there has always been the probability of committing the naturalistic fallacy, as David Hume (1740/1998) and G. E. Moore (1903) pointed out long ago. This has recently been an obvious problem when going from constructivist descriptions of how we (supposedly) actually learn, to prescriptions of how we ought to teach (Duffy & Jonassen, 1992). Where does this new "ought" come from? My own solution to this dilemma is to posit "The Ought That Is"—to assert that the ought has already been historically evolved right through the genetic and on into the neuronal systems of humanimals; so that as we learn and teach, what we are doing is uncovering and working with a biologically universally preexisting ought. The normative idea of constructivists is to design learning activities that facilitate a natural process rather than ones which hinder or frustrate it.

What is presented here is a much simplified composite of four decades of work, interpreted and somewhat elaborated by me (Boyd, 2001; Boyd & Pask, 1987), rather than a complete explanation of a finished theory. CT, like memetics theory, is not a mere finite game. Rather, they are parts of our infinite game as humankind. There are, therefore, inconsistencies and the theory remains incomplete. But many believe that CT/IAT is ahead of other current cognitivist and constructivist theories, at least as a heuristic for research progress.

8.2.5 Pask's Original Derivation of CT From the Basics of Problem Solving and Learning

Pask started with the definition that a *problem* is a discrepancy between a desired state and an actual state of any system, and then went to the question: What is the simplest problem solver possible? The simplest problem solver is a random trial and error operator that goes on trying changes in the model system

until it hits upon the solution (if ever). The next simplest is a deviation-limiting feedback loop cybernetic solver which remembers how close the last change brought things and compares the result of the current action, to choose which direction to go next in the problem space in order to hill-climb to a good solution.

But hill-climbers are only "act pragmatists" (Rescher, 1977). Such problem solvers work, at least suboptimally, given enough time and in a restricted problem space But they don't learn anything. And they may end up on top of a foothill, rather than on the desired mountaintop.

That weakness can be partly fixed by adding some random decision dithering. The L_0 problem solvers of CT are of this type. If the L_0 level is augmented by a higher L_1 level adaptive feedback controller which remembers which sorts of L_0 solution paths were good for which classes of problems, then one has a rule-learning machine. These two level P-individuals are what Rescher (1977) calls rule pragmatists.

The minimal P-individual then has three components: a problem modeling and solution testing facility, together with a hill-climbing L_0 problem solver, and an L_1 rule learner, all executing on some M-individual (see Fig. 8.2.)

The problem with such a simple adaptive learning system is what Pask calls cognitive fixity; it develops one good way of learning and dumbly sticks to it, even when it repeatedly fails to generate a solution to some new type of problem. Harri-Augstein and Thomas (1991) refer to this as functioning as a "learning robot." The stability of selves depends on there being some cognitive fixity.

Pask also identified forms of metacognitive fixity as often occurring in two distinct learning styles: serialist and holist. However, many other sorts of limiting habits occur when only one P-individual is executing in one M-individual. The main ways beyond cognitive fixity are either to have several P-individuals executing and conversing in one M-individual, or to have P-individuals executing in a distributed way over many M-individuals.

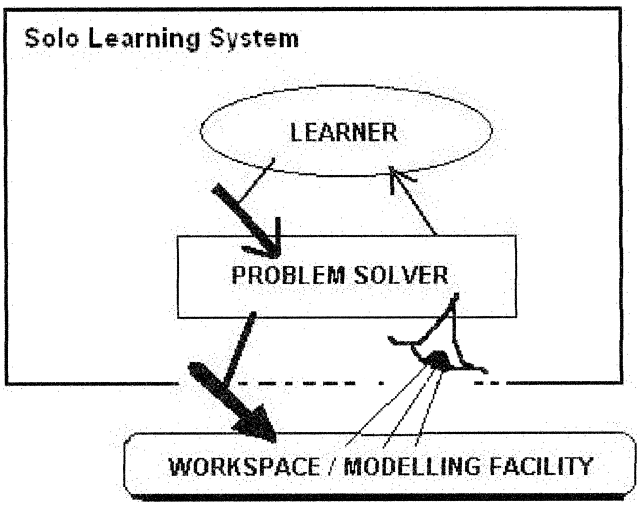

FIGURE 8.2. Simple solitary adaptive learning system.

If one particular way of rule learning doesn't help, what then? As Rescher (1977) showed, the next thing to do is see if you can invent a general method for creating good rules. Ideally higher levels of self conversation (L_1-L_n) would function as what he calls a methodological pragmatist. If you add some crossbreeding by conversation with another P-individual, such variation can yield an evolutionary system. Some genetic algorithm generators are of this nature: A-life crossbreeding.

8.3 HISTORICAL ROOTS AND EVOLUTION OF CONVERSATION THEORY

There are some similarities between CT and the ancient Socratic dialogue model as reported by Plato, also between the mediaeval dialectical antithesis debating strategy of Peter Abelard. And the first known educational technologist, Comenius, who (after Seneca) pointed out, "*Qui docet, discit,*" (He who teaches, learns)—although, admittedly, Seneca's Latin is not so broad as to imply reciprocal learning conversations. The Hegelian, Marxian, and Frankfurt-school forms of dialectic might also be seen as precursors of Conversation Theory, as might Martin Buber's profound *Ich und Du* conversations (1970).

Gordon Pask's Conversation Theory is a learning theory which initially arose from the perspectives of Wittgenstein and (Gordon's mentor) Heinz von Foerster. By putting reciprocal conversation-action in first place ontologically, Pask builds on Wittgenstein's (1958/1978) argument against private languages and on von Foerster's conception of second-order cybernetics (1981). And Pask can indeed be seen as putting forward a sort of posthuman (Hayles, 1999) critical social theory.

Conversation Theory seriously challenges both naive realists and folk psychology. However, CT is not irredeemably idealist, nor is it hyperrationalist, as some have accused Habermas of being. For those who care to think it through, CT can probably be accommodated within the new Critical Realist ontologies (Bhaskar & Norris, 1999). Gordon Pask usually assumed the perspective of conventional modern scientific realism.

Also the neurophysiological learning research of Pask's friend, Warren McCulloch (1969), was probably a related outgrowth of Pask's own experiments with dendritic physical–chemical learning systems. These latter were concretely embodied (unlike McCulloch's mathematical models) proto-connectionist systems. And now we see that CT is interestingly compatible with recent connectionist neurophysiological learning theories such as Edelman's Extended Theory of Neuronal Group Selection (Edelman, 1992).

At a more mundane level, the Personal Scientist and repertory-grids model (Kelly, 1955), each of us coconstruing our own scientific models of the world, can also be seen to correlate with CT, and has been used by Shaw (1985) and by Harri-Augstein and Thomas (1991) to extend CT.

Conversation Theory was developed interactively through a long series of experiments with new notations, adaptive teaching machines and computer aided learning environments. CASTE (Course Assembly and Tutorial Learning Environment)

was the most notable of Pask's systems. CASTE served to interactively construct domain representations as entailment meshes and the associated topic tasks, but it also provided tutorial support to, and teachback acceptance from, the learners (Pask & Scott, 1973). The most striking features of CASTE were its large interactive display of the entailment mesh of the domain to be learned, and its smaller facility for actually carrying out learning conversations and teachbacks. The large domain display generally had an array of terminal competences at the top, and various supporting topics below. This was not a simple hierarchical tree graph of prerequisites but an hetrarchical net linked in the many valid ways. To start, the learner would mark the terminal competences he or she aimed for, and also some of supporting topics to be worked on. Then, after manipulation and conversation, when understanding of that topic had been demonstrated, the display indicated which other topics would be good choices to get on with. For more details, and photographs of various versions of CASTE, see Pask (1975), Mitchell and Dalkir (1986), and Pangaro (2002).

THOUGHTSTICKER, the next most noteworthy of Pask's machines, was originally produced in 1974, by Gordon Pask and Yitzhak Hayut-Man, as a system for filling and using a collection of pigeonholes for course-assembly topic files. The ultimate goal was to make THOUGHTSTICKER so simple to use that it could be, in Pask's words, "a children's toy." As Hayut-Man explained (2001), it was to be an "intelligent holographic Christmas tree" domain embodiment on which to hang topic knowledge as practical ornaments. Unfortunately, the hardware and software of the day was not adequate for this dream to be realized. Subsequently, in the 1980s, Paul Pangaro (2002) implemented a really usable and effective THOUGHTSTICKER on a LISP machine. (Functional, but far too expensive for a child's toy.)

Later many of these ideas were brought together and developed in various forms by, among others, Mildred Shaw (1985), Sheila Harri-Augstein and Laurie Thomas (1991) in their Learning Conversations methodology, and by Diana Laurillard (2002).

8.4 CYBERNETIC AND PSYCHOLOGICAL PREREQUISITES TO CONVERSATION THEORY

Do we need prerequisites here at all? Without some special prerequisite knowledge, Pask's Conversation Theory is very difficult to grasp. It is a transdisciplinary theory that draws on cybernetics, automata, and control theory in particular, and on formal linguistics and computer science concepts, theorems and notations, as well as on aspects of cognitive psychology and neurophysiology. Without certain ideas from those fields, CT is not really understandable. Throughout the chapter, I provide explicit references to sources that give detailed (and correct) accounts of these topics. However, for those unfamiliar with the literature and lacking the leisure to follow it up, here I will give very much simplified yet, I hope, plausible accounts of the few most needed key ideas.

8.4.1 Hypothetical Real Underlying Generative Entities

Important advances in science often require the postulation of new nonobservable entities and underlying generative mechanisms, which enable research to go forward to the point where either it turns out that these hypothetical entities are as real as Quarks or, like phlogiston, they are found to be expendable. Pask's once-novel use of an hierarchy of formal languages and meta-languages L_0, L_1, L_2- L_n has now become a normal approach in AI (artificial intelligence) and computational linguistics. Pask's various types of P-individuals (actors), his active-process definition of concepts, and his parturient (P-individual producing) bifurcations are more novel leveraging hypothetical constructs. Their reality has not yet been altogether validated nor, arguably, have they been replaced by any appreciably better learning process model components. They remain as working tools, which many have been finding to be helpful guiding heuristics for either learning systems research or for instructional systems design. So let us see how they can be used to carry our work forward.

8.4.2 Cybernetic Background Needed

8.4.2.1 Automata. The components of Conversation Theory are various kinds of automata functioning in parallel. Automata are abstract comprehensive generalizations of the idea of a machine. An automaton may be thought of as a box with an input, some stuff inside—part of which may amount to transformation rules, output rules—and an output. If you input a signal, it will cause changes in the internal state of the automaton. Sometimes an input will also prompt an automaton to produce an output. For example, if you type some data into a computer, it may simply store the data. Then if you type in a command to execute some program, the program can take the data and calculate and produce an output to the printer, say. The history of what programs and data have previously been fed into the computer determines what it will do with new inputs. This is true for all but trivial automata. Just about anything can be modeled by automata. However, as Searle (1969) pointed out, a model of digestion does not actually digest real food! Automata are not all that is. Automata may be deterministic—you get a definite output for a given series of inputs—or probabilistic—you get various possible outputs with different probabilities. Automata may also be fuzzy and/or rough, possibly as people are. But let's skip that, except to say that automata can be used to model very unmachinelike behavior such as the self-organizing criticality of mindstorms.

8.4.2.2 Self-Reproducing Automata. John von Neumann was, I believe, the first to demonstrate that for an automaton to be able to reproduce itself, it must possess a blueprint of itself. Consider a robot with arms and an eye. It can look at itself, choose parts, and pick them up, and put them together to copy itself. . . until the eye tries to look at the eye! Or until an arm has to disassemble part of the robot so the eye can

look inside; then the whole procedure breaks down. However, if the robot has a "tail" with full plans for itself encoded on the tail, then all is well. The eye can read the tail and instruct the arms to do everything necessary. Well, that assumes there is a substrate or environment that provides the necessary parts and materials and energy. That von Neumann theorem is why self-reproducing, and indeed self-producing, automata must always have two main parts: the productive automaton itself, and a blueprint or a genetic or memetic code plan for producing itself. This also applies to living organisms. (Viruses, however, are just the blueprint and an injector to inject it into cells that have the producing machinery.) Since they are self-producing and reproducing, von Neumann's theorem is why the "bundles of executing procedures," which Pask calls P-individuals, always have at least the two main levels: L_0 problem-solving procedures and L_1 learning metaprocedures or plan-like programs, for guiding the choice of problem-solving procedures during execution—as well, of course, as some substrate to work on. Further levels will be discussed below.

8.4.2.3 Control Theory. A large part of the problem solving which P-individuals do is to bring about and maintain desired relationships, despite disturbances over time. They do this by deviation-limiting (technically called negative) feedback controllers. (These are in principle just like the thermostat which controls a furnace and an air conditioner to keep room temperatures comfortable despite large variations in the outside weather.) They observe some condition, compare it with the desired condition and, if there is a difference, they set in motion some corrective action. When the difference gets small they stop and wait until it gets too large, then correct again. If anything at all stays more or less constant with small fluctuations it is because some natural, or person-made, negative feedback control loop is at work observing, comparing and correcting. (On diagrams such as Pask's, the comparison is usually indicated by a circle with a cross in it, and perhaps also a minus sign indicating that one signal is subtracted from the other, hence "negative" feedback.) We generally imagine what we would like to perceive, and then try to act on the world to bring *that* to be. If I am hungry I walk across the street to reduce the distance I perceive between myself and a restaurant. If I write something strange here (such as: negative feedback is far and away the most valuable sort), you probably try to reinterpret it to be the way you like to think of things (Powers, 1973), which may unfortunately emasculate the meaning.

8.4.2.4 Hetrarchical Control Theory. What if a feedback controller cannot manage to iron out the disturbance well enough? One option is to use several controllers in series. Another is to change the requirement standard (or goal) being aimed at. (Too many kids failing? Lower the passing grade!). The standard changer (or goal changer) itself must have some higher level goal to enable it to choose the least bad alternative to the current unachievable standard. If this situation is repeated, a hierarchy of feedback controllers results. Bill Powers (1973) has shown how such feedback control hierarchies are present and function in animals and especially in people, to enable us to behave precisely to control our perceptions to be what we need them to be in order to survive. The levels in a CT conversation are levels of negative feedback controllers for steering problem-solving activity.

Actual living systems and especially humanimals are of course very complicated. There are both parallel and series feedback controllers continually operating, not just in a single hierarchy capped by our conscious intentions, but rather in what Warren McCulloch defined as an hetrarchy: a complex multilevel network with redundancy of potential control. For example, redundancy and possible takeover occurs between conscious intentions and the nonconscious autonomous nervous system and the hormonal control systems (Pert, 1993). In Conversation Theory, a learning conversation among P-individuals is just such a complex hetrarchical learning system, with redundancy of potential control through different active memories taking over to lead the discourse as needed.

8.4.2.5 Evolving Automata and Genetic Algorithms. Probabilistic self-reproducing automata, or sexually reproducing automata-like organisms, in an environment that imposes varying restrictions, will evolve by natural selection of the temporarily fittest. This is because those variant automata which best fit the environment will reproduce and those which don't fit cannot. The variation in P-individuals occurs through both probabilistic errors in their reproductive functioning (forgetting or confusing their procedures) and their conjugation with other P-individuals in the (mind-sex of) learning conversations that usually change both participants. The selection of P-individuals occurs through the initial (L^* level) negotiations among persons, concerning which domains and which topics are to be studied when, and also through the limitations of available learning-support modeling facilities (L_0 level).

8.4.2.6 Second-Order Cybernetics. Second-order cybernetics is the cybernetics of observing systems (von Foerster, 1981) and, most interestingly, of self-observing systems. We have already noted that a system cannot reproduce itself by observing itself unless it has a genetic or memetic blueprint on itself from which to build copies. There are other paradoxical effects occurring with self observing systems which can lead to pathological (recall Narcissus) and/or creative behavior. Rogerian psychotherapy is based partly on reflective technique, mirroring troubled persons' accounts of themselves back to them with unconditional positive regard. Martin Luther, on encountering a parishioner who repeatedly crowed like a cock, joined him in this incessant crowing for some days; then one day Luther simply said, "We have both crowed enough!" which cured the neurotic (though some might say Luther himself went on crowing).

In CT terminology when I hold a conversation with myself, two of my P-individuals are conversing with each other and also monitoring themselves in the internal conversation. For instance, one P-individual may be my poet persona throwing up poetic lines, while the other may be my critic pointing out

which lines fail to scan or fail to rhyme. Each must monitor itself (at L_2 level) to be sure it is fulfilling its role, as well as carrying on the (L_0 and L_1 levels of) conversation. (Look ahead to Fig. 8.4.)

8.4.3 Psychological Background Needed

8.4.3.1 Awareness and Narrative Consciousness. Conversation Theory is about the mind-generating processes of which we are aware or can become aware. It is not about nonconscious neurophysiological and hormonal processes underlying the generation of minds at lower levels of emergence. The scope and nature of awareness and consciousness are therefore important considerations in CT.

The best current scientific theories of awareness and consciousness appear to be those expounded by Antonio D'Amasio (1994) and those of Edelman and Tononi (2000), which indeed are grounded in neurophysiological results. Peter Hobson's (2002) theory of emotional engagement and early attachment to others fits with Edelman's selectionist theory. One might also espouse Daniel Dennett's (1991) philosophical multiple-drafts theory of consciousness, as complementary to the multiple participants in conversations.

What are the points of contact with Conversation Theory? And is CT compatible with these newer models? There is not space here to give more than a bare indication of what is thought. All three deny the Cartesian theater idea that everything comes together on a single stage where "we" see, hear and feel it. Both D'Amasio (1994) and Edelman (1992) are convinced that there are two importantly different kinds of consciousness: the present-moment centered primary awareness of animals, and the linguistically mediated narrative consciousness of human beings which involves many more central nervous system components. If the drafts of multiple-draft narrative consciousness can be associated with the P-individuals of CT, then an interesting compatibility emerges.

8.4.3.2 Punctuated and Multiple Personae. The continuity of memory and being and the singleness of self, which most of us assume without question, are actually found to be partly illusory (Noë & O'Reagan, 2000). There seems to be a good deal of resistance to this knowledge, probably based on the widespread acceptance of the enlightenment ideology of the individual. Memories are not just recordings we can play back at will. When we recollect, we re-produce. When we reconstruct memories, we tend to interpolate to cover gaps, and frequently err in doing so. The more often we recall an old memory, the more it is overlaid by reconstructive errors. What we do remember for a long time is only what carried a fairly intense emotional loading at the time of experience (D'Amasio, 1994). If the emotional loading was too intense, the memory may be suppressed or assigned to an alternative persona, as in multiple personality syndrome. The very distinct and complexly differentiated personalities, which show up in pathological cases of multiple personality, are seemingly one extreme of a continuum, where the other rare extreme is total single-mindedness (which is usually socially pathological, as with the "True Believer" of Hoffer (1951), if not also personally pathological).

According to CT, much of our really important learning is made possible because we *do* each embody different personae (P-individuals) with different intentions, and have to reconcile (or bracket) their conflicts within ourselves by internal dialog.

Less well recognized, until the recent emergence of social constructivism (Gergen, 1994), is that parts of each of us function as parts of larger actors who I like to call transviduals (such as families, teams, religious congregations, nations or 'linguigions,' etc.), which commandeer parts of many other people to produce and reproduce themselves. Conversation Theory, which takes generalized participants (P-individuals) as its central constituents, is one of the few theories of human being which seriously attempts to model both the multiple subviduals which execute within us, and the larger transvidual, actors of which we each execute parts in belonging to society.

8.5 BASIC ASSUMPTIONS AND HYPOTHESES OF CONVERSATION THEORY

1. The real generative processes of the emergence of mind and the production of knowledge can be usefully modeled as multilevel conversations between conversants (some called P-individuals, others merely "participants") interacting through a modeling and simulation facility.
2. Various emergent levels and meta-levels of command control and query (cybernetic) language (L_0 L_1—L_n L^*) need to be explicitly recognized, distinguished, and used in strategically and tactically optimal ways.
3. The concepts, the memories, the participants and their world-models all can be represented as bundles of procedures (programs) undergoing execution in some combination of biological (humanimals) and physical parallel-processing computers called M-individuals.
4. Useful first-cut models called "strict conversation models" can be made which bracket off the affective domain, but keep part of the psychomotor and perceptual domain. (I think this is a very unsatisfactory assumption, but one certainly needed by Pask at the time to enable work to go forward. GMB.)
5. New P-individuals can be brought into being when agreements in complex conversations result in a new coherent bundle of procedures capable of engaging in further conversations with other such P-individuals.
6. When such conversation occurs at high enough levels of complexity it is asserted that a new human actor, team, organization, or society emerges.

Insofar as I understand Conversation Theory, those six are the basic hypotheses. The overall basic scheme of CT is that of a ramifying mesh of concepts and participants in *n*-dimensional cultural space. The details concern just how multilevel interactive discourse must be carried out to be so productive, taking into account: precisely which formal languages are needed,

and just what affordances the modeling facility should have, and what kinds of M-individual processors and networks are needed, to support all of these activities.

8.6 THE BUILDING BLOCKS OF CONVERSATION THEORY

There are 12 main building blocks of CT:

8.6.1 M-Individuals

M-individuals are the hosts, or supporting processors, for the bundles of procedures that in execution together learn. The abbreviation stands for mechanical individuals (term originated by Strawson, 1959), which are biological humanimals and/or computers with communication interfaces coupled to one another via communication channels of any suitable sort.

8.6.2 L-Languages

L, L_0 and $L_1 \ldots L_n$ are in general functionally stratified (hence the subscripts [0,1, . . . ,*n*] and superscripts [*] in Pask's texts). In the case of "strict" conversations, they are abstract formal or formalized languages and meta-languages that the M-individuals can interpret and process together. L_0 is the action naming and sequencing language, L_1 is for commands and questions about the building of models. The construction of models brings about relations and amounts to a practical explanation. L_2 is for verbal explanation and querying of actions. L_3 may be for debugging. L_4 is the operational meta-language for talking about experiments, describing the system, prescribing actions to pose and test hypotheses; and L^* is for negotiating the experimental contract. "Two Levels are not enough: you have not only to have the conversation and to be able to be critical of it (meta-level) but also to position it so that what is being talked about is known (meta-meta-level)" (Glanville, 2002).

8.6.3 P-Individuals

P-individuals is what Pask called "psychological" individuals, which are understood to be autopropagative discursive participant procedure-bundles, running (being executed) in one or among two or more M-individuals. A P-individual is a coherent self-aware cognitive organization consisting of a class of self-reproducing active memories. Simpler conversants lacking self-awareness are called merely 'participants.' The notion of P-individuals may become more plausible if you recall how you talk to yourself when trying to solve a difficult problem. What C. J. Jung called "personae" would be P-individuals, as would be the various personalities evident in cases of multiple personality syndrome (Rowan, 1990). P-individuals are taken to be the actual evolving conversational participants (i.e., learner–teachers), and thus the main self-building components of human persons, and on a larger scale of peoples and ultimately of the transvidual World–mind—insofar as such exists.

Note: all P-individuals are both learners and teachers at various levels of discourse. No P-individual is simply a learner, nor simply a teacher. (Note also that the emergence progression is from: procedures interacting in discourse, generating > concepts generating > memories generating > P-individuals.)

8.6.4 Procedures

Repertoires or collections of synchronizable procedure-bundles—usually nondeterministic programs or fuzzy algorithms—generate everything. Each P-individual is, and has as memory, a repertoire of executable procedures that may be executed in synchronism with one another and/or with those of other P-individuals. Information in the quotidian sense is not transferred; rather the procedures constituting concepts in participants become synchronized and thence similar. Incidentally, some of these procedures are probably of creative affective types that (so far) can be executed only in biological M-individuals.

(Note: As Baeker (2002) has pointed out, in second-order cybernetics such as CT, a system is recursively defined as a function of the system S and its environment E [i.e., $S' = f(S, E)$], not merely as $S = f$ (objects, relationships); and it is therefore a historical production whose history must be known to understand its current operation.)

8.6.5 Conversations

A "strict CT conversation" is constrained so that all topics belong to a fixed agreed domain and the level of language L_n of each action is specifically demarcated (a bit like Terry Winograd's Coordinator™, 1994). Understandings are recognized and used to mark occasions that are placed in order. A CT conversation is a parallel and synchronous evolving interaction between or among P-individuals, which if successful generates stable concepts agreed upon as being equivalent by the participants. Optionally, it also may generate new P-individuals at higher emergent levels. Participants may, and often do, hold conversations by simultaneously interacting through multiple parallel channels (e.g., neuronal, hormonal, verbal, visual, kinaesthetic). Most CT conversations involve reducing various kinds different of uncertainties, such as: Vagueness, Ambiguity, Strife, Nonspecificity (Klir & Weierman, 1999). This is done through questioning and through making choices, of which agreed concepts are to be included in a given domain of the participants' explanatory and predictive world construction. However, as learning proceeds, new kinds of uncertainties usually emerge.

8.6.6 Stable-Concepts

The confusingly broad and vague multifarious notions of concepts which currently prevail in cognitive science, are replaced by "Stable-Concepts" radically redefined by Pask to be a cluster of partly, or wholly, coherent L-processes undergoing execution

in the processing medium M, which variously may: recognize, reproduce, or maintain a relation to/with other concepts and/or with P-individuals. CT stable-concepts are definitely not simple static rule-defined categories. A CT concept is a set of procedures for bringing about a relationship, not a set of things.

Such an understanding of concepts, as going beyond categories and prototypes to active processes, does also appear in the current USA literature; the version which appears to be closest to Pask's is that of Andrea diSessa (1998), whose "coordination processes" and "causal nets" roughly correspond to Pask's "concepts" and "entailment meshes."

8.6.7 The Meaning of a Concept

In my view, certain emergent levels of meaning should be carefully distinguished from each other, particularly Re-Enacted Affiliative Meaning [REAM]—such as that arising in historically rooted ritual performances—versus Rational-Instrumental Meaning [RIM] (Habermas, 1984, 1987; Weil, 1949).

It is worth noting here that Klaus Krippendorff (1994), who has specialized in discourse analysis, makes another important distinction: fully humanly embodied multimodal "conversations" which are unformalized, fluid, and emotionally loaded, versus "discourses," which he defines to be rule-governed, constrained, and formalized (and often dominative). Pask's "strict conversations" are "discourses" in Krippendorff's terminology, whereas Pask's own personal conversations with friends and students were dramatic examples of the former—inspiring, poetic, warmly human conversations.

Emotion is much more than just "feelings." The autistic author Donna Williams (1999) writes, "The emotions are the difference between 'to appear' and 'to be'; I would rather be." Pask himself said, "The meaning of a concept is the affect of the participants who are sharing it" (Barnes, 2001).

With shared emotion, meaning arises. This is compatible also with D'Amasio (1999) who has shown that emotional signals from the prefrontal cortex have to reach the hippocampus in order for short-term memories to be converted into long-term memories, really meaningful memories. Some emotional loading is essential for nontrivial cognition, although too much emotion paralyzes it.

There also appears to be an intrinsic motivation of all human participants to elaborate and improve the predictivity of their world models, in ways that can probably be delightfully and potently shared with others indefinitely into the future. This evolved-in imperative to clone chunks of ourselves (identity memeplexes) is what I call "The Ought That Is" (Boyd, 2000).

8.6.8 Topics

Many topics through a history of conversations compose a DOMAIN of study. Each topic is the focus of a particular conversation. A topic is a set of relations of the kind which, when brought about, solves a particular problem. Any problem, according to Pask, is a discrepancy between a desired state and an actual state.

Generally, P-individuals (learners) choose to work on and converse about only one topic at a time, if for no other reason than limited processing power and limited channel capacity. A topic is represented as a labeled node in an entailment structure.

8.6.9 Entailment and Entailment Structures

Chains, meshes, networks. . . . An "entailment" in CT is defined as any legal *derivation* of one topic-relation from another. Entailment meshes are computer-manipulable public descriptions of what may be known/learned of a domain. They show all the main topics and their various relationships in sufficient detail for the kinds of learners involved. They are generalized graphs (i.e., ones which include cycles, not simply graphs of strict logical entailments). They can be partitioned into topic structures. Their edges display various kinds of entailment relations between the nodes, which represent the "stable-concepts" in the given domain; the specific kinds can most unambiguously be exhibited through j-Map notation (Jaworski, 2002). Really useful representations of entailment structures are very complicated. (For a good example, see Plate 10, pp. 309–318 in Pask, 1975.) For a simplified (pruned) and annotated version of an entailment mesh, see Fig. 8.3.

Entailment structures are not simply hierarchies of prerequisites in the Gagne or Scandura (Pask, 1980) sense. They might be considered improved forms of Mind maps (Buzan, 1993) or of "concept maps" (Horn, Nicol, Kleinman, & Grace 1969; McAleese, 1986; Schmid, DeSimone, & McEwen, 2001; Xuan & Chassain, 1975, 1976). There is one similarity with Novak and Gowin's (1984) Vee diagrams, in that separate parallel portions of the graph (often the lefthand side vs. the righthand side) usually represent theoretical abstract relations versus concrete exemplifications of the domain (as in Plate 10 mentioned above).

Externalized, objectively embodied entailment meshes are principally tools for instructional designers and for learners. Although some analogues of them must exist inside human nervous systems, the entailment meshes are not intended to be direct models of our real internal M-individual neurohormonal physiological mind generating processes. (For what is known of those, see D'Amasio, 1994; Edelman & Tononi, 2000; Milner, 2001; Pert, 1993.)

8.6.10 Environments

Special conversation, modeling and simulation supporting machines and interfaces (which are [multimedia] facilities for externalizing multilevel conversations between/among P-individuals, in publicly observable and recordable form—e.g. CASTE, THOUGHTSTICKER [Glanville & Scott, 1973; Pask, 1975, 1984]) are required, for research and development. These environments, usually external hacked, or engineered, educational system components, provide necessary affordances. Most human learning is facilitated by the affordances of some external objects (blackboard and chalk, paper and pen, books, spreadsheets, DVDs, computers, etc.) which enable internal P-individuals to externalize large parts of their learning conversations.

(A)

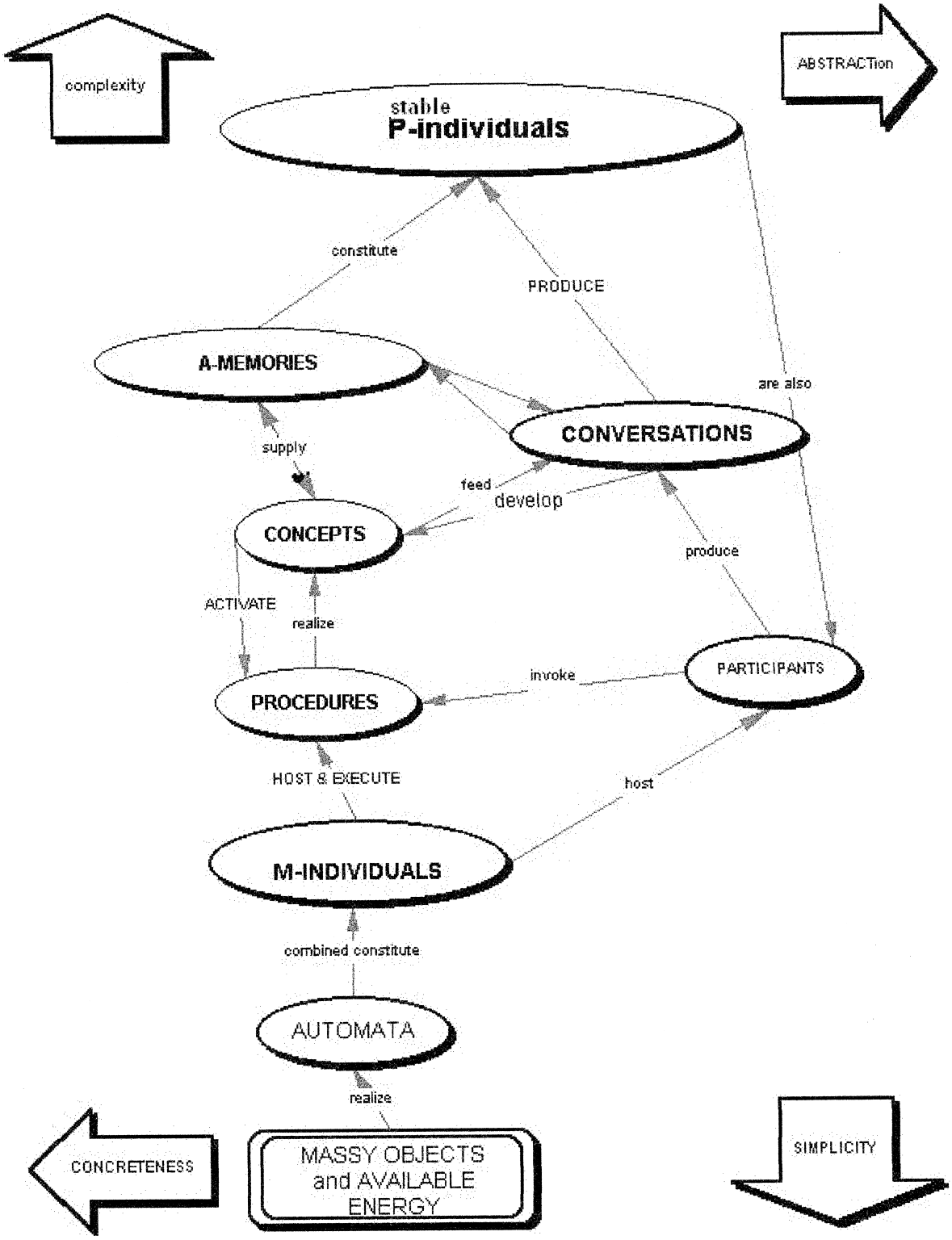

FIGURE 8.3.(A): An annotated entailment graph of the topic Conversational Learning.

(B)

																	ENTAILMENT MESH j-map derived from Fig.8.3a.
																	NOTATION = meaning of connector symbols used below
																	A::= set is 'cast' in *aggregations* role
																	v::= column (n-ary) is 'cast' in *part-of* role
																	E::= set is 'cast' in *edges* role
																	m::= edge descriptor is 'cast' in *middle* role
																	F::= set is 'cast' in *flow graph nodes* role
																	f::= node is 'cast' in *from* role
																	t::= node is 'cast' in *to* role
																	b::= node is 'cast' in both 'from' and *to* roles
						N-ary RELATIONSHIPS											SETS AND ELEMENTS
E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	15	14	{Edge Descriptor}
m															1		constitute
	m														1		produce
			m												1		supply
		m													1		are aslo
					m										1		feed
						m									1		develop
								m							1		activate
									m						1		realize
							m								1		produce
										m					1		invoke
												m			1		host & execute
											m				1		host
													m		1		combine constitute
														m	1		realize
F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	15	9	{Node names}
t	t	f													3		P-Individuals
f			b	b											3		A-Memories
	f			b	t	f	t								5		CONVERSATIONS
		t					f			f	t				4		Participants
			b		f	t		f	f						5		Concepts
								t	t	t		t			4		Procedures
											f	f	t		3		M-Individuals
													f	t	2		processors
														f	1		MASSY OBJECTS and AVAILABLE ENERGY
v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	15		Syntax and Patterns © by W.M. Jaworski, 1988-2002

FIGURE 8.3.(continued)(B): A pruned version of the (A) entailment graph represented in j-Map type notation. The righthand side lists entities and symbol definitions; the lefthand side exhibits all the main connections among the entities by using the connector symbols.

8.6.11 Task Structures

For each topic structure in an entailment mesh there should be constructed an associated procedural (modeling and/or explaining) task structure giving operational meaning to the topic. In general, the tasks are uncertainty-reducing tasks. Uncertainties unfold about what should be constructed as our world, and how it should be constructed as our (subjectively) real worlds. We gradually reduce the uncertainties by carrying out these tasks and discussing them with each other.

(Note to critical realists, and monist humanists: Especially where human beings are concerned, there *is no implication* that all the procedures required to be executing in M-individual bodies, for our various P-individuals to function and to converse with one another, *can be directly accessed nor fully* modeled, let alone wholly separated from such biological bodies.)

8.6.12 Strategies and Protocols

For learning conversations to be effective two basic types of uncertainty, Fuzziness and Ambiguity (Klir & Weierman, 1999) have to be reduced. Distinct strategies are required for reducing each and each of their subtypes. The two different subtypes

of ambiguity, strife and nonspecificity, call for characteristically distinct measures and strategies.

Cognitive "fixity" (Pask, 1975, p. 48) blocks further learning progress. When habits of action and old learning habits ("task-robots" and "learning robots" as Harri-Augstein and Thomas (1991) call them) block new learning, *uncertainty must actually temporarily be increased* by conflictual reframing conversational strategies, in order to allow for the construction of new habits.

It should be noted that every significant thing we learn, while reducing uncertainties we had in the past, opens vistas of new kinds of uncertainty opportunity if we allow it to do so.

8.7 CONVERSATION THEORY PER-SE

Now that we have reviewed the prerequisites, and exhibited the entities involved, we can go ahead and put a simple version of Conversation Theory together.

8.7.1 Putting the Building Blocks Together

For strict conversation learning to take place (as in Pask's CASTE, 1975), there are a number of requirements.

First, in order to start a learning conversation, there has to be an informal agreement in natural language (L^*) between A and B, to embark on a learning venture concerned with some specific topics in a given domain. Second, there must be a modeling facility based interactive level of doing. Third, above that, there has to be a propositional assertive level using a formalized language (L_0) for commanding actions, and for naming and describing the demonstrations of concepts as sequences of actions, and for Teachback—for explaining actions, descriptions, and concepts. And again above that, there should be at least one illocutionary level of discourse using a meta-language (L_1), for questioning and for debugging explanations concluding how and why they are correct. Further meta-levels of linguistic interaction (languages $L_2 \ldots L_n$) are optional for (ecological, moral, political) pragmatic justifications, and for critically and creatively calling into being further P-individuals.

It is difficult to show the multiplicity of feedback loops in various modalities (verbal, visual, etc.) and of Deviation-Limiting, and sometimes Deviation-Amplifying feedback, which link all parts of this system. See Pask (1975, 1976, 1984, 1987) for a full unfolding of the complexities.

8.7.2 Elaboration of the Basic Learning Conversation

Here is a somewhat more formal example, in order to get across the characteristic features of a learning conversation as prescribed by Conversation Theory.

Consider two Participants A and B who both know something (mainly different things) about a domain, say cybernetics, and who have agreed to engage with each other, and who have agreed to use natural language conversation and a modeling and simulation facility, and a recording and playback facility, to learn a lot more (see Fig. 8.4).

A is a medical student and B is an engineering student. The modeling facility they have to work with might be Pask's CASTE (Course Assembly System and Tutorial Environment, Pask, 1975); equally possibly now one might prefer STELLA™or prepared workspaces based on Maple™, MathCad™, or Jaworski's j-Maps™. The recording and playback system may conveniently be on the same computers as the modeling facility, and can keep track of everything done and said, very systematically. (If not those parts of a CASTE system, a version of Pask's tutorial recorder THOUGHTSTICKER (Pask, 1984) could well be used). See Fig. 8.4 for a schematic representation of somewhat complex, two participant, conversational learning.

Here are five separate, roughly synchronous, levels of interaction between A and B.

Level 0–Both participants are doing some actions in, say, CASTE (or, say, STELLA™), and observing results (with, say, THOUGHTSTICKER) all the while noting the actions and the results.

Level 1—The participants are naming and stating WHAT action is being done, and what is observed, to each other (and to THOUGHTSTICKER, possibly positioned as a computer mediated communication interface between them).

Level 2—They are asking and explaining WHY to each other, learning why it works.

Level 3—Methodological discussion about why particular explanatory/predictive models were and are chosen, why particular simulation parameters are changed, etc..

Level 4—When necessary the participants are trying to figure out WHY unexpected results actually occurred, by consulting (THOUGHTSTICKER and) each other to debug their own thinking.

The actual conversation might go as follows. In reply to some question by A such as, "HOW do engineers make closed loop control work without 'hunting'?" B acts on the modeling facility to choose a model and set it running as a simulation. At the same time B explains to A how B is doing this. They both observe what is going on and what the graph of the systems behavior over time looks like. A asks B, "WHY does it oscillate like that?" B explains to A, "BECAUSE of the negative feedback loop parameters we put in."

Then from the other perspective B asks A, "How do you model locomotor ataxia?" A sets up a model of that in STELLA and explains How A chose the variables used. After running simulations on that model, A and B discuss WHY it works that way, and HOW it is similar to the engineering example, and HOW and WHY they differ. And so on and on until they both agree about what generates the activity, and why, and what everything should be called.

This, at first glance, may now seem like a rather ordinary peer-tutoring episode using simulations. It is. But the careful metacognitive demarcation of levels of intercourse, according to their distinct cognitive functions, and the way in which multiple perspectives are brought together to construct a deep and transferable agreed understanding are the novel key aspects.

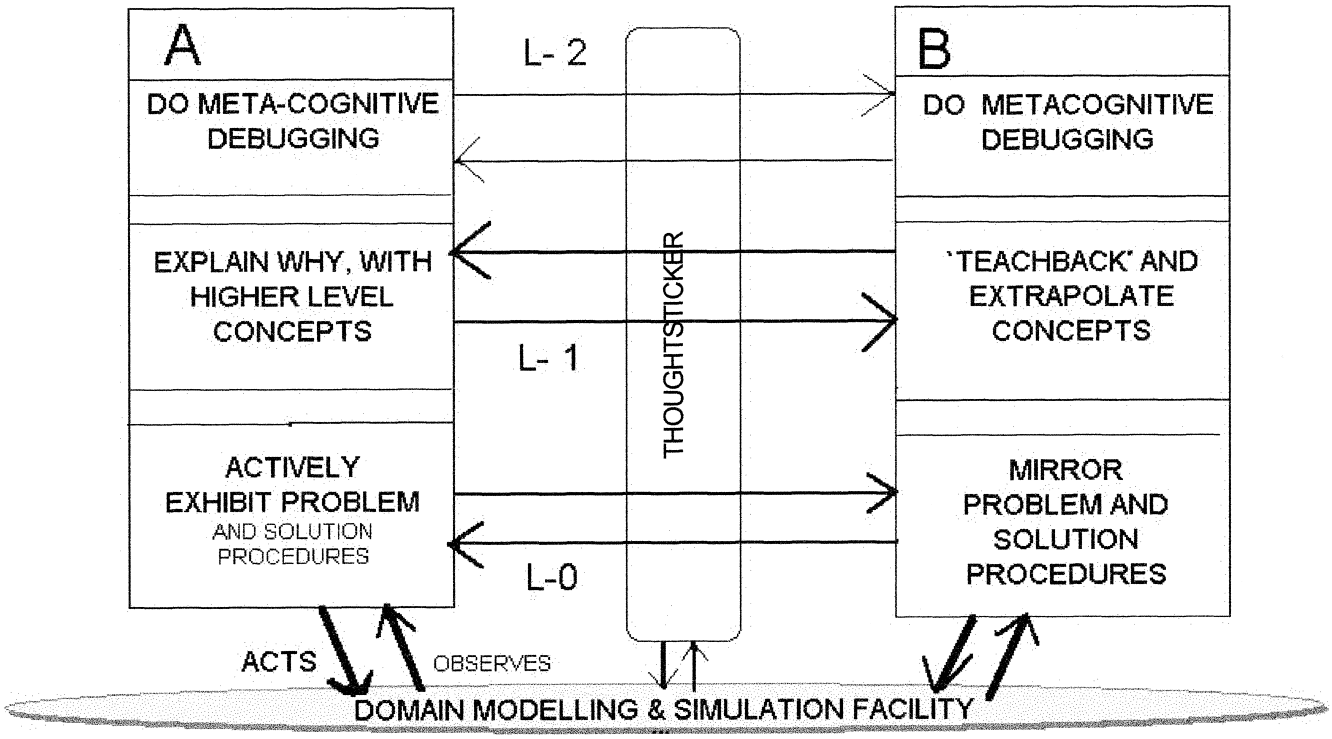

FIGURE 8.4. Conversational learning system—simplified to interaction at only three levels (after Pask, and somewhat after Bernard Scott, 2001).

8.8 HOW TO USE CONVERSATION THEORY AS A BASIS FOR LEARNING SYSTEM DESIGN

(The model for this is Course Assembly System and Tutorial Environment (CASTE), Pask, 1975; Mitchell & Dalkir, 1986.)

- Choose some domain, and some topic areas within it, of importance to you and to some population of other learners.
- Do a crude information mapping of the most important topics and their probable dependencies on each other—make a proto-entailment mesh, say, with stick-on notes on a whiteboard. Gather illustrations and exercises to exemplify the topics.
- Acquire or build a modeling and simulation running (and possibly gaming) facility which can be used to externalize and experientially exemplify those topics in the chosen domain. One could simply use an hypertext glossary system (Zimmer, 2001). One could use "Inspiration"™or AskSam™. One could use a generalized multidimensional matrix modeling facility such as Jaworski's j-Maps™. For more mathematical subjects one might use Maple™or MathCad™to construct modeling spaces. For stack-and-flow or predator–prey domains one might well use an existing dynamic systems modeling facility such as STELLA™. Fit the gathered domain material into the modeling facility using the sketched out mesh as a guide. The result is just a prototype domain model for improved conversational learning.
- Choose a small but diverse sample of learners from the target population.
- Set up multimodal recording arrangements with persons and machines in a pleasant tranquil environment.
- Discuss with the learners why understanding and ability to teachback topics in this domain can be lastingly valuable and timely for them and for you. Get their wholehearted agreement to participate and to commit enough time to the undertaking—if possible. (L^* conversation)
- Pick a seemingly simple relation or operation and, using the facility, demonstrate it to the learners, name and explain what you are doing. (L_0)
- Answer their questions; explain why you are answering that way. (L_1)
- Ask the learners why they are asking those questions, in order to evoke metacognitive consciousness of how they are learning to learn. (L_2)
- Get each learner, and/or the group of learners, to use the facilities to teachback or to creatively demonstrate other versions of the relation/process back to you and the other learners. Note agreements; explain distinctions. Record the lot. Thus the domain representation is improved, and an understanding of it is cultivated in each participant. (L_3) Also look

and listen for limiting habits: task robots and learning robots (Harri-Augstein & Thomas, 1991).

- Edit the transcriptions and dribble-files etc. to produce a master entailment mesh, and task structures, and appropriate tasks (exercises, tests) for that Domain, for Goals Topics and for Population of Learners.
- Prune! Eliminate redundant labels and links. Use the system, formatively evaluate, and prune more.
- Embed the entailment mesh and task structure protocols in the software of your support facility.
- Hold further learning (scientifically and philosophically—ecologically, ethically, morally—critical) conversations in order to go on responsibly improving the affordances of the learning support facility.
- Work with others to extend and clone what can become a canonical CT learning support facility for that domain, one which can generate working versions suited to different populations of learners, environments, etc.

8.9 HOW TO USE CONVERSATION THEORY FOR DOING FORMATIVE EVALUATIONS

Ask, "Does the support system provide the following desiderata?" And creatively suggest how they can be provided.

8.9.1 Shared Modeling/Simulation Tool-Space

Does it share a working space where all participants can carry out and observe actions made with appropriate tools, and various interactions of kinds appropriate to the particular field of study (e.g., C/CASTE—Mitchell & Dalkir, 1986; THOUGHTSTICKER—Pangaro, 2002)? If not readily available, then recommend an appropriate groupware modeling facility.

8.9.2 A Processable, Pluggable, Canonical Entailment Mesh and Task-Structure Representation-Model and Multiple Views Generator

Is a processable, canonical representation (model) of the relevant history of the domain language-field stored and readily accessible and rerunable—e.g., in j-Map™form (Jaworski, 2002)—together with variously versioned (e.g., graphical) views of its procedural entities and relationships (entailment meshes, task structures, etc.)? It is helpful if the important levels of a taxonomy of competencies, or of learning objectives such as Bloom and Krathwohl's (1956), or of human values such as Maslow's (1954), are incorporated.

8.9.3 Interaction Stratification

Is dialogue among participants stratified in terms of levels of languages and meta-languages? Are all participants aware of the need to converse at different levels roughly in parallel? Are clear distinctions made, and continually supported, between three or more levels of discourse: demonstration, L_0; and explanation (and teachback) agreement-negotiation, L_1; and debugging level, L_2; and situating levels, L_3. The commitment meta-negotiation level L^* may also have to be revisited if participants balk at so much engagement.

8.9.4 Scenarios

Are scenarios and/or exemplary model performances provided as rough guides to exploration, construction, evaluation and revision for all types of participants? If not, provide some models.

For example, about the simplest possible CT learning scenario would be like this: A pair of P-individuals having agreed to learn about a common topic, one P-individual originates a conceptual bundle of procedures which when applied (i.e., executed) produces a Description, image or an action, observable by the other. The other P-individual tries to do the same. If the Descriptions or actions, which they produce and display in a shared conversation workspace are regarded by each other after a reasonable amount of conversation to be about the same, then it is noted that an agreement has been reached, and the agreed Concept can be given one label which both participants can confidently use in further conversation. If, however, the productions differ, so that the participants realize that they are executing different concepts even though they both started from the same topic label, then the participants set about to externalize precisely these differences in the ways they are executing their concept-procedures, in order to establish a sharp distinction between the two. At this point they agree to assign two different labels (in which case each participant gains a new coherent distinctly labeled executable Concept).

8.9.5 Responsibility

Are reminders included, to philosophically and politically question who benefits and who is disadvantaged "malefits" by the kinds of productions of models of reality involved?

8.10 SOME IMPORTANT OMISSIONS FROM AND ADDITIONS TO CONVERSATION THEORY

8.10.1 Network of Actors

According to the extension of Conversation Theory and the Interactions of Actors Theory (IAT) each human biological being (humanimal) incorporates portions of many interbody P-individuals (transviduals). Thus, CT + IAT is a theory which potentially accommodates explanations of a wide variety of complex phenomena such as versatility of learning styles, autism, narrative-consciousness, multiple personality syndrome, the collective behavior of teams, families, churches, crowds, etc. Unlike other constructivist theories (e.g., Piaget, Gergen), Pask's CT and IAT nicely account for the emergence of coherent values (Scott, 2001) and also for what Habermas considers to be the universal essential human value—that of promoting rational understanding through nondominative

discourse. Pablo Navarro (2001), an esteemed sociologist, accords CT praise for overcoming the false Hobbesian dichotomy between society and the individual.

8.10.2 Dominant Nonconversational Emergent Supra-Systems Ignored?

Pablo Navarro also notes that because of Pask's deliberate limitations of its scope to that of intra- and interpersonal intentional learning, CT ignores the nonintentional, nondiscursive, society-wide chaotic emergence of dominative systems such as global markets, and various wars and trade wars, which determine much of our lives—which indeed are very important parts of the E in the human system $S' = f(S, E)$.

8.10.3 Disembodiment Versus Integrity?

More concretely and viscerally, Klaus Krippendorff (1994) shows that serious limitations arise from Pask's expedient exclusion of the physiological and emotional conflictual dimensions of each human's being (Johnson,1987). And in the Kybernetes Festschrift (2001), Pablo Navarro also points out that CT (so far) does not contain a specification of whatever maintains the integrity of intentional P-individuals, despite their openness to conversational evolution. All this leads to the very important open research question: "How do the characteristics of the M-individuals impact the P-individuals executing and conversing through them?"

8.10.4 Motivation

Motivation is dealt with very little, in Pask's Conversation Theory writings, compared to its actual importance for human learning. Pask usually conducted L* negotiations with learners before the CT experiments, to get their agreement and commitment to participate wholeheartedly in the learning work. There is a formal description of the directional unfoldment of entailment meshes leading to possible action, but this is a very abstract and skeletal model of motivation; how it might relate to emotion is problematical.

Actually, it is now known that much cognition carries and generates affective loadings. In particular emotion, as distinguished from feelings, is essential to the formation of long-term memory (D'Amasio, 1994). Soon our improved models of teaching–learning conversations must specifically operationalize this. Also now it is clear that trans-M-individual P-individuals (transviduals) are deeply implicated in motivation for learning and (other) action, and this is not explicitly explored. It is, though, allowed for by Pask's theory, particularly by the L* level and more explicitly by the Interactions of Actors Theory (IAT) which he was working on at the time of his death (de Zeeuw, 2001).

Intellectual adolescents hold motivated learning conversations in their love relationships. Young professionals hold motivated learning conversations as part of the relevant credibility status games of scientific and professional societies. Elders' motivation for learning conversations is to distill the best of what they know and get it re-created in the young. How are such perspectives to be operationalized in CT systems?

8.11 EXAMPLES OF RESEARCH AND DEVELOPMENT WORK DONE WITH CONVERSATION THEORY

Second-order cybernetic (von Foerster, 1981) research on complex learning, where the researcher–experimenter–observers are acknowledged explicitly as part of the system which they are researching, can probably be better conducted by using versions of Conversation Theory and THOUGHTSTICKER-like or CASTE-like facilities; this was Pask's aim. However, to date, most CT research work (e.g., that of Pangaro, Harri-Augstein and Thomas, Scott, or Laurillard) has been done as a by-product of educative ventures, rather than with the study of complex learning as their primary aim.

Interesting possibilities beckon: study and overcoming of cognitive fixity (learning robots); study of various kinds and levels of conflict among personae and of their divergent motivations; study of multiple perspectives and cognitive switches, and so forth.

Pask's CT can be very helpful for improving the work of course development teams in Distance Education organizations, according to Zimmer (2001), of the UK Open University.

Also, as Diana Laurillard and Ray Ison (1999) have pointed out, there is a great opportunity for studying the learning of Learning Organizations and the learning of the Learning Society through the lens of Conversation Theory. Much of my own work (Boyd, 2002) has involved having graduate students collaboratively make cybersystemic models of teaching–learning systems that they have been (or are) in, and using CT and other cybernetic principles to diagnose and prescribe improvements to those systems.

Detailed examples of applications of CT are given in Pask's (1975) book *Conversation Cognition and Learning*. However, the text and notations there (and in the AECT journal paper) are rather difficult to work through. Some of the most practical and readable prescriptions for actually carrying out learning conversations have been provided by Diana Laurillard (2002) (Laurillard & Marnante, 1981), by Bernard Scott over the years up to the present (2001), and by Harri-Augstein and Thomas (1991). In at least one important respect, Harri-Augstein and Thomas and Mildard Shaw (1985), go beyond Pask, by combining his theory with that of George Kelly and by insisting upon two very important specific types of levels of discourse, one being a metacognitive level explicitly devoted to discussing and improving learning strategies (an L_n), and another a pragmatic level (an L*), explicitly dealing with why this particular learning is relevant and important to these participants in this context. Both these language levels exemplify aspects of $S' = f(S, E)$.

Jesus Vazquez-Abad and Real LaRose (1983) developed and researched an Operational Learning System based on Conversation Theory combined with Structural Learning Theory. It was

implemented on the PLATO system to carry out research on instruction of rule-based procedures in science education.

Robert Barbour of the University of Waikato, New Zealand, used Pask's Conversation Theory to arrange for and study the learning of sixth and seventh form students using the UK Domesday Book interactive videodisks. Pask's and Husserl's views of cognition are both considered together (Barbour, 1992).

Steven Taylor (1999) developed a successful biology (photosynthesis) TEACHBACK/ computer aided learning system where the human learners try to teach the computer (playing the role of a simulated learner) the topic relations they have nominally already learned. Teachback has recently been rediscovered and rechristened as "Reciprocal Teaching" by Palthepu, Greer, and McCalla (1991) and Nichols (1993).

Conversation theory has also been found to be helpful in designing and understanding second-language learning (Miao and Boyd, 1992). Recently some quite good approaches have been cropping up for organizing conversational learning. Some have drawn on CT (Zeidner, Scholarios, & Johnson, 2001), but there are others which have not drawn on Conversation Theory but might gain from doing so (e.g., Keith Sawyer's Creating Conversations, 2001).

Another interesting informal and dramatic example of conversational learning using Pask's CT is in Yitzhak Hayut-Man's play (2002) "The Gospel of Judith Iscariot." In Act 2 Scene 3 Judith, at the Messiah Machine, conducts conversations with three cybernetic specters, to resolve her conflicts about Jesus. The solution is arrived at by conversing with all three conflicting parties until they agree on the betrayal of Jesus by Judith. The whole Academy of Jerusalem play is an exercise in transformative redemptive learning conversations, and indeed was directly inspired by Hayut-Man's years of work with Gordon Pask.

Gordon McCalla (2000), in his discussion of AI in education in 2010, asserts, "An explicit focus on learning and teaching, using computational models, can bring together a wide range of issues that considered separately or in other contexts would be intractable or incoherent." Conversation Theory provides a framework for creating better forms of such computational models.

Conversational learning is not limited to P-individuals within biological persons but may be carried out with P-individuals who execute in a distributed fashion across many persons and machines. Two important cases of transvidual P-individuals are Learning Organizations and Learning Societies. Laurillard (1999) explains just how Conversation Theory can be applied to realize better learning organizations such as e-universities and truly learning societies. *One might well dream of creating organizations which use communicating AI agent supported CT to learn to be wiser than even their wisest members.*

8.12 CONCLUSION: THERE ARE GOOD OPPORTUNITIES TO DO MORE WITH CONVERSATION THEORY

Conversation Theory begins to constitute a new kind of comprehensive ontology of subindividual, individual, and collective human being, which gets beyond the sterile individual—society dichotomy. To my mind, this understanding of human being implies a profound criticism of simplistic individualism. Competitive possessive individualism and freemarket ideology are evidently self-defeating ideologies if one understands that every person is inextricably woven into the fabric of other human beings.

CT now seems an even more plausible theory of participant beings than it did in 1975, since it fits well with so much other more recent work. Proto-conversations probably start right down at Edelman & Tononies (2000) second level of consciousness, where the selection of neuronal groups occurs through mimetic and linguistic interaction (although NOT much below that), and functions as a good explanatory and heuristic model (with the caveats listed above), on up to the level of competing global cultural memeplexes (such as the English language, Arabic-Islam, capitalism, socialism, etc.).

8.12.1 Conversation Theory as Open-Ended

Conversation Theory has not at any time been a fixed finished theory. De Zeeuw (private communication, 2002) sees it as a set of procedures itself (L_0 and L_1) that helps learners to create "languages"(L's) to talk "to" what is observed, such that actions may be performed with "limited" (pre-state-able) effects. Many versions of CT exist because it evolved steadily, through conversations and experiments from early proto theory in the 1950s, to the IAT—Interactions of Actors Theory (de Zeeuw, 2001; Pask, 1992)—which itself continued to evolve in his various ongoing conversations until Pask's death in March of 1996.

Conversation Theory has proven to be a very inspiring and practically useful theory for many other educational cyberneticists and technologists, because it indicates how realistically complex *n*-personae learning, for actors(P-individuals) with different learning styles (e.g., holist; serialist; versatile), should be supported by second-order cybernetic technology.

Cognitive fixity—learners being trapped by their habitual ontologies and their habitual ways of learning, remains a central problem especially for any science education which aspires to the cultivation of a deep understanding of the complex systems in which we live (Jacobson, 2000). The multiple P-individual, and distributed processing across multiple M-individuals, reconceptualization which CT offers may be the most promising way to liberate persons from inadequate ontologies and epistemologies.

Conversation Theory and Interaction of Actor Theories initially generated by Pask and his collaborators, continue to evolve their own sort of immortality as educational development heuristics—particularly among those of us who knew Gordon Pask and studied with him and who have incorporated those systems into our own thinking (e.g., de Zeeuw, 2001; Laurillard, 1999; Scott, 2001).

Pask's P-individuals forever seek to engage in new conversational learning ventures, which change them, enlarge domains of knowledge, and change other participants, and sometimes

replace both. When one considers real persons *and communities,* rather than quasi-algorithmic A-life models, there are clearly aesthetic, ethical, moral, and biophysical dimensions which must be democratically taken into account Wenger (1999). This is especially so when we apply our theory in our educational and human performance system interventions. How to fit these into a coherent universally ethically acceptable cybersystemic theory of selves-researching, selves-changing human community systems?

Interactive intermittently, positively reinforcing aesthetically engaging systems, without scientifically and philosophically critical levels of learning conversation, are pathological addiction machines (e.g., Video Lottery Terminals and Massive Multiplay Games like Doom). Can our simulation systems and conversational learning tools be augmented with appropriate artificial intelligence to bring harmony among vast numbers of competing communities, as Gordon McCalla (2000) envisions? And how do such augmented learning conversations fit into our understanding of, and obligations toward, the closely coupled system of all Life on this delicate little planet Earth?

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