Introduction to Cybernetics and the Design of Systems

Collected Models
January 2010

Working Draft v4.1
Not for re-distribution

Hugh Dubberly
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Conversation

Model of Communication
after Shannon & Weaver

origins

a. individuals
Claude Shannon was the primary source for the model. His co-author, Warren Weaver, hoped for a broader scope for the model than Shannon. Weaver claimed extension of the model to explain the transfer of 'meaning', which was never achieved.

b. era/dates
Late 1940s.

c. references for model, context, author(s), concepts
Shannon, Claude E., and Weaver, Warren: The Mathematical Basis of Information, University of Illinois, Urbana, Illinois, 1964.

Note that Ashby's *Introduction to Cybernetics* includes a mapping of requisite variety to Shannon's channel model.

d. examples
Telephone transmission lines were the original context of the model's development.

a. goal of model
The model distinguishes sources of information from their encoding and transmission. The impact of noise in the communication channel is countered by a quantitative approach to calculating the required redundancy of the channel—additional data that must be inserted into the source's message—in order to achieve a desired accuracy of transmission.

b. description
A hypothetical communication channel is presented and the effectiveness of the channel at transmitting the original information of the source can be computed.

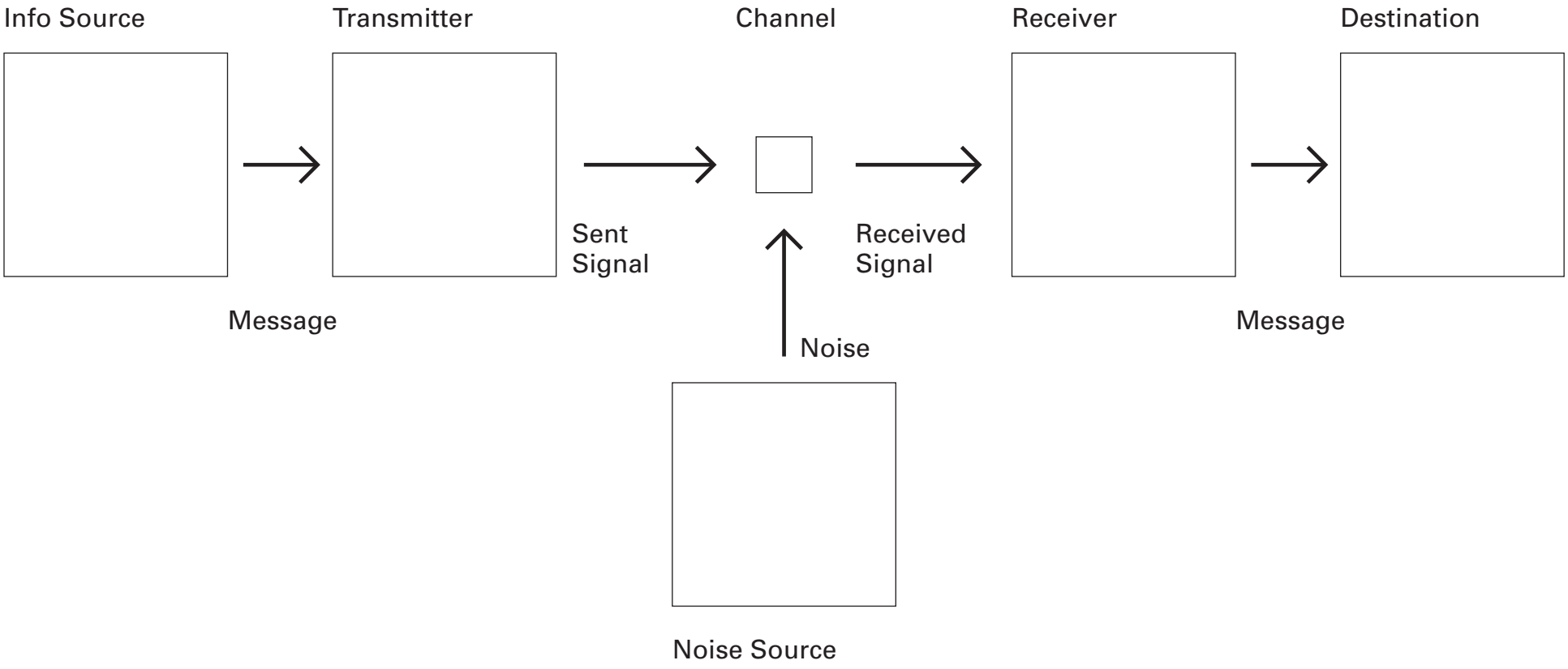
c. components and processes
An information source composes a message in the form of a set sequence of characters from a given alphabet. The transmitter encodes the message into a signal that is sent through a communication channel. At the far end of the channel, the signal is received and decoded by the receiver and turned into a message, which is delivered to the destination.

d. important aspects of model/breakthrough/limitations
Not shown here, the model provides a mathematical basis for designing a channel to guarantee a desired level of accuracy ("goal") against an anticipated level of noise ("disturbance"). Innovations of the model include the measures of "information" based on the number of bits of data required to distinguish distinct characters in the transmitted alphabet; this was an innovation at the time. The limitation of the model is that the alphabet must be pre-agreed by both the transmitter and receiver.

Model of Communication
after Shannon & Weaver

This model describes the process of one telephone communicating with another.

Weaver points out that *The Mathematical Theory of Communication* (and the model below) are primarily applicable to "*technical problems* [which] are concerned with the accuracy of transference from sender to receiver of sets of symbols (written speech), or of a continuously varying signal (telephonic or radio transmission of voice or music), or of a continuously varying two-dimensional pattern (television), etc."



Model of Human Communication

origins

a. individuals

b. era/dates

c. references for model, context, author(s), concepts
Paul Pangaro, "Cybernetics and Conversation", at http://pangaro.com/published/cyb-and-con.html

d. examples
A: I'd like to have hamburgers at home for dinner.
B: [imagines that this will require defrosting]. Are there any left in the freezer?

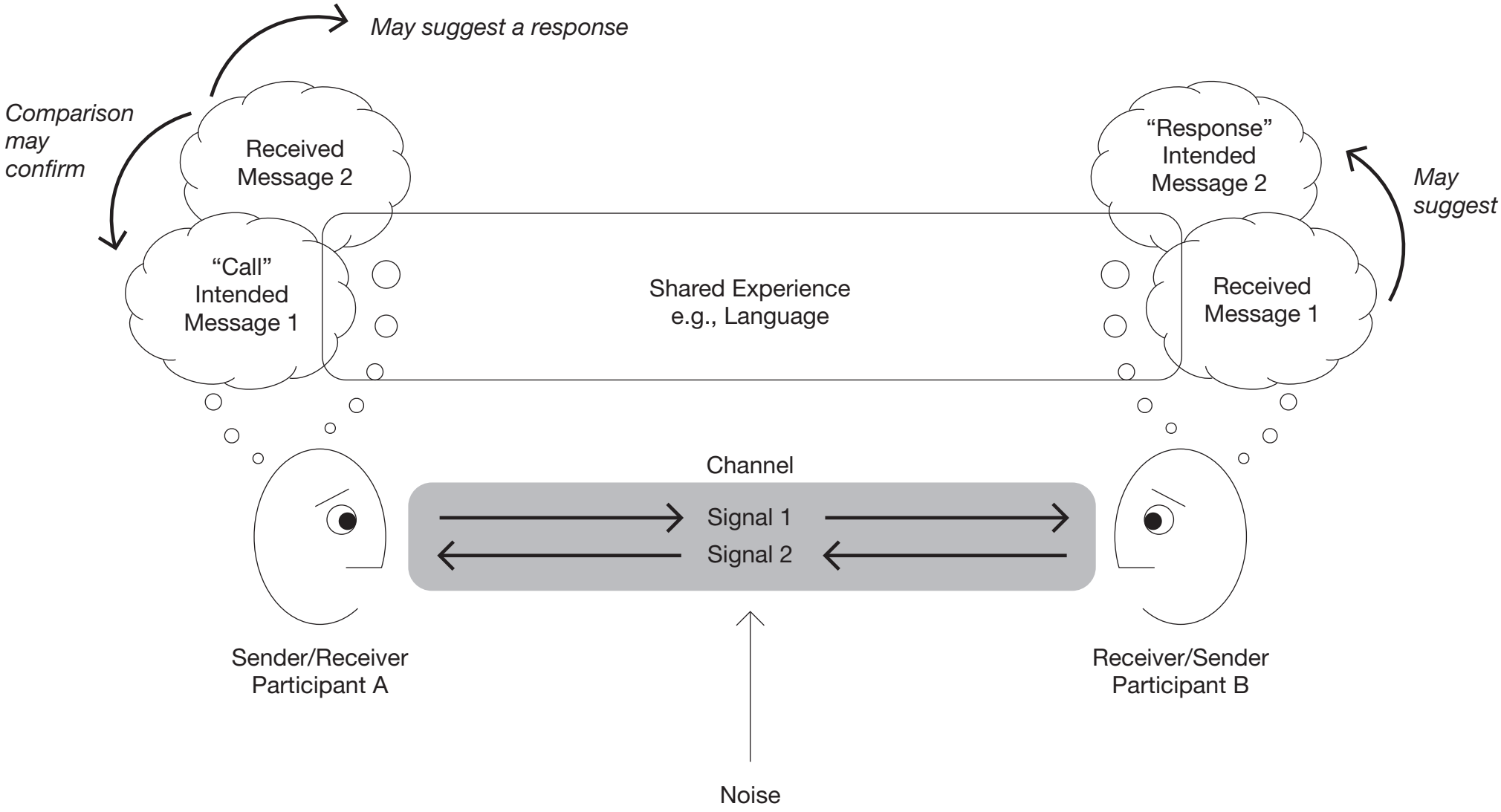
a. goal of model
The model bridges Shannon's Information Theory and Pask's Conversation Theory. It moves from the pure syntactic operation of Shannon's theory ("What character was sent?") to the semantic domain ("What message was meant?").

b. description
The channel of communication is seen as parallel to a context of shared experience that is required for the correct interpretation of the message. Senders and receivers become "participants" who must actively engage in the message in order to interpret it, rather than deterministic processes that merely distinguish among predetermined characters in an alphabet.

c. components and processes
Participant A uses a channel, for example a telephone, to speak a message. Message arrives to Participant B who uses shared experience to interpret the meaning, for example, the context of preparing dinner or achieving some other a shared goal. (Little need be spoken, much is understood.) Participant B may formulate and send a response back along the channel to A, who in turn interprets the message, formulates a meaning, compares that meaning to A's original intention, and may formulate and transmit a response.

d. important aspects of model/breakthrough/limitations
The model should not be interpreted too literally as it involves certain compromises for the sake of making a bridge from the mathematical/syntactic Information Theory to the cybernetic/semantic Conversation Theory. For example, "trigger" is a better label than "signal".

Model of Human Communication
after Pask and Pangaro



Model of Agreement
after Dubberly

a. goal of model
The model informally presents the necessary layers required to "come to agreement" about a particular subject.

b. description
The context of agreement is represented as a relationship among two participants and a subject.

c. components and processes
Participants, represented as "me" and "you" each have a model of a subject, represented here as an abstract cube. I hold a model of the subject "in my mind". I also imagine that you hold a model of the subject "in your mind".

One aspect of agreement is my model of the correspondence between my model and your model of the subject. If they correspond sufficiently, then I believe that we "agree" about the subject. The next aspect of agreement involves my knowing about your model of this first aspect, that is, whether you believe that we agree (how this is achieved is not shown).

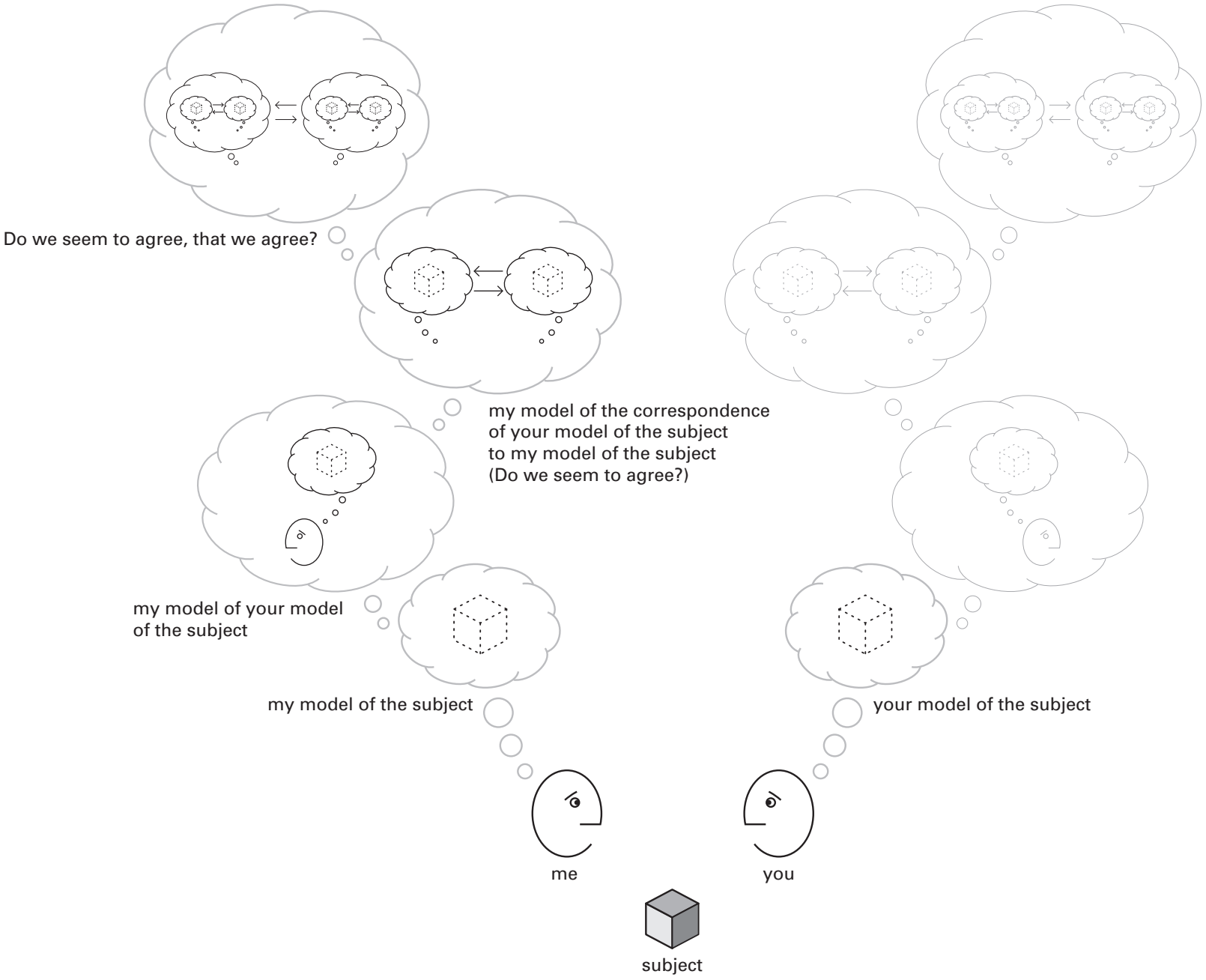
We may agree that we agree about a subject.
However, we may be wrong.

d. important aspects of model/breakthrough/limitations
The model is symmetric, in that all the aspects internal to me must also hold internal to you for agreement to take place.

There is an additional case not shown: where we agree that we do not agree.

Model of Agreement

Human communication relies on agreement.



Who defines the ‘system’?

origins

a. individuals
Heinz von Foerster, Godon Pask

b. era/dates
Second-order cybernetics, implicit and discused from the 1940s, becomes “mainstream” in the 1960s though resisted within the community for another 25 years.

c. references for model, context, author(s), concepts

“The meaning of Cybernetics in the Behavioural Sciences”. In *Progress of Cybernetics*, Volume 1, Editor, J. Rose. Gordon and Breach, 1970, 15-45. Reprinted in *Cybernetica*, No. 3, 1970, pp 140-159 and in No. 4, 1970, pp 240-250. Reprinted in Artoga Communications, 1971, pp 146-148.

d. examples
The observer observes the system of a thermostat, noting its control of a heater, based on sensing the air in the room, and striving toward the goal of maintaining a set temperature.

a. goal of model
The model is intended to show the dependency of the system on the observer.

b. description
The system arises as a consequence of the observer. The system—its boundaries and features—is delimited by the observer and does not exist as distinct from the environment except insofar as the observer chooses to delimit it.

c. components and processes
A first-order system (a placeholder for a system of any complexity) shown as before. Arrows indicate actions toward and sensing from the system by the observer.

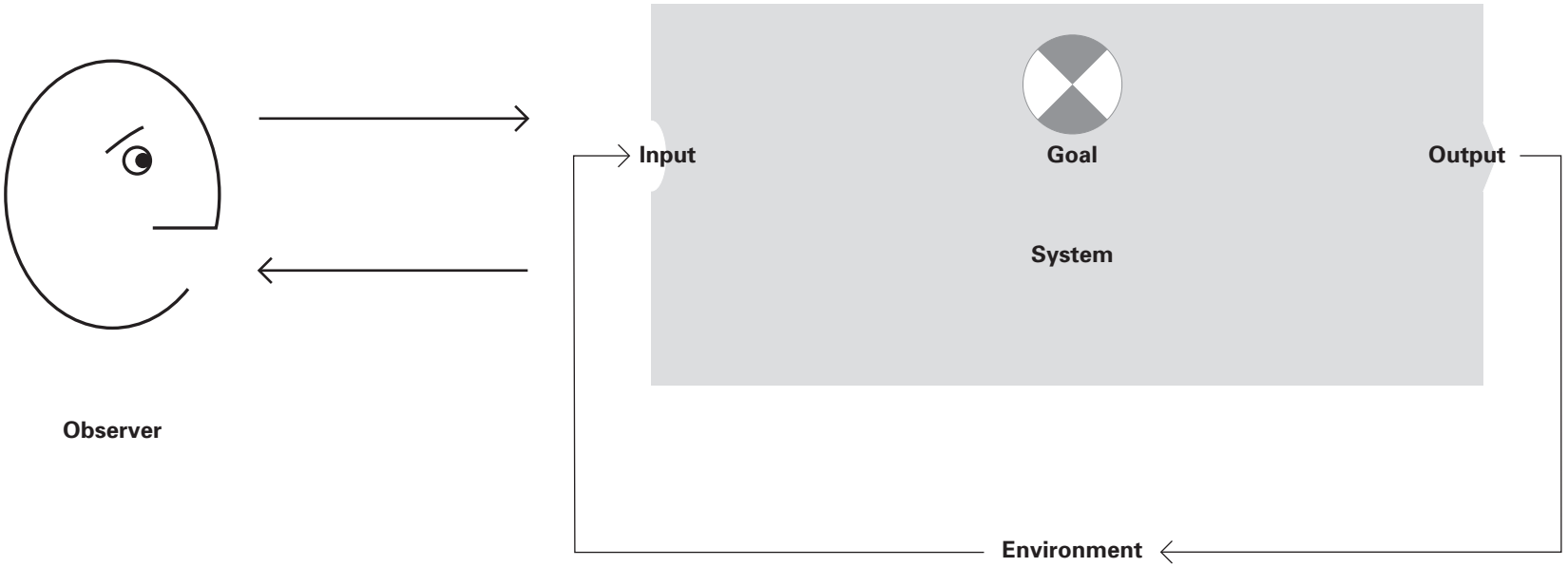
d. important aspects of model/breakthrough
The model supports the constructivist epistemology of cybernetics, that is, the stance that systems do not exist except as boundaries created by observers.

It is appropriate to say that observers *have goals for* the systems they create/observe. Specific systems have specific value to observers, whether for scientific, technological, or social reasons, but cybernetics considers them as artifacts of observation and not independent entities.

A more careful statement would be to say that observer and system co-arise as a consequence of interaction.

Who defines the ‘system’?

The system is an observer phenomenon.
Heinz von Foerster: ‘Objectivity is the delusion that observations could be made without an observer.’



2nd-Order Cybernetics and the Introduction of Subjectivity

origins

a. individuals
Ernst von Glasersfeld is a primary source of writings of cybernetics as a constructivist epistemology from the perspective of philosophy.

b. era/dates
Second-order cybernetics, 1960s+.

c. references for model, context, author(s), concepts

Ernst von Glasersfeld, "An Exposition of Constructivism: Why Some Like it Radical ", available at http://www.oikos.org/constructivism.htm.

d. examples
Choosing what language to use delimits what we see, want, and do. "Problem framing", from design methods, is the process of deciding what to observe.

a. goal of model
The model shows the related scope of first- and second-order cybernetics and that the inclusion of the observer requires recognition of subjectivity in all observation.

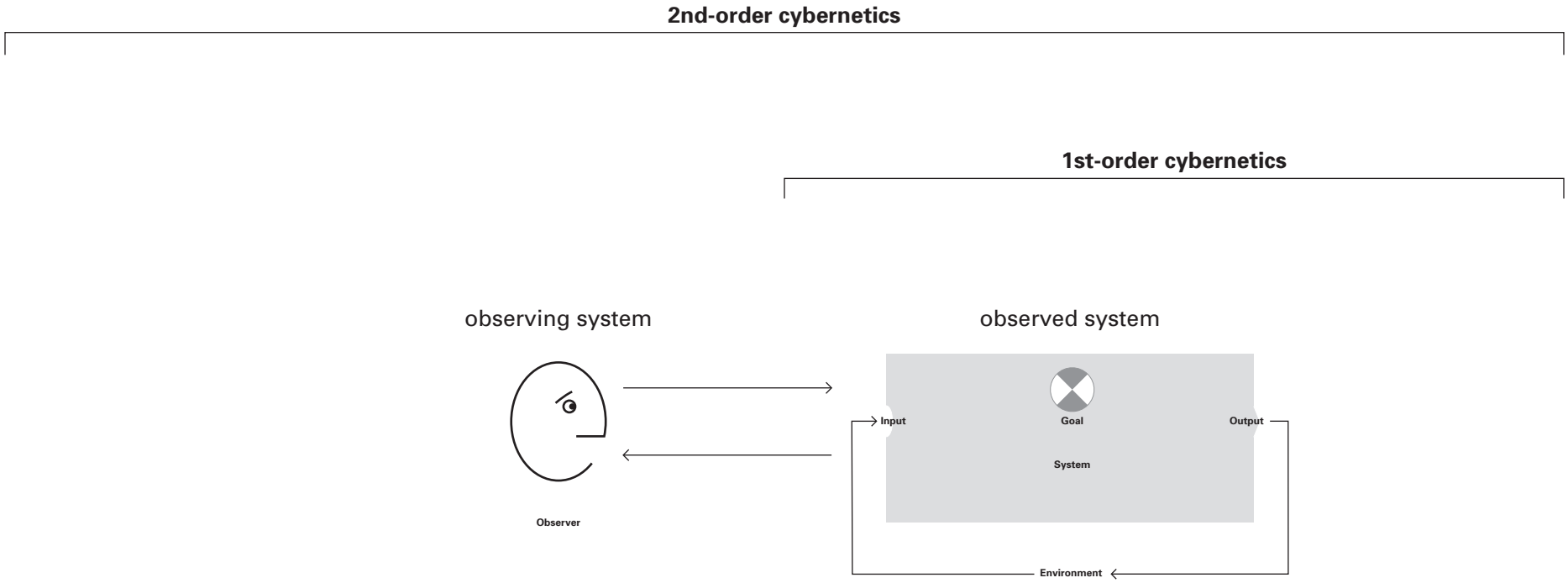
b. description
1st-order cybernetics is concerned with observed systems ('systems that are observed'). 2nd-order cybernetics adds the realization that it is an observer who specifies or creates the observed system, and that the observer is limited by biases of reference frame, perception, preference, values, beliefs. Therefore, systems are necessarily subjective in nature, that is, subject to the biases of the observer.

c. components and processes
First-order system shown as shaded area with loop through environment, as before. Observing system ('system that is observing') interacts with first-order system, as per previous model.

Brackets above show the domains of 1st- and 2nd-order cybernetics.

2nd-Order Cybernetics and the Introduction of Subjectivity

Heinz von Foerster noted:
'First-order cybernetics is "the science of observed systems".
Second-order cybernetics is "the science of observing systems".'



Observing the observing

origins

a. individuals
Heinz von Foerster was a foundational force behind establishing 2nd-order cybernetics as the main discipline.

b. era/dates
Second-order cybernetics, 1960s+.

c. references for model, context, author(s), concepts
von Foerster, Heinz: "On Constructing a Reality".

d. examples
An observer observes the interaction between an observer and a thermostat, where the nested observer is seen to delimit the boundaries and features of the thermostat in terms of its input, output, and goal. In practice, the two observers may be different perspectives in the same person.

a. goal of model
The diagram explicitly adds the further layer, that of the observer of the interaction between the observing and observed system (which was merely implicit in the previous diagram).

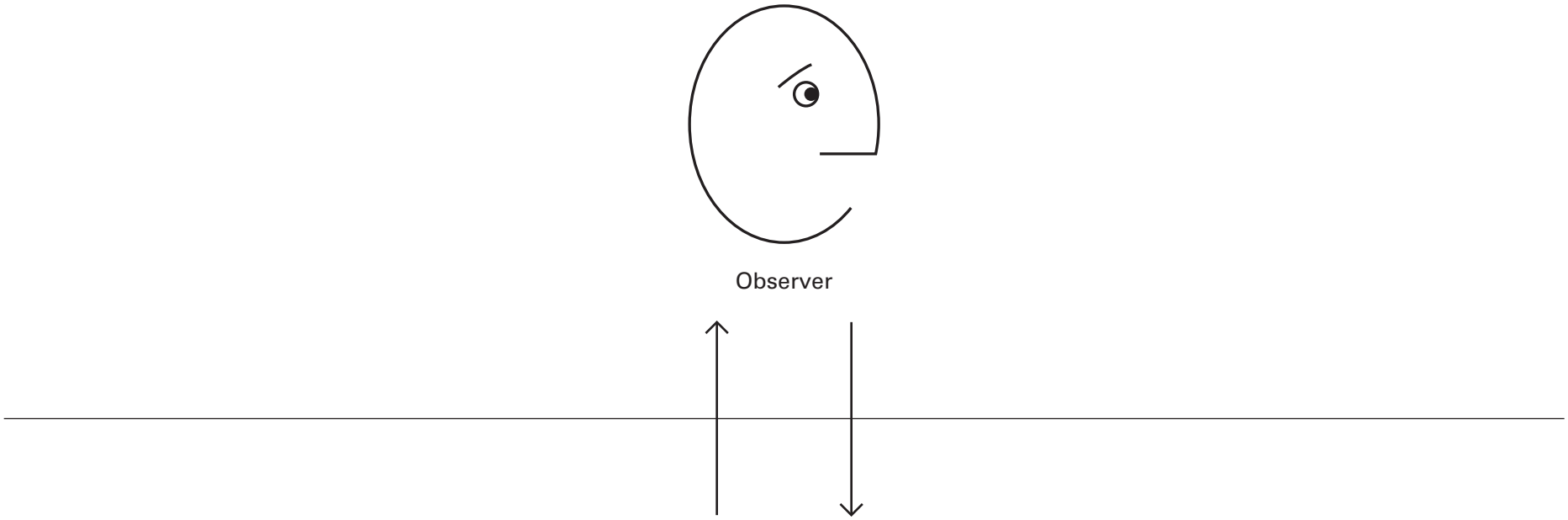
b. description
The upper observer has an interaction with the observing/observed system interaction shown in the lower part.

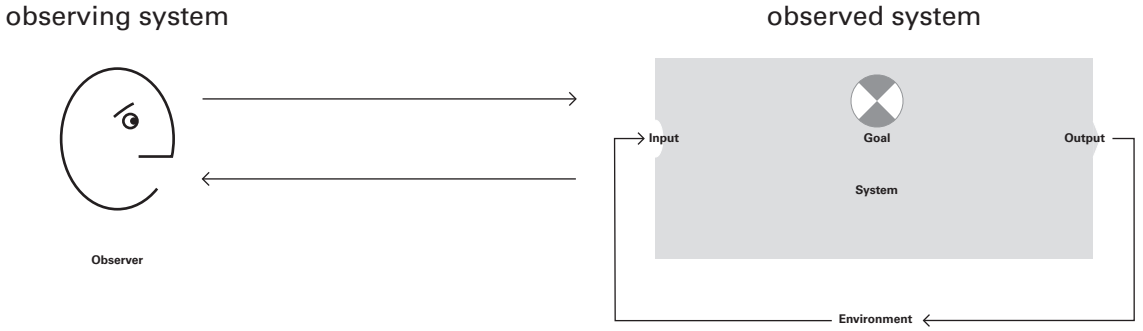
c. components and processes
Upper-observer interacts with the system of lower-observer-interacting-with-system.

Observing the observing

We can back up still further and observe the observer observing.

Maturana said, “Everything said is said by someone.”
And Von Foerster added, “Everything said is said to an observer.”





Observing conversations

origins

a. individuals
Gregory Bateson, Margaret Mead, Gordon Pask.

b. era/dates
Side bar infomation text size

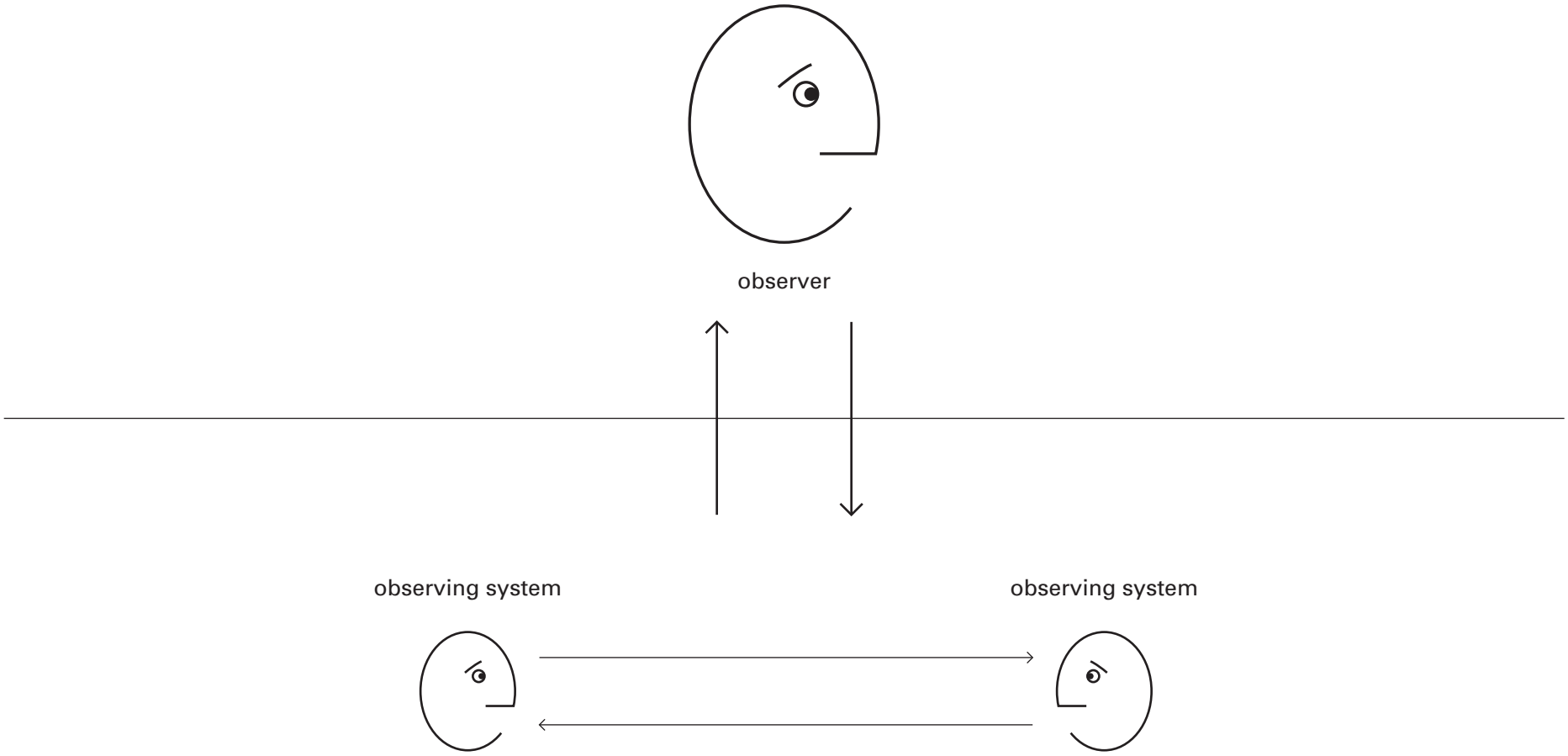
c. references for model, context, author(s), concepts
Gordon Pask, *The Cybernetics of Human Learning and Performance*, London, Hutchinson, 1975.

d. examples
An observer observes the interaction between two participants in a conversation and formulates the viewpoint that the conversation is an argument about politics.

a. goal of model
Continuing to build on prior models, this diagram shows that the observed interaction may be that of conversation.

Observing conversations

The observer in the upper level may observe a pair of observing systems that are interacting in a conversation, shown in the lower level. Under certain circumstances, it is possible for this observer to judge whether the two observed systems are in agreement.



Conversations about conversations

a. goal of model
The diagram shows the relationships among two sets of participants in different conversations, where one conversation is about the other.

b. description
Many conversations are about other conversations

c. components and processes
Lower conversational exchange as above.

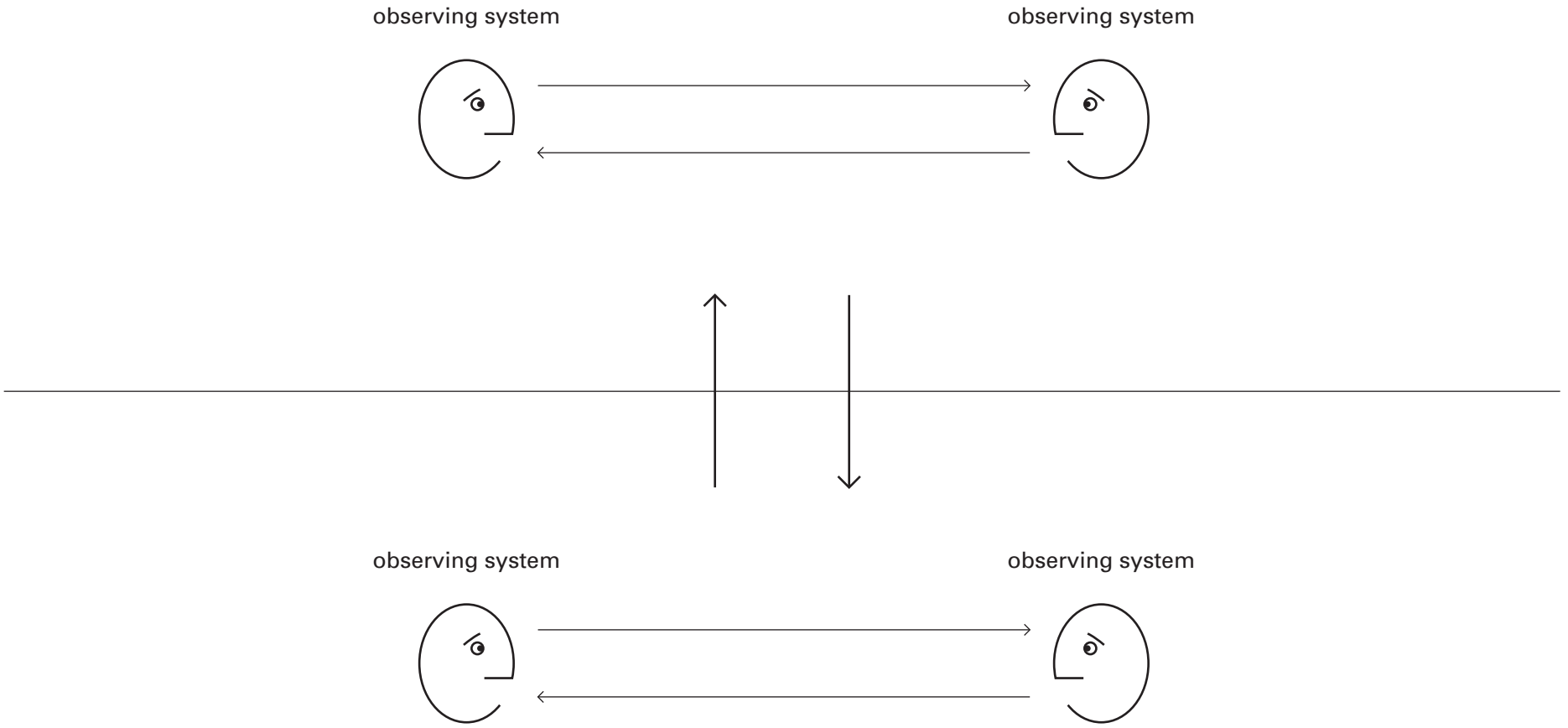
Upper exchange between participants who monitor (a.k.a. sense) and converse about the lower conversation (upward-facing arrow). These participants may choose to intervene (act) by interrupting the lower conversation (downward-facing arrow).

d. important aspects of model/breakthrough
The organization of this model acknowledges that conversations specifically, and interactions in general, take place on multiple levels—at least, according to an observer.

While the model allows for each observer/role to be a separate person, it is equally valid (and perhaps equally common) for multiple roles to be instrumened by the same person.

Conversations about conversations

Observers in the upper level may have a conversation about what they observe in a different conversation, shown here in the lower level. Participants in the upper level may be the same as those in the lower level. For example, one participant might say, 'That conversation we just had was interesting, wasn't it?'



‘Interaction’
after Pask and Pangaro

a. goal of model
The model casts the concept of ‘interaction’ in the framework goals and actions.

b. description
Multiple layers of interaction are shown (horizontal flows) as well as multiple participants (vertical boundaries). The emerging relationship between Participant A’s goals to B’s goals begins to form.

c. components and processes
A’s goals direct A’s actions. B interprets A’s actions and uses them to infer A’s goals. B compares B’s goals to inferred goals for A.

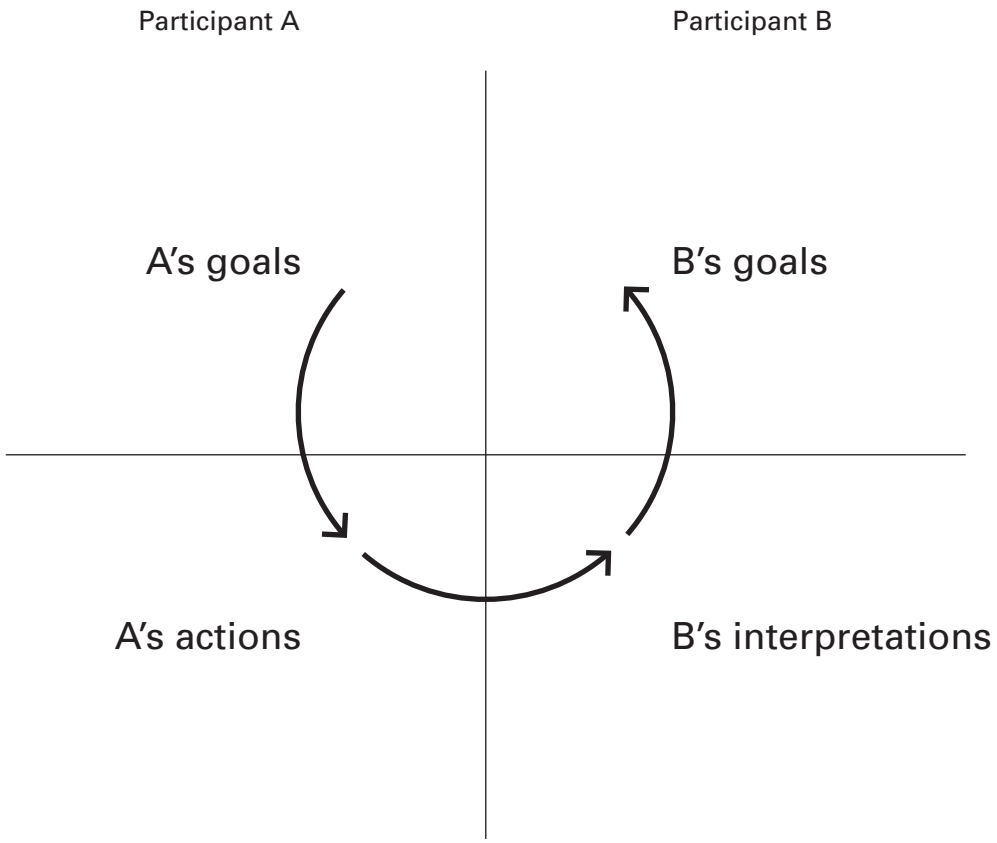
Actions may be physical movements or, as is most common in conversation, speech or writing or other modes of conveying language-based messages.

d. important aspects of model/breakthrough
The model shows how B does not have direct access to A’s goals, but only to A’s actions—actions which could be what A says about A’s goals. A may not be correct or honest—A’s actions may not reflect A’s goals. B’s interpretations may be also incorrect.

‘Interaction’

Participant B attempts to determine if A shares B’s goals.

B compares B’s goals to A’s actions.
(A’s actions may indicate A’s goals)



‘Relationship’

a. goal of model
The model casts the concept of ‘relationship’ in the framework goals and actions.

b. description
The reciprocal relationship between Participant B’s goals and Participant A’s goals builds from interactions that flow in both directions. By adding recursion and therefore history to initial, one-way interactions of the previous model, reliability of each’s models of the other is increased, (Contrast with the addition of redundancy to increase reliability, per Shannon model.)

c. components and processes
Similar to previous model, B’s goals direct B’s actions.
A interprets B’s actions and uses them to infer B’s goals.
A compares A’s goals to inferred goals for B.

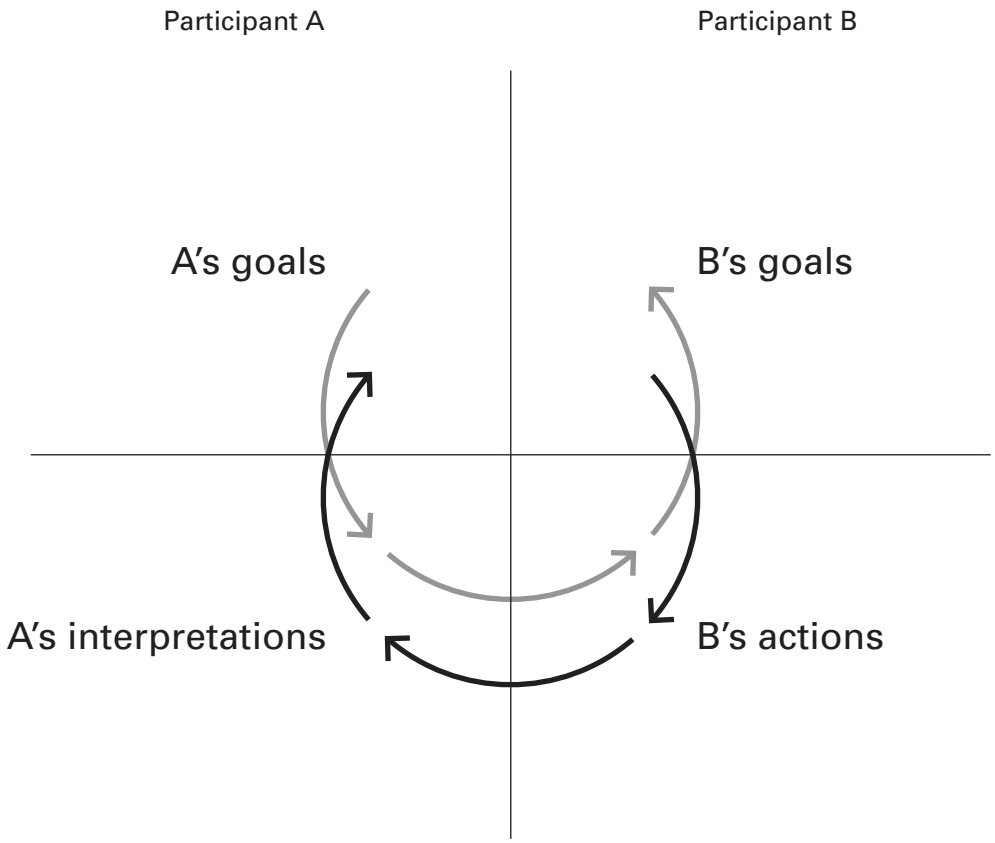
d. important aspects of model/breakthrough
Similar to previous model, this model shows how A does not have direct access to B’s goals, but only to B’s actions.

However, consistency of interactions over time may be sufficient for B to develop a sufficiently correct correct model of A. Should B’s goals be compatible with A’s, B may choose to cooperate or collaborate with A.

One aspect of the relationship may be the development of trust, that is, the judgment of the reliability of a belief about someone else.

‘Relationship’

Participant A develops A’s model of B’s goals.



‘Conversation’

origins

a. individuals

b. era/dates

c. references for model, context, author(s), concepts
W. Ross Ashby, Design for a Brain, Chapman and Hall, 1960.

d. examples

A. goal of model
The model casts the concept of ‘conversation’ in the framework goals and actions.

b. description
The close-coupled connection between goals and actions is shown to be fundamental to conversation.

c. components and processes
As before, goals lead to actions that result in interpretation and response among participants. Actions take place in the physical world, while goals do not. Goals, the province of cybernetics, are the “immaterial aspects” of interaction [W. Ross Ashby]. The dotted lines indicate that recursions via conversations are as if we are interacting directly at the level of goals, while in practice we are not. The interaction loops are shown as closed because there is coherence or consistency in recursive conversations over time, moving from goals to actions and back to goals. The loops are shown as overlapping yet separate because the participants may strongly agree and yet can never be identical.

d. important aspects of model/breakthrough
The interaction model is shown to bridge both physical actions and the less-intangible, ‘immaterial’ interactions engaged in by participants that possess language. Because participants are able to build stable models of others’ goals as a consequence of their relationship, coöperation and collaboration are possible.

‘Conversation’

Conversation: Basics

origins

a. individuals

b. era/dates

c. references for model, context, author(s), concepts
Gordon Pask, "Artificial Intelligence - a Preface and a Theory". Preface to chapter on Machine Intelligence, in *Soft Architecture Machines*, ed., N. Negroponte. MIT Press, 1975.

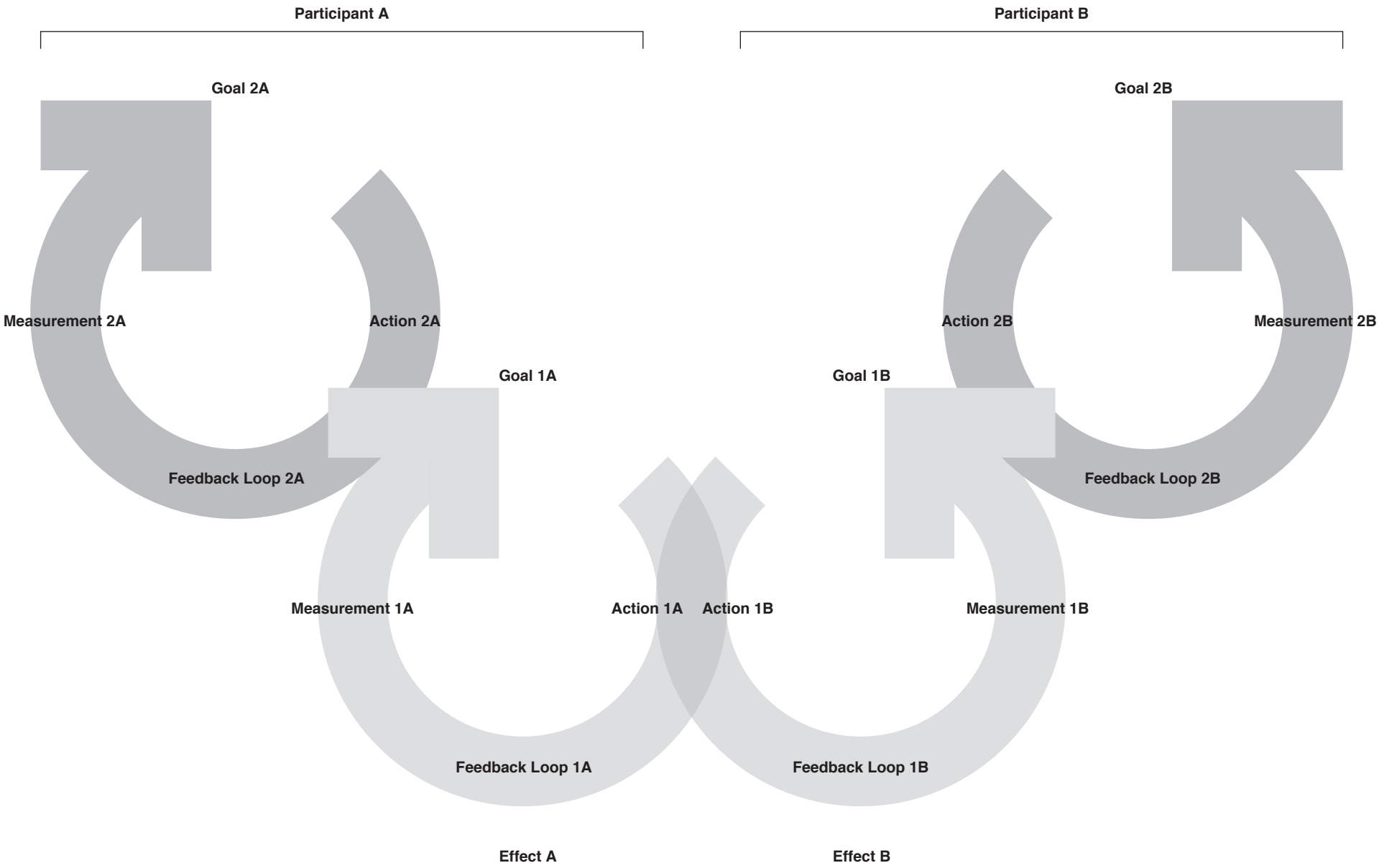
d. examples

a. goal of model
The model brings together the graphical form of the feedback models with the developing architecture of conversations.

b. description
As before, multiple participants interact at multiple layers, with feedback loops operating to build stable relationships and converge to shared goals (see also later models where goals are conflicting).

The horizontal layers are not controler/controlling relationships [see below] but may involve physical or linguistic interactions.

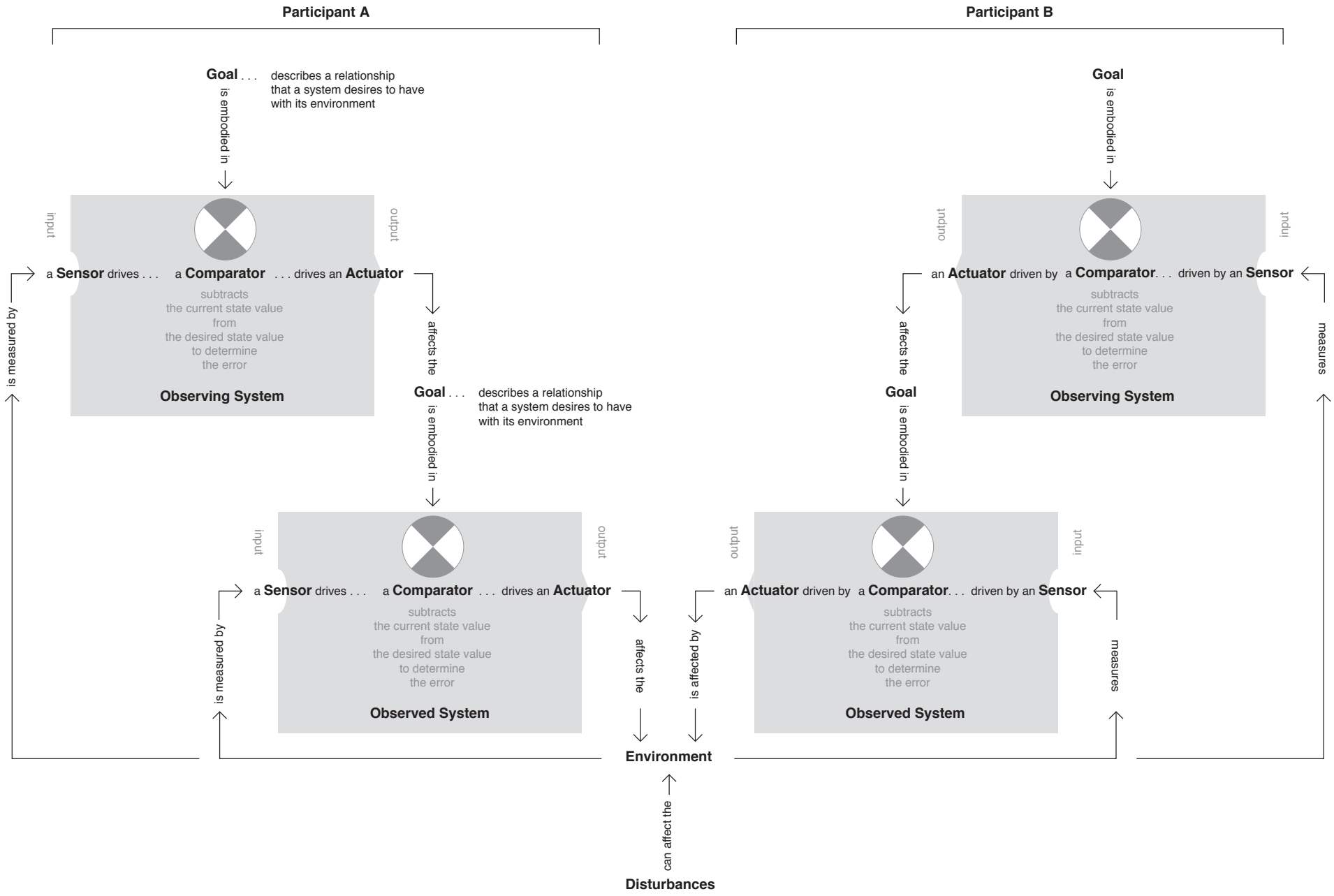
Conversation: Basics
after Pask



Conversation: Formal Mechanism

a. goal of model
As before, the basic cybernetic model is mapped out into the formal mechanisms involved.

Conversation: Formal Mechanism



Conversation: Biological Example

origins

a. individuals

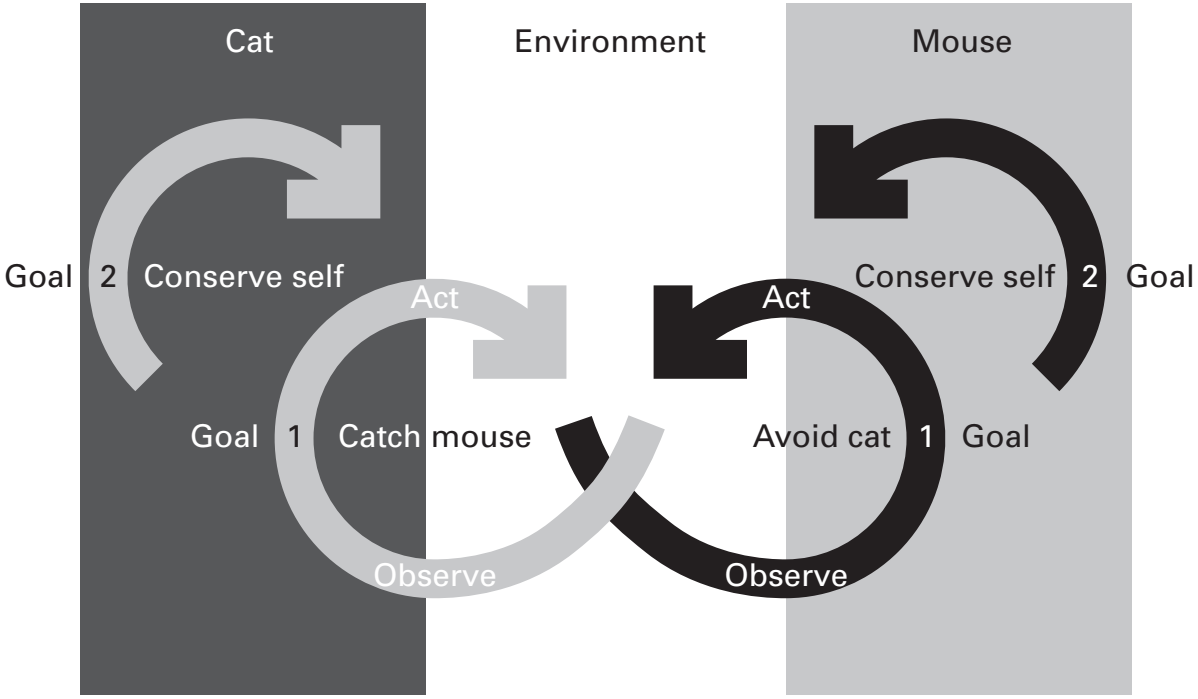
b. era/dates

c. references for model, context, author(s), concepts
Hugh Dubberly, Peter Esmonde, Michael Geoghegan, Paul Pangaro, "Notes on the Role of Leadership and Language in Regenerating Organizations", produced for Sun Microsystems, 2002. Available at http://pangaro.com/littlegreybook.pdf

d. examples

a. goal of model
The relationship between two biological systems, in terms of double-loops of goals and actions, is shown. The model applies the same double-loop, double-layer architecture to non-language interactions.

Conversation: Biological Example



The mouse teaches the cat.

The cat's nervous system
compels it to respond to every small thing that moves.

Trying to catch a mouse,
a cat observes the mouse's actions closely.
The cat actively learns
from the mouse's behaviors,
continually changing its capture strategy
in response.
So: The mouse teaches the cat.

Of course,
the mouse's behavior also changes continually,
in response to the cat's shifting tactics.
So: As the mouse teaches the cat,
the cat also teaches the mouse.

The cat's behavior may be thought of as a double feedback loop:

The first feedback loop defines the cat's catching behaviors. The second feedback loop dominates the first; it conserves the cat itself. (For example: The cat may want to chase the mouse out a window, but its system of self-preservation will prohibit that behavior.)

The mutual learning process is also
a double feedback loop:

Processing input from the mouse, the cat continually adjusts its capturing behavior, adaptively increasing efficiency and reducing noise in the message (that is, limiting extraneous actions). Conversely, the mouse changes its output based on the cat's input. As a result, the entire system evolves over time.

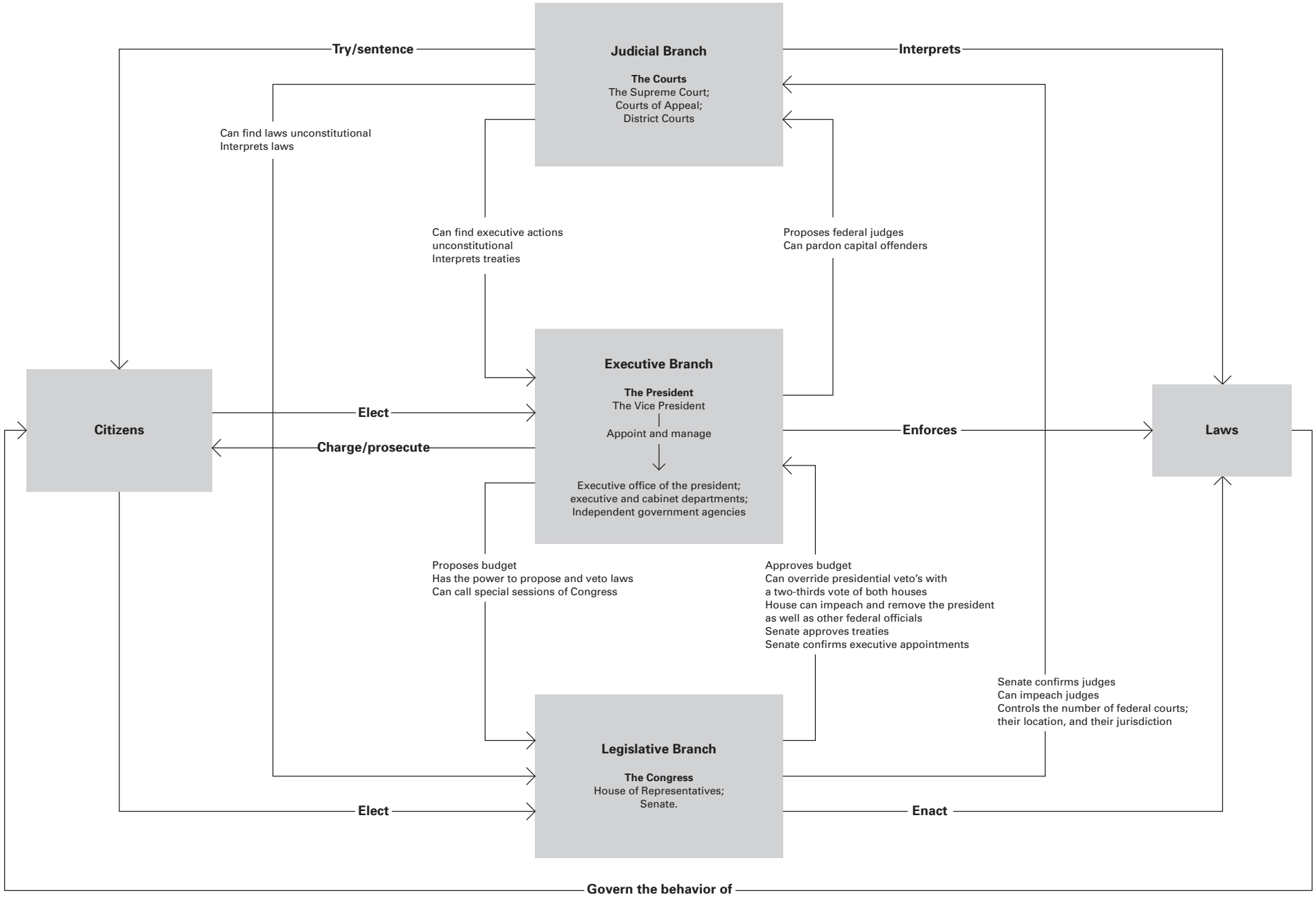
Checks and balances in the U.S. Federal Government

a. goal of model
The three branches of the US Federal Government is modeled as a series of interactions among the components.

b. description
This diagram is a departure from those above and below. Instead of showing the layered relationship in a conversational exchange, arrows indicate interactions among processes.

Checks and balances in the U.S. Federal Government

Feedback systems help each branch of the government balance the others.



Architecture of Conversation
Conversation Theory after Pask

origins

a. individuals
Gordon Pask and his collaborators at System Research, Ltd., England, including Dionysius Kallikourdis and Bernard Scott.

b. era/dates
The comprehensive theory was developed by the early 1970s. Published in 1976 in Nicholas Negroponte's Soft Architecture Machines.

c. references for model, context, author(s), concepts
Gordon Pask, "Aspects of Machine Intelligence", published as introduction to chapter in Soft Architecture Machines, Nicholas Negroponte (Ed.), MIT Press, 1976.

Paul Pangaro, "Architecture of Conversation Theory", at http://pangaro.com/L1L0/index.html.

Paul Pangaro, "A Model Of Entailment Meshes", at http://pangaro.com/ entailments/entailing-v2.htm

a. goal of model
The model explicates the interactions between "participants" in a conversation. Participants may be persons, schools of thought, or distinct viewpoints within a person. Their interactions can be classified by an observer as concerned with goals or methods.

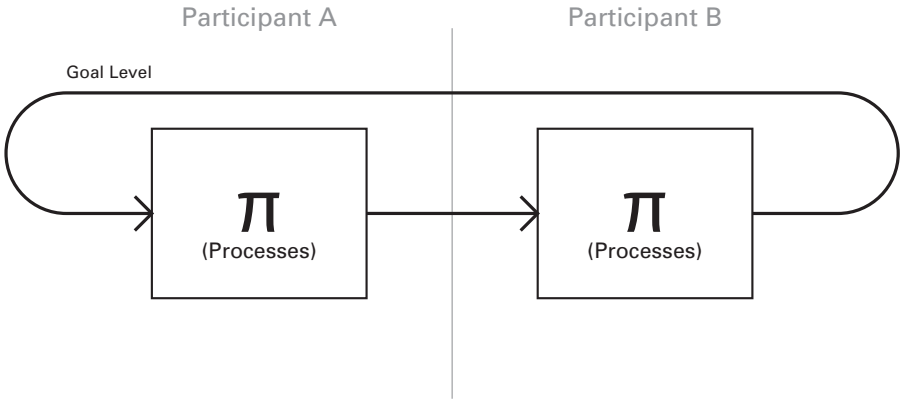
b. description
Conversation may take place between participants, here labeled 'A' and 'B'. The vertical line represents the distinction between the participants. The exchanges in language are shown as arrows that form a loop: A to B to A to B...

c. components and processes
Each quadrant contains a box with the symbol π; or "pi" that stands for "processes", namely, mental activities that manifest as knowing, believing, and acting, including language exchanges.

Each loop—the arrow from A to B and the closing by arrow from B back to A—represents triggers carried by language. The "traffic" of these loops occur in language, interpreted by the listener, for whom entailments are triggered and meaning is (potentially) made.

d. important aspects of model/breakthrough
The model shows how observers may distinguish conversational participants as well as levels of language in their discourse.

Conversation Theory
after Pask



Example:
A: Can I have a hamburger?

B: Sure, you want fries with that?

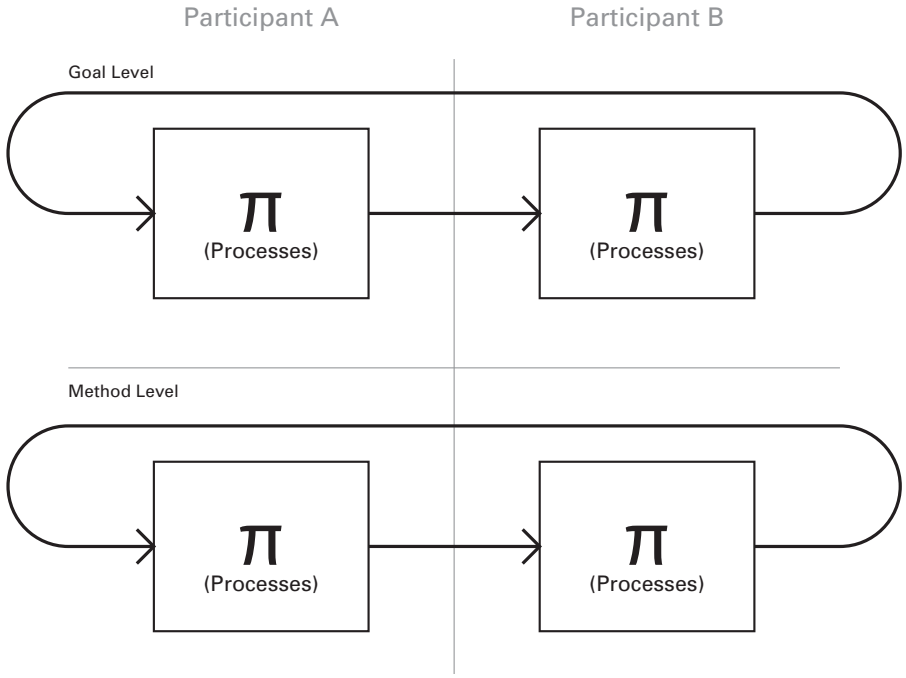
Architecture of Conversation
Distinguishing Goals and Methods

a. goal of model
Show the multiple levels that may be observed in a conversation.

b. description
An observer may classify conversational exchanges between A and B as about goals or methods.
Goals are desired outcomes. Methods are the ways participants may act to achieve goals. The horizontal line, drawn by the observer, distinguishes the levels.

c. components and processes
Each quadrant contains a box with the symbol π; or "pi" that stands for "processes", namely, mental activities that manifest as knowing, believing, and acting, including language exchanges.

Architecture of Conversation
Distinguishing Goals and Methods



Example:
A: Can I have a hamburger?

B: Sure, you want me to make you one here or get takeout?

Conversation (Objective)
Interactions with ‘it’

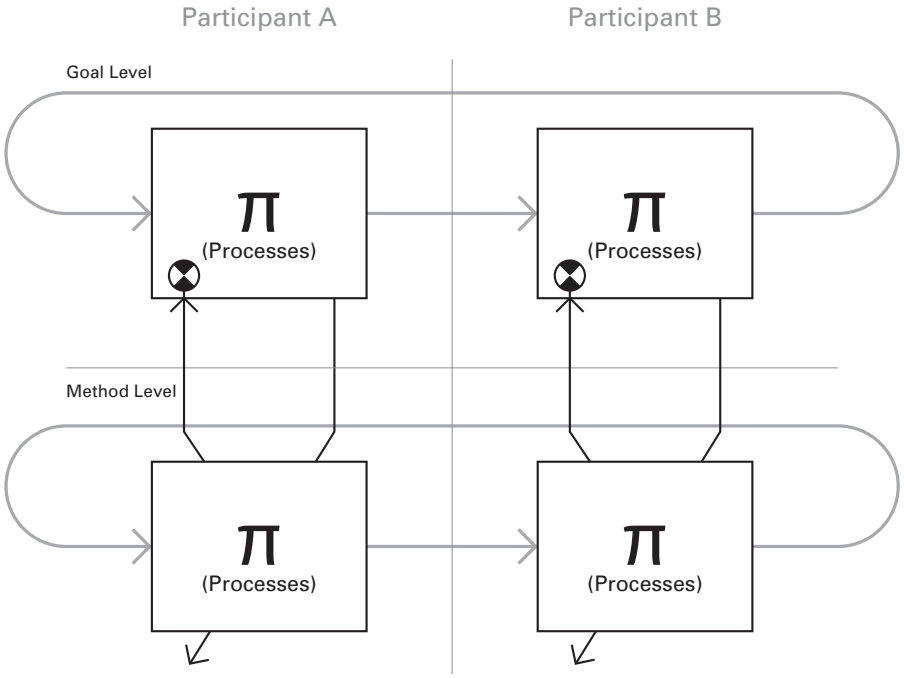
a. goal of model
To model those exchanges within a participant that are “control”, or objective, interactions.

b. description
The upper level treats the lower level like an object, that is, like an “it”. The lower level has no choice in the interaction; its goals are dictated. The vertical loops show that processes in the upper level control processes in the lower level. The loop is closed from lower to upper level via feedback of outcomes at the lower level.

c. components and processes
The upper process (“goal”) selects and initiates (“controls”) a lower process as a means to achieve the goal (“method”). The performance of the method yields a result (“current state”) that may or may not achieve the goal. Result of performance of the method is returned to the goal level as feedback, where comparison of the current state to the desired state leads to the next response/action of the system.

d. important aspects of model/breakthrough
In this model the relationship between goals and methods is shown as a “control” relationship. Contrast this model with Conversation (Subjective), Interactions between “I” and “you” (next page).

Conversation (Objective)
Interactions with ‘it’



Example:

A: (upper) I’d like to have a hamburger for dinner.

B: (upper) I’d like to eat chicken. I’ll go get takeout.

A: (lower) [Performs the actions of taking the meat out of the fridge, putting it on the grill, turning the grill on, watching until it’s done, etc.]

B: (lower) [Gets coat, leaves the apartment, walks to the takeout place, orders the food, waits until it’s done, pays for it, brings it home and then eats it.]

A: (upper) I’ve cooked the hamburgers and achieved my goal.

B: (upper) I’ve eaten the chicken and achieved my goal.

Conversation (Subjective)
Interactions that refer to ‘I’ and ‘you’

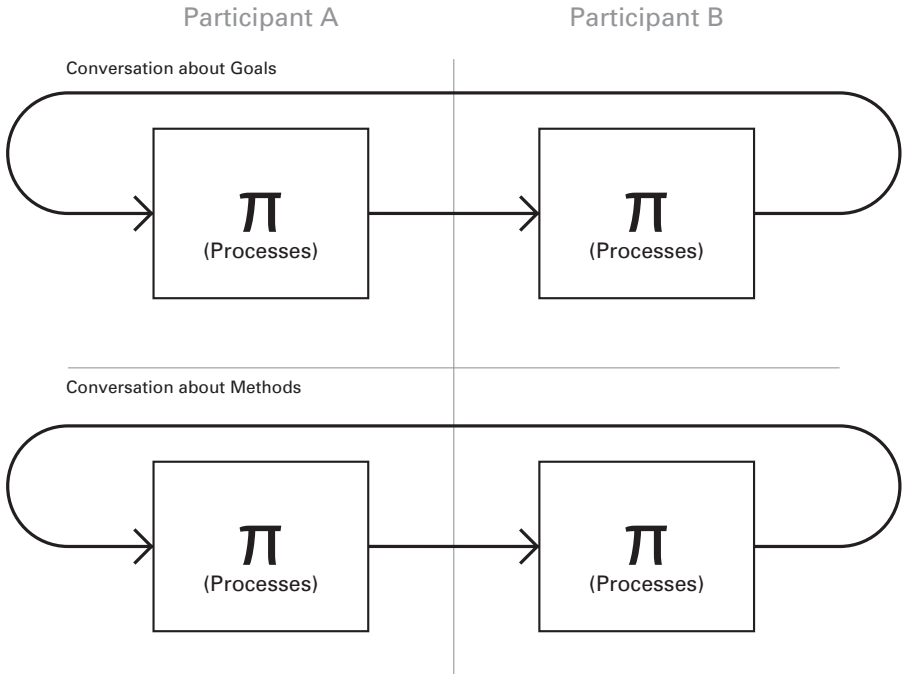
a. goal of model
The model distinguishes those exchanges between participants that take place in language. The experience for participants is subjective, i.e., it is subject to the limitations of language, constrained by individual interpretations, and may include misunderstandings.

b. description
The horizontal loops carry messages. The upper level may comprise exchanges about the whys or the goals of the participants: what they want to achieve and the degree to which they share the same goals. The lower level may represent exchanges about the hows or the methods to achieve the goals: what they might do to achieve goals and who might do it.

c. components and processes
The participants are the “I” and “you” of the title.
By looping around horizontally, the participants can build on previous exchanges and create a history and relationship. The relationship may include agreements to help each other define goals or define and carry out the methods to achieve the goals.

d. important aspects of model/breakthrough
This model shows that participants may choose to cooperate and to engage in conversation, or not. Contrast this model with Conversation (Objective), Interactions with “it” (previous page).

Conversation (Subjective)
Interactions that refer to ‘I’ and ‘you’



Example:

A: (upper) I’m thinking we might want to have hamburgers for dinner.

B: (upper) Well, ok. We had them last night. What about chicken instead?

A: (upper) Chicken is fine too.

B: (lower) We don’t have any chicken defrosted.

A: (lower) You could go to that takeout place and bring it back.

B: (lower) I went last time, so it’s your turn.

A: (lower) I’ve been twice recently.

B: (lower) Yes, ok, I’ll go after I finish reading my email.

A: (lower) Ok.

Conversation for Understanding
Explaining Concepts to others

a. goal of model
The model displays the levels of exchange required to bring about shared understanding among conversational participants.

b. description
Informally, a concept is a set of topics that 'make sense together'. Participant A wishes to convey a concept to Participant B with some level of confidence. This requires exchanges in language at 2 levels: Why and How.

[upper level] Why—the goal or purpose of the overall concept; this comprises a description of the role that each component or topic plays in the concept.

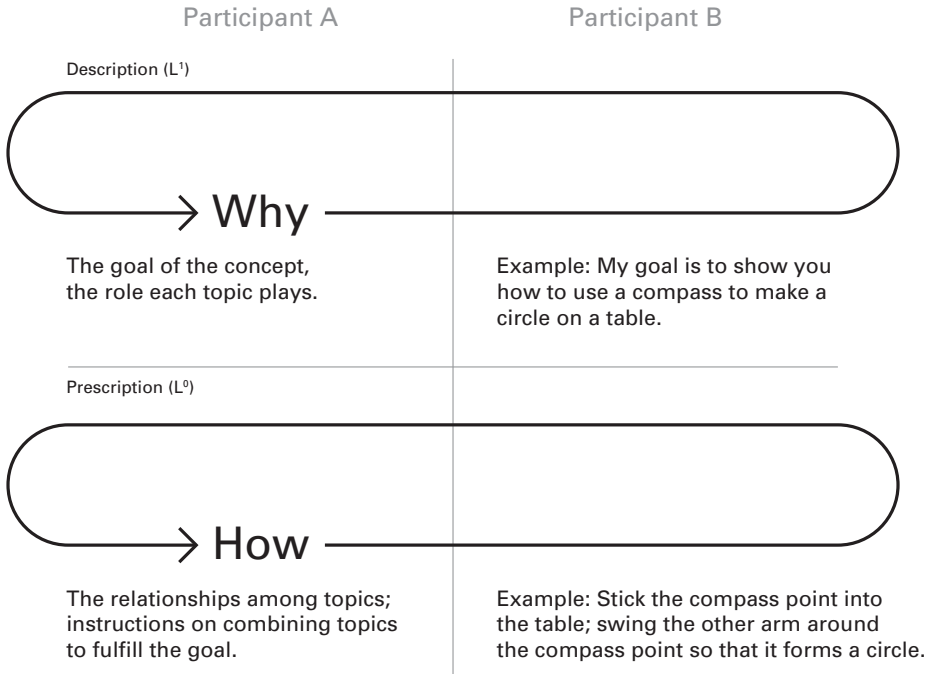
[lower level] How—the specific relationships among the topics; this comprises prescriptions (instructions) for how to combine the topics to fulfill the goal.

c. components and processes
Participant A comprises processes that embody the concept. These processes can be split into two (or more) levels. Processes at each level must be consistent with each other across levels, so that Participant B can, in any order:

i. understand the intention of the Why exchange
ii. situate the How exchange in the context of the Why;
iii. compare the consequences of the How and determine
that, in practice, the goal of the Why exchange is achieved
by performing the instructions in the How.

d. important aspects of model/breakthrough
The model visualizes the consistency that is required for Participant B to 'put it all together', to 'make sense of', and hence to 'understand' what A intends, based on what A says. Put another way, the exchanges do not carry meaning; rather, meaning is created by Participant B as a consequence of the guidance or triggers afforded by the conversation with A and as structured by the strict relationships among the components of the concept in the complementary aspects of Why and How.

Conversation for Understanding
Explaining Concepts to others



Collaboration on Goals and Actions

a. goal of model
The model explicates classes of conversational relationships.

b. description
[left] Conversation about goals and methods: Participants converse about goals and about methods to achieve them [see models above].

[middle] Cooperation to achieve goals: Participants ask each other to help achieve goals by performing necessary tasks [criss-cross].

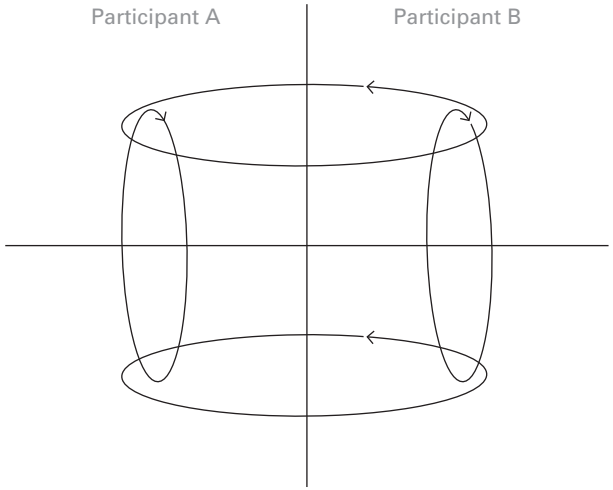
[right] Collaboration for common goals: Participants agree to collaborate on the formulation goals and agree on methods to achieve them.

c. components and processes
Horizontal and vertical interactions are as before. Diagonal interactions [middle diagram] are manifest in language but involve a "control" component in the sense that the receiver of the request to take action is not told the reason why the request is being made (the "goal") and does not participate in its formulation. The receiver may infer it, or choose to act anyway, or choose not to act.

d. important aspects of model/breakthrough
The figures constitute a taxonomy of interactive modes, from conversation, to cooperation, to collaboration.

Collaboration on Goals and Actions

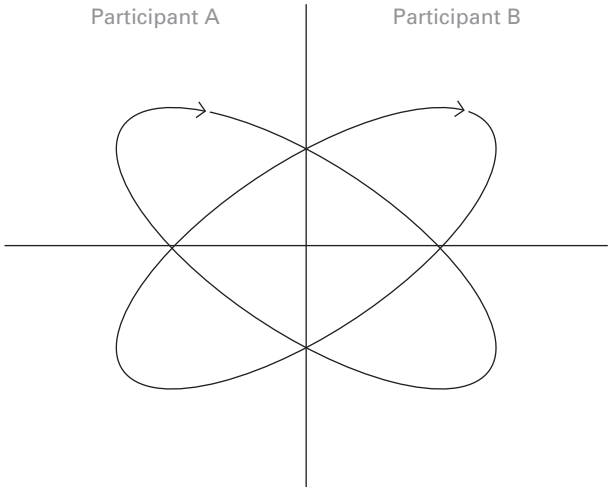
Conversation about goals and methods



Participants converse about goals and about methods to achieve them (horizontal loops). Internally, each participant checks for consistency in the conversation (vertical loops).

Example—A: (Upper horizontal) It's important that I avoid certain food allergies and minimize cholesterol. (Lower horizontal) So I buy the ingredients and prepare nearly all my meals myself.

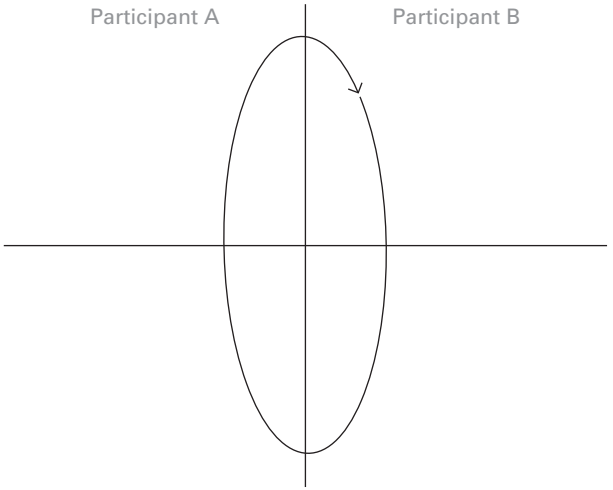
Cooperation to achieve goals



Participants ask each other to help achieve goals by performing necessary tasks (criss-cross). A's goals and B's goals may be different, but each agrees to help with the other's goal.

Example—A: (Upper left to lower right) Would you mind going to the store for me on your way home? I need some organic cabbage.
B: Sure. Think you can pick up my cleaning from downstairs?

Collaboration for common goals



Participants agree to collaborate on the formulation of goals and agree on methods to achieve them. In this sense, they merge to become a single system of goals and actions. In exchange for losing their individuality, they lower their individual biocost.

Example—A/B: Let's decide what to make. Then we can go together to the store to buy whatever ingredients we need.

Conversations (Objective Interactions)
Required Elements for an Intelligent System

a. goal of model
First of two diagrams that summarize Pask's architecture of conversation.

b. description
The figure enumerates the necessary interactions for a system to be 'intelligent', that is, to use feedback between upper and lower levels (vertical loop) to achieve its second-order goals. Existing or planned systems can be evaluated for their completeness, that is, to ensure they embody all the necessary components, A through F.

c. components and processes
See figure.

d. important aspects of model/breakthrough
The concept of 'intelligent system' is given a specific definition. Existing or planned systems can be evaluated for their completeness, that is, to ensure they embody all the necessary components, A through F.

Conversations (Objective Interactions)
Required Elements for an Intelligent System

A: "Controlling Process (alias goal)" is, for example, management policy defined at this level ("increase revenue by 4%") but carried out at another (see below). The distinction of levels is made in the course of the modeling process. The precise levels are chosen to display the flows of control and feedback that are of interest.

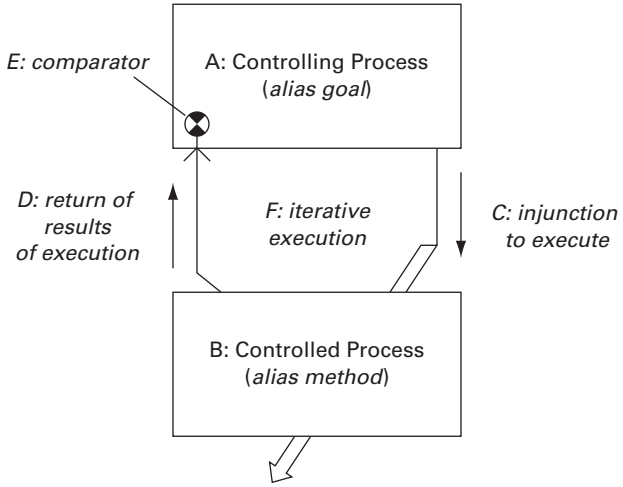
B: "Controlled Process (alias method)" is, for example, the increase of revenue via hiring more salespersons, as dictated by the level above.

C: "Injunction to execute" is the actual line of control that causes the lower level to respond, for example, the memorandum indicating start of a project or a budget authorization.

D: "Return of results of execution" is the actual feedback of information to the higher level, as for example a report indicating results of specific manufacturing procedures, or an internal survey.

E: "Comparator" is the specific mechanism whereby the feedback information is used by comparing the actual result to the desired result, or original goal.

F: "Iterative execution" of the entire loop takes into account the result from the comparator above, that causes changes in various processes, flows of control and feedback, etc., to make the entire loop more effective.



Closure occurs when comparator confirms execution of controlled processes is coherent with controlling processes (as when a goal is achieved by executing a successful method)

If all of the above aspects are present, the system of interactions is deemed "intelligent."

It must be emphasized that the two levels shown are only two of (possibly) many vertical levels; modeling by the observer leads to distinguishing multiple vertical layers in the conversation. Hence a box that appears at a "lower level" in one interaction may itself be at the "higher level" relative to a further box that appears below it.

Conversations (Subjective Interactions)
Required Elements for
Language-oriented Interactions

a. goal of model
Second of two diagrams that summarize Pask's architecture of conversation.

b. description
The figure enumerates the necessary interactions for a system to achieve a reasonable degree of certainty that it is understood by another system. In practice, this requires interactions at a minimum of two levels in language exchanges (horizontal loops).

c. components and processes
See figure.

d. important aspects of model/breakthrough
It is important to note that references to "goal" or "method" are relative to any pair of vertical boxes; changing level by moving up or down the hierarchy changes the attribution of "goal" or "method" for a given box. These attributions are always relative to a specific neighbor.

Not shown for simplicity in the figure are potential responses, from right to left, to any given communication. In the general case, the entire relationship is completely symmetrical.

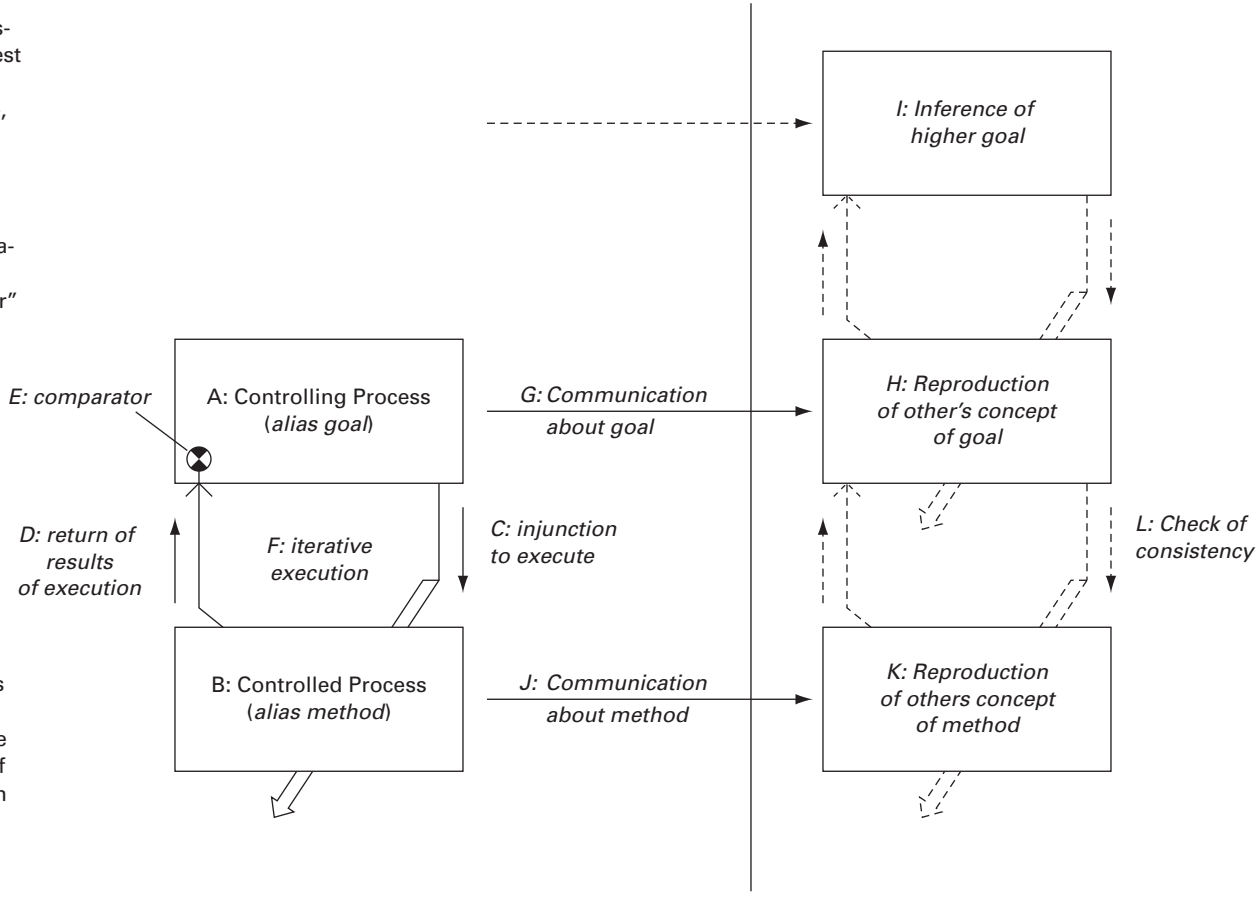
The figure completes the Conversation Theory model that encompasses subjective (horizontal) and objective (vertical) interactions in conversational systems that have second-order goals and use cooperation and/or collaboration to achieve their goals.

Conversation (Subjective Interactions)
Summary of Elements

G: "Communication about goal" is, for example, the communication to a customer that the company's value proposition expressed via its advertising is to provide products with the best cost/benefit ratio, or durability, for a given application; or, to an employee, that the company considers the employee to be an essential asset for its future.

H: The actual result of the communication is different than what came from the "sender." ("Sender" and "receiver" are held in quotations to retain a different meaning from that of information theory.) The "receiver" attempts "Reproduction of other's concept of goal" but this may not be accurately achieved.

I: "Inference of higher goal" is the production of a higher goal for which the previous interaction is consistent and affirming. This is as if the "sender" had actually exchanged something (shown as the upper, dashed arrow) but in fact nothing has actually been "transferred" at this level, up to this point. Quite often, the context or the common experience of the two conversants provides enough for a higher-level goal to be correctly inferred. However, sometimes the "sender" creates a false context to encourage an incorrect inference, as for example when advertisers imply a food product is healthy simply because it uses the word "natural", or when a participant simply states "I have your interests at heart" while not having demonstrated this to be the case.



J: "Communication about method" is, for example, the communication to a customer about the details of a product's capabilities (which should affirm its stated goals, G); or, an exchange with an employee about the details of working conditions and health benefits from the corporation, which should show the method by which that employee is to be considered an asset to the corporation, relative to the goal as communicated in G.

K: "Reproduction of other's concept of method", as in H above, is subject to interpretation and later modification.

L: "Check of consistency" is a reproduction in the "receiver" of the entire vertical loop of the "sender". This may show the consistency across the upper and lower levels, and thereby affirm understanding of the "sender's message." Of course, this can only be (at best) very close and (at worst) only a small fraction of the intended message. Alternatively, the consistency check can expose the inconsistency between communicated goal and method. For example, the loss of retirement pensions or erosion of healthcare coverage would contradict the assertion that the employee is a valued asset to the corporation. The "receiver" can either make queries back to the "sender" about intended meanings in order to clarify understanding (not shown in the diagram); or maintain a model of the perceived inconsistency in the "sender."

Du Pont Goal Structure
Snapshot 1910 to 1940

origins

a. individuals
Developed by Paul Pangaro for Dr. Michael C. Geoghegan, Research Fellow, Du Pont.

b. era/dates
The models were developed in the late 1980s as part of a enquiry funded by Geoghegan to explain the degradation of employee experience from his early employment, in the 1960s, to the time of this modeling exercise.

a. goal of model
The model explicates the goal hierarchy that was implicit in the management philosophy and organizational structure of the Du Pont company between 1910 and 1940.

b. description
After World War I, when Du Pont had again made huge profits by supplying explosive materiel to a major armed conflict, the decision was made to focus on the mission of achieving growth through diversification (top-most process box). All subsequent processes (sub-goals represented by lower-level boxes) were consistent and effective means to carry out that mission. Not shown are the forces that moved the organization toward the new mission: anti-trust pressure plus innovations that were made possible by recent innovations in macromolecular chemistry.

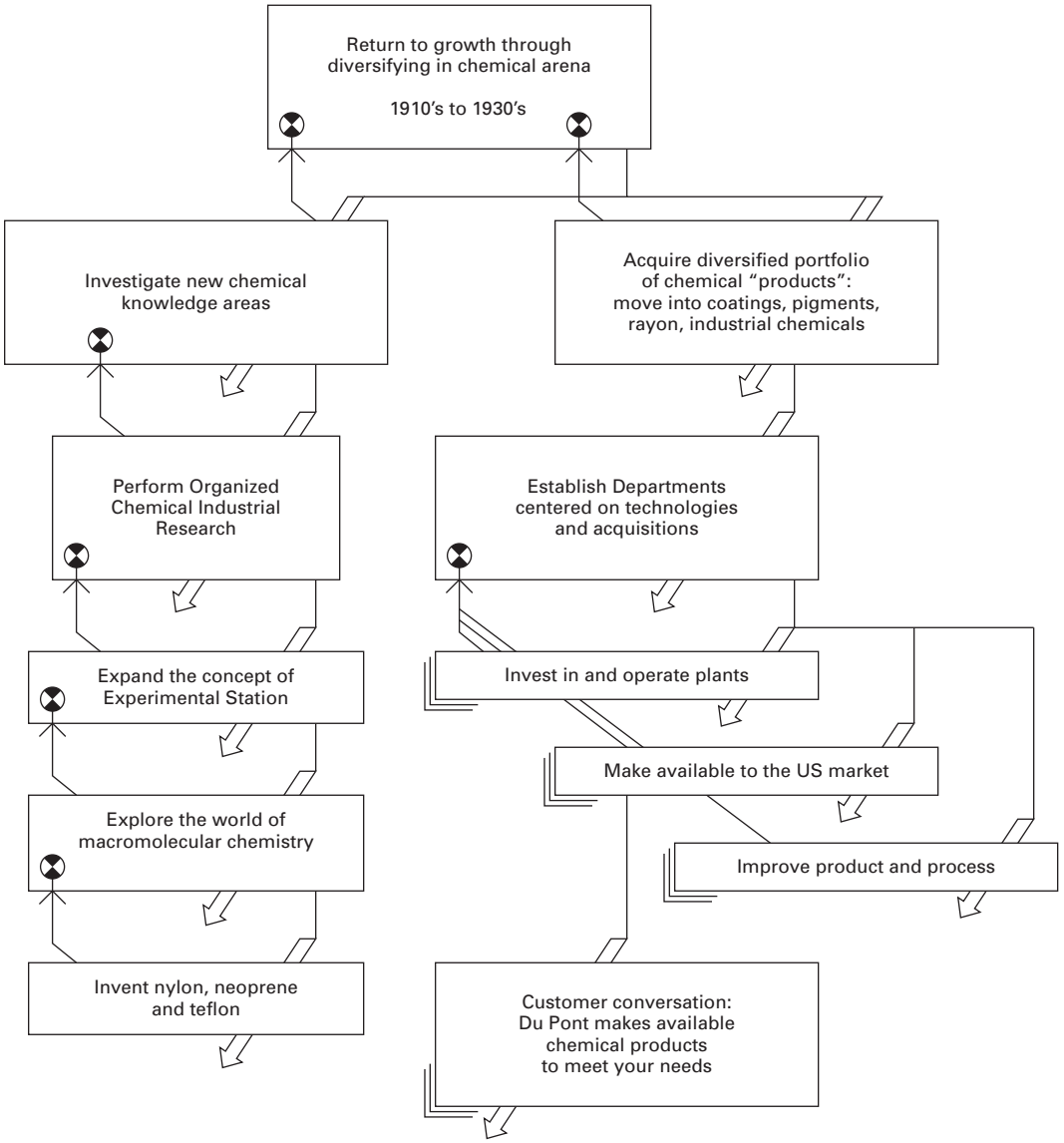
c. components and processes
Each level in the figure controls ('dictates') the processes at levels below it. The result of performing the processes at a given level are returned as feedback to upper levels to steer the processes to achieve their goals.

The organization is fundamentally divided between research (left side) and production (right side).

d. important aspects of model/breakthrough
A rare example of post-hoc examination of organizational evolution, this model offers an explanation as to why Du Pont was successful in this period: because of the consistency of the structure and processes of the organization in relation to its mission.

Du Pont Goal Structure
Snapshot 1910 to 1940

Laid the foundation for a new business—
'invention' phase.



Du Pont Goal Structure
Snapshot 1940 to 1975

a. goal of model
The model explicates the goal hierarchy that had evolved in the management philosophy and organizational structure of the Du Pont company between 1940 and 1975.

b. description
Success in research explorations in macromolecular chemistry led to the ability to mimic natural products—cotton, rubber—in the form of synthetic "knock-offs"—nylon, neoprene (central box). The organization shifted in response, developing the mission of "Better Things for Better Living through Chemistry", which was both the company's advertising slogan and a literal mission consistently carried out by the organization. Not shown are post-WWII demand growth of consumerism, creating huge demand for Du Pont's output, which in turn caused increased focus on controlling manufacturing, and the rise of paternal attitudes toward its industrial customers to the effect that "Du Pont provides solutions to your needs."

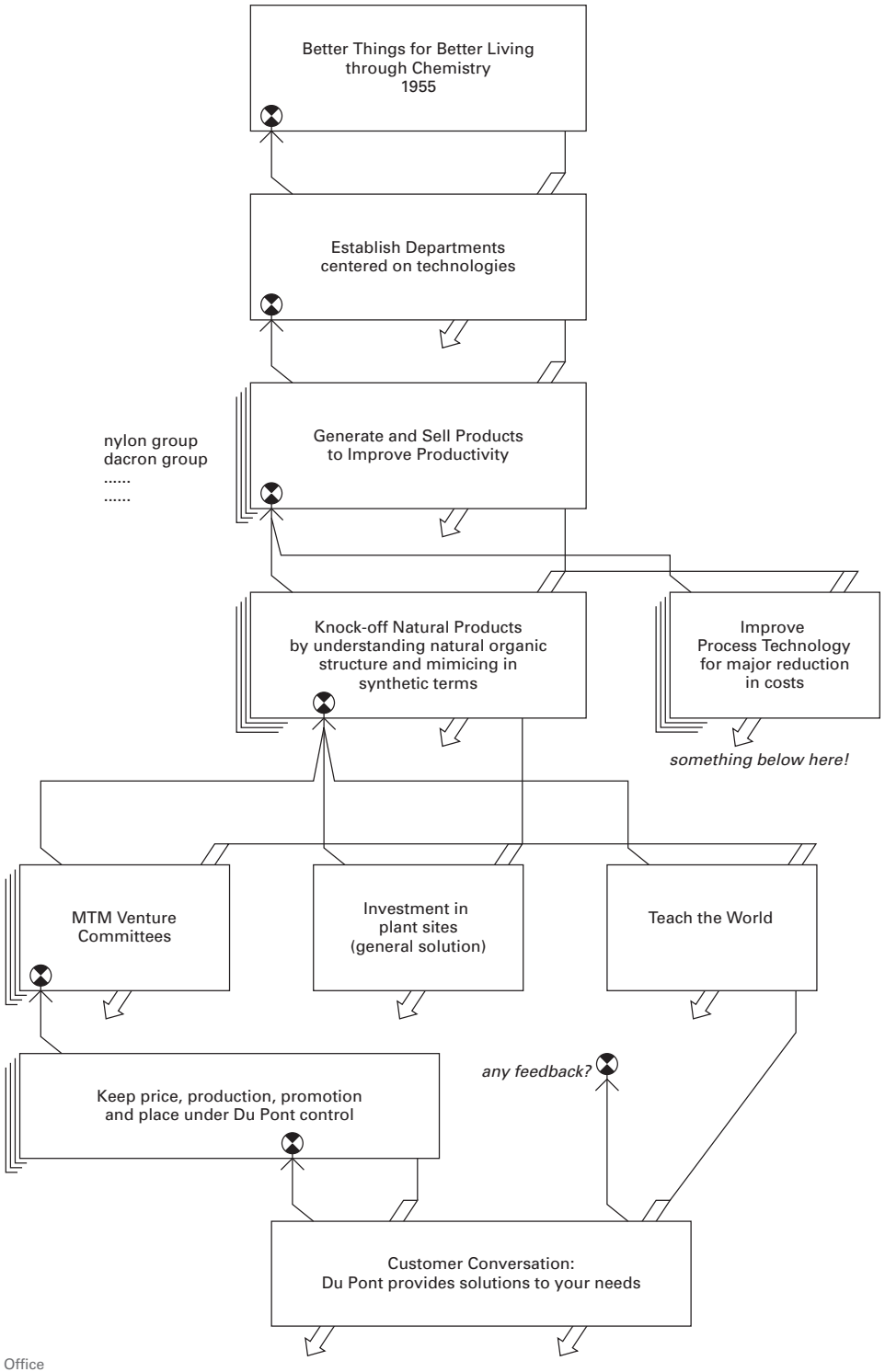
c. components and processes
Model components of control and feedback as before.

Research, though still a significant expenditure, is de-emphasized in this phase. Note the beginning of the unraveling of goal/method consistency as the organization fails to monitor feedback from customer conversations in relation to its paternal stance (bottom process).

d. important aspects of model/breakthrough
The reassignment of focus and resources from the previous phase is relatively smooth. However, in the new structure are sown the seeds of later failure.

Du Pont Goal Structure
Snapshot 1940 to 1975

Built on the foundation—
'discovery' phase.



Du Pont Goal Structure
Snapshot of 1980's

a. goal of model
The model explicates a major shift in mission for Du Pont, as a direct consequence of previous phases.

b. description
With fewer new products coming from research, the company was forced to focus on earnings as its primary mission in order to maintain viability. This causes another change in structure and priorities, reflected in the progression from mission (top box) to the methods for achieving that mission (subsequent levels below top).

Not shown is a major shift in the philosophy of management promotions: formerly, successful chemists became executives, whereas in this era MBAs and other businessmen [sic] rose to power. Research innovation diminished because of the relative maturity of macromolecular chemistry; that is, little new could come from chaining molecules together because all the possibilities had been explored.

c. components and processes
Model components of control and feedback as before. The earlier dual structure of research & production evolved to a relatively monolithic focus on earnings. Note the continued unraveling of customer relationships as sales processes were immune to hearing of changes in customer needs, and the organization overall would miss new competitive threats and opportunities to collaborate with its customers.

d. important aspects of model/breakthrough
The company is disconnected from the market and loses any ability to understand or respond to continued market pressures. The number of employees shrinks to one-half that of the 1960s, further evidence of loss of preeminence.

Du Pont Goal Structure
Snapshot of 1980's

Milked the existing structure—
'efficiency' phase.