The law of requisite cognitive capacity in human communication, conflict resolution and cooperation solicitation

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Abstract

The author identifies a Law of Requisite Cognitive Capacity in human communication, conflict resolution, and cooperation solicitation. Based on Ashby's Law of the Requisite Variety and Jaques's theory of cognitive capacity and by combining the author's previous work on the cognitive model of improving communication efficiency, a quantitative limitation for people to understand each other can be identified. On the Jaquesian Cognitive Capacity Strata, it is necessary for the person on a higher stratum to make extra efforts to explain/translate his/her mental model for the person (or P-individual) on a lower stratum, using the language/mental model available at the lower stratum. Without such explanation/translation, the person on a lower stratum cannot cognize the mental model being used and will misunderstand, therefore effective communication cannot be achieved. The existence of such limitation explains a number of interesting social and organizational phenomena.

Introduction

A hypothesis usually links two observations (or one observation with one explanation) into a relationship of causality (i.e., an explanatory model,) that then can be used to extrapolate to predict new phenomena, which can be confirmed (for the time being) or falsified (forever) by new observations. In a similar construction, I am trying to build a linkage among three theoretical elements: W. Ross Ashby's Law of Requisite Variety (Ashby, 1958), Elliott Jaques's hypothesis of Stratified Human Cognitive Capacity (Jaques, 1986), and the constructivist cognition-based model of communication I built to help improving effectiveness and efficiency of communication (simplified as the Communicatics Model) (Hu, 1993, 1995).

The result of integrating these three elements suggests an interesting hypothetical theorem that may be useful for people studying human communication, conflict resolution and consensus building in an organizational development context. A number of preliminary cases of observation seem to support this theorem, which can be called the Law of Requisite Cognitive Capacity. This theorem highlights a specific pre-requisite when dealing with communication issues: When trying to communicate to a person functioning at a lower Jaquesian stratum of cognition capacity, one needs to always put in extra resources to translate one's original language or representation of the issue into the language being used in the other communicator's stratum. On the other hand, when one is receiving communication from a person who functions on a lower Jaquesian stratum, one must be aware of the need of using more tolerance, patience or respect measures in order to really hear what is being

said.

A typical example would be the conversation between parents and children: The parents need to use a language appropriate to the children when making suggestions or giving advice; they also need to use more patience in their listening to really understand what the children are talking about.

This pre-requisite sounds intuitive and simple at the first glance, or may be thought as arbitrary or insignificant especially in the case of parents-children communication. But according to Jaques, a person's cognitive capacity develops/matures on a certain trajectory over their life time, so any two communicators may stand on different levels/strata of cognitive capacity, not much different from the parent/child case.

Therefore, by reviewing the findings from Ashby and Jaques and integrating their essences into the Communicatics Model, we can find that such pre-requisite is a quantifiable and required pre-condition for any successful communication involving people functioning at different Jaquesian strata.

Ashby's Law of the Requisite Variety

In "An Introduction to Cybernetics" published in 1956, W. Ross Ashby presented the Law of Requisite Variety (LRV) in rigorous mathematical language (Ashby, 1956) about the limit of successful regulation. Simply interpreted in daily language, it tells us that in the relationship between a regulator and the system being regulated, the variety (distinguishable number of possibilities) of the regulator must be equal to or larger than the variety of the system being regulated, so that the regulator could possibly achieve its goal of regulating this system.

For example, a manager with a certain capability of producing effective decisions must come up with a number of possible solutions equal to or greater than the number of possible problems that may happen in the factory he/she manages, so that the management could have a chance to be effective.

LRV received wide attention and was considered one of the most important findings in the field of cybernetics. It was more general, thus having a wider application area, than Claude Shannon's Tenth Theorem of Communication in Information Theory (Shannon, 1949). Based on LRV, another Conant-Ashby Law about regulation was developed later, which says "every good regulator of a system must be a model of that system." Therefore, "…the living brain, so far as it is to be successful and efficient as a regulator for survival, must proceed, in learning, by the formation of a model (or models) of its environment" (Conant & Ashby, 1970). Figure 1 illustrate the relationships of a regulator and a system being regulated, with other three elements—disturbance from the environment, outcome from the system being regulated and a preset standard indicating the goal of the regulation, based on ideas of Ashby and Conant.

It is interesting to point out that the topics about information, variety, and the number of available choices in construct meanings from data or messages is frequently interrelated in one way or another with the topics of regulation, communication, and conflict resolution. In later sections we shall examine how LRV could also contribute to the effort of improving the effectiveness and efficiency of human communication.

Figure 2 illustrates an isomorphic relationship applying the Ashby-Conant idea to the situation of communication. Communicators A and B take the role of the regulator, and the system being regulated during their communication, 'original meanin' in place of 'standard', and 'desired understanding' in place of 'desired outcome'. Based on this relabeling,

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Fig. 1: Figure 1

Ideas of Ashby and Conant

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Fig. 2: Figure 2

Ashby and Conants's Ideas Applied in Communication

the Law of the Requisite Variety can be used in cases of communication.

Jaques's Theory of Cognitive Capacity

Elliott Jaques authored RO theory (Requisite Organizations), arguing that human capacity for leadership depends on the development of cognitive power which can be measured with "time-span". Time-span refers to the time frame of the individual within which one operates/plans ahead. His research indicated that adult individuals vary radically in terms of the time periods they can think out, organize, and work through. He believed that this time frame is the best indicator of a mental capability, described in several different terms such as "intellectual capability," "cognitive power" or "cognitive capacity." In this paper I prefer to use "cognitive capacity" to capture this faculty since our focus will be on its influence in the communication process—a process that I see as a special case of cognition that invokes a certain capacity of the hardware (the brain) and software (the working mental model).

In addition to the different time frame that every person functions within, Jaques's main hypothesis was that everyone does not mature along the same track of cognitive development, some maturing further along the track than others. Jaques proposed a theory of multiple track cognitive development. He concluded that "cognitive development differs from intelligence quotient (IQ), and that it occurs regardless of social and economic opportunities for exercising cognitive power (Jaques, 1986). The discontinuous leaping developmental stages were summarized by Jaques in eight observable strata, shown in Table 1.

In a later, more comprehensive book, Jaques updated the terminology he used in this structure. The four logical types remained the same, but the "Unit of Thinking", now called "Orders of Information Complexity", increased from four to six (Jaques, 2001):

- 1st: Here-and-now tangible entities (this coin, this dollar bill);
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- 2nd: Intangible entities and collection of tangible entities (money, rent);

- 3rd: Categories of intangible entities (investment, budget,);

- 4th: Abstract Concepts: Categories of categories of intangible entities (corporate financial status?);

- 5th: General Principles: Categories of categories of intangible entities (business strategies, business financial plans);

- 6th: Universals (market economy, democracy). The level of true genius.

As I was writing this paper, I had email conversations discussing Jaques's theory with Professor Jerry Harvey, who was a close friend of Jaques for many years, and Professor Sergey Ivanov, who worked with Jaques during his last years. Ivanov provided me with an important but unpublished working paper that Jaques wrote after the previous book cited, in

Figure 3

Cognition based Communication Model (Communicatics Model)

Stratum	Time Frame	Related logic type	Other descriptive terms used
I	1d-3m	B-1 Symbol-Assertive	Ability of shaping
II	3m-1y	B-2 Symbol-Cumulative	Reflective articulation
II	1-2y	B-3 Symbol-Serial	Extrapolation
IV	2-5y	B-4 Symbol-Parallel	Shape the whole systems
V	5-10y	C-1 Concept-Assertive	Transformation of systems
VI	10-20y	C-2 Concept-Cumulative	0.03% of population (for age 21-70)
VII	20-50y	C-3 Concept-Serial	0.005% (for age 21-50)0.045 (for age 51-70)

Stratum	Time Frame	Related logic type	Other descriptive terms used
VIII	50-100y	C-4 Concept-Parallel	10/million (for age 21-50)90/million(for age 51-70)

which he re-arranged the descriptions of the Order of Information Complexity into five orders (Jaques, 2002):

- 1st: Tangibles: (that can be pointed to and touched) (this coin, this dollar bill);

- 2nd: Intangibles: categories of things and peoples (money, rent);

- 3rd: Related systems of intangibles: intangibles tied together in unified systems (investment, budget);

- 4th: Continuously changing intangibles: "…intangibles which are themselves dynamic in the sense that they are continuously changing to make for a constructed world that models an approximation to relevant on-going changes that are currently 'out-there'." (corporate financial models/strategies);

- 5th: Related systems of continuously changing intangibles: "e.g. construction of a general theory such as the laws of motion, a theory of relativity, or quantum theory; or geopolitics." (market economy, democracy).

It seems that Jaques never finished re-constructing/improving his theory. Interested researchers could continue digging out the intellectual treasure he left behind. In this paper, however, I shall focus on and borrow his discovery of the discontinuity of the development of human cognitive power expressed as different strata, which I prefer to call cognition capacity strata, and discuss its implication on the topic of conflict resolution. In my opinion, the words "capability" or "power" sound more subjective, the word "capacity" highlights a connotation of "limitedness" that captures the essence more accurately, and will be more compatible with other elements to be used.

Although Jaques's theory has caused a number of controversies and was even "tabooed" in some academic communities, still, research reports kept providing support to his ideas. According to Karl Popper, theories can be taken as true before they are falsified. Even I'm still not clear how to put Jaques's theory to a falsification test; I shall take the risk of using it as a working hypothesis, assuming it is valid and thus useful for developing a new application of it. Moreover, I suggest that Jaques's theory is a good extension of Piaget's cognition development theory besides a number of post-Piagetian or neo-Piagetian efforts: While Piaget's classic works were focused on the period from birth to the age of 12 (puberty) of the human cognition development, Jaques discovered that such development would actually continue through the whole adult life span. Thus, all human beings are created equal, but they develop differently. This might not sound politically correct for some, but are worth the serious attention of all social scientists.

Cognitive Model of Improving Communication Efficiency

The third part of the intended integration in this paper is a cognition based model of human communication. There were several different and popular models explaining the phenomenon or dynamics of human communication (i.e., Ruesch & Bateson, 1951; Schramm, 1954; Westley & MacLean, 1957; Berlo, 1960; McCroskey, 1968). These models treat communication process as "coding-decoding" or "sending-receiving" processes in a more or less mechanistic point of view. The model I propose applies findings in Self-organization System Theory, Second Order Cybernetics, and takes a constructivist philosophical standpoint. Communication process is viewed as two interactive cognition processes of the two communicators influencing each other, each constructing the "meaning" of the other side through data/information/meta signals detected from the other side.

Signals, words, descriptions, and meta-language gestures presented by one communicator, representing messages, intentions, requests, explanations etc., are to be *re-cognized* by the other communicator's cognition system. Such a system consists of not only all sensory channels, but also (at least) an internal mental model (about the current environment), a set of epistemological lenses (cultural values, believes, observation guiding principles), and a set of reactive-responsive styles (social styles observable in interactions). This process is neither "receiving" nor "decoding" but re-cognizing, i.e., actively constructing something as the result of "receiving" the communication from the first communicator.

The new model highlighted the (subjective) constructive behavior of the listener, offering a hint to the speaker that, no matter how perfect s/he think her/his communication is delivered, delivery is just half of the work. The other side has to perform an almost equal amount of information processing within her/his cognition system to hopefully make this communication effective. There is not any "thing" being passed through the "communication tube" from one side to the other. It is only a coordinating effort initialized by one side aimed at achieving desired coordination with the other side, who will perform a series of cognition/action tasks during the session. Quoting Maturana and Varela: "…saying does not ensure listening. From the perspective of an observer, there is always ambiguity in a communicative interaction. The phenomenon of communication depends on not what is transmitted, but on what happens to the person who receives it. And this is a very different matter from 'transmitting information.'" (Maturana & Varela, 1992: 196)

Figure 3 illustrates the idea of my model. Within a same environment (E) two persons trying to understand each other through an interplay of one person's motor/action channel (R, stands for "regulatory") and another person's sensor/cognition channel (P, stands for "perceiving"), and vice versa. Inside each brain, there is one mental model (M) about the outside world including the other communicator. This model (or theory or worldview) is directing or influencing the processes in the cognition channel and action channel with its unique ways. Intentions or purposes or understandings within one brain are, if their interactions are done right, being re-constructed, or if done wrong, being mis-constructed, within the other brain, in a continuing, circular process. In this model, there is nothing concrete going through a "tube" to another side, nor can the process be viewed as a "coding/decoding" process. Highlighting the reconstruction-on-the-fly brings our attention to the problem of "you may know a lot, but you don't know how right you are," i.e., the likelihood that the re-construction of the "receiving" party could be wrong or very wrong if the raw materials, or context, and the construction methods or types of logic, are not sufficiently similar to the sending party.

I have named this model "Communicatics Model" to eliminate the need to explain it each time it is referred, and to avoid it to be called "Hu's Model" since it contains insights from a number of scholars: W. Ross Ashby, Heinz von Foerster, Elliott Jaques, Gordon Pask, Humberto Maturana and Francisco Varela, among others (Hu, 1995).

One of the possible advantages of this model is its recursive feature, which opens a link with the fruitful new field of complexity

Fig. 3: Figure 3

Cognition based Communication Model (Communicatics Model)

science, in the direction of using computer simulation to capture more understanding about cognition and communication. In my previous work (Hu, 1995) a method of "shoelace view of history" was borrowed from Soros (1987) to tackle the recursive feature of such processes when quantitative mathematical models were not possible. The shoelace method (named "shoelace table" (Hu, 1995)) could be seen as a very much simplified form of recursive functions expressed in text/list format. The similarity is that both are interested in the eigenstate of the process—will it stabilize at some certain outcome or will it go into a trajectory of chaos. In other words, will the communication process (mutual-cognition process) generate a stable outcome—shared understanding—or will it go "out of control," producing completely unanticipated results. So there is a potential to make use of nonlinear dynamics methodologies to study communication further.

The Law of Requisite Cognitive Capacity

Now let's look at a possible synergy of linking the above three elements together. These three models have in common that they all point to some limitations.

Ashby's Law of Requisite Variety points to a quantitative limitation in the relationship between a regulator and its system being regulated. Jaques' strata of cognitive power points to a limitation of the capacity of each individual's computing device—the brain serving the needed information processing, the cognition system, at a certain age or stage of the individual's brain development. The author's Communicatics Model points to a limitation that all of us have experienced with "communication difficulties," i.e., the frequent remarks we heard: "That's not what I meant;" "You're wrong, (I'm right);" "You just don't understand;" etc. Communication difficulties are actually difficulties in achieving desired coordination between the two communicators, or between two groups of people.

We need deeper understandings about the possible causes of general communication difficulties. Human beings are trying to communicate every day, for coordinating their behaviors and actions, for explaining their ideas, for resolving conflicts, and for soliciting cooperation. If they are lucky, they achieve effective communications followed by desired coordination. Otherwise, the outcomes would be misunderstandings, bias, conflicts, divorces, fights, wars, invasions, oppressions, vicious spirals of hostile interactions, all the way up to terrorist acts.

The above three theoretical parts, when linked together, highlight a quantitative limitation in human's communication behavior. It tells us that in certain cases, effective communication is not possible if extra effort is not made to overcome such a limitation to be explained below.

First, let's review, in the light of the Communicatics Model, what exactly is happening during a communication session. Suppose on the dinner table I find it's too far to reach the salt so I produce some sounds to my friend on the other side of the table: "Would you please pass the salt?" My friend, whose cognitive system is able to react to these sounds using a software called "English 2008" installed in her brain, constructs an understanding with a decision to mobilize her hand, fetch the salt bottle, extend her arm, and send the bottle into my hand, which is in

the same time reaching out to meet hers. Coordination accomplished —and the communication succeeded. This one sounds too easy—or not too easy though, from a neuropsychological point of view, since thousands of muscles in the two bodies must have precisely coordinated a dramatic dance, under the directorship of our two brains involving huge amount of neurons processing a lot of signals to achieve this.

Now, suppose I'm doing some repair work on my car, hood raised, my hands dirty and head a little sweating. I produce some sounds "Would you please bring me a glass of water" to my friend, watching my laboring and trying to be helpful. She hurries to the kitchen, finds that we're out of drinking water, and brings back a glass of orange juice. "No, I need water." I said. She makes another trip to the kitchen, this time brings a can of coke. "No, water please." She begins to be a little annoyed— "We're out of water, why don't you take orange juice or coke, you were not so fussy before…" Things may start getting a bit blue here, if I don't explain in time that I actually need tap water to add in the car, not into my mouth.

Successful communication generates understanding within the "receiving" party expected by the "sending" party, confirmed by the coordination of their actions. The re-construction of the expected understanding could easily go wrong without notice. According to Russell Ackoff, understanding is constructed with knowledge, knowledge is constructed with information, information is constructed with data (Ackoff, 1999). I would like to add that data is constructed by behaviors of measurement, observations, or cognition—our sensory system is detecting signals (guided by our mental model about "what to expect"), perceiving them as data, discerning useful/meaningful information (something relevant to the observer), linking such information into knowledge (our models about how the world works) and finally reaching the (re-)construction of some understanding (our models about why the other communicator is saying what s/he is saying).

To simplify, for two communicators A and B, the above process can be represented by the following:

1.
   Mental model of A ?

2.
   Intention to let B know something ?

3.
   Choosing a way to express it ?

4.
   Some signals being generated;.

5.
   Mental model of B ?

6.
   Observing signals from A ?

7.
   Generating data ?

8.
   Discerning information ?

9.

Forming new knowledge ?

10.
Inducing understanding ?

11.
Producing signals of understanding or not understanding ?

12.
Repeating steps (5)-(11) till a result is generated.

Now this multi-layer construction process, which might be very quickly happening in our cognitive system so we may not be aware of it, is made clear. Let's consider the findings of Ashby and Jaques, and discuss an inference of integrating them with the Communicatics Model.

According to Jaques, "thinking unit" or "order of information complexity" and "types of logic reasoning" could be different from person to person if their cognitive capacity are on different strata (Jaques, 1986). Therefore, persons on different strata would have different micro processes (internal language, so to speak,) when carrying out the steps (6) through (10) described above. Each of these steps can be viewed as a "controlling" or "regulating" process—a self-organizing process among a network of "sense-making" concepts represented by some neuron activities in our brain. The reason I view such processes as regulatory is because they are not completely "free"—they all have a need to generate some certain result that "fit" into the other communicator's expectation, i.e., the right "understanding."

If we can view such processes in such a way, then Ashby's Law should apply to each of these steps (6) through (10). Only we need to twist it a little bit: In each of these steps, the varieties of the language systems of the two communicators (A and B) must also match, otherwise the communication breaks down.

The tricky part is how to measure "variety of a communicator". I propose that we can use an approximate replica of it: the concept system being used, or more simplified, the set of vocabulary available. That is, a communication process (a re-construction process) can only be successful when two similar sets of vocabularies (elements within a concept system) AND similar types of logic reasoning (relationships within a concept system) are being used. From Jaques's theory we know this would not always be the case.

Let me provide another example. A young professor of economics had three hours to wait in a small city in a developing country before the next flight to his destination. In order to make use of his waiting time in the city that he never visited before, he decided to take a taxi to investigate the economic status of this city.

"Where would you like to go sir?" The taxi driver asked.

"Well, anywhere that you think I could observe the economy in this city. I have three hours to spend," said the professor.

"I beg your pardon?" The driver could not make sense of what the professor said.

"I mean, how is the economy going here… and what is the Gene coefficient in this city… could you show me the streets with many shops and shoppers." The professor suggested.

"Where exactly do you want to go, sir?" The driver is more confused.

"Okay, why don't you drive me to a market."

"Oh, okay."

With that specific term "market", the driver took the professor to the tourist souvenir market.

"That's not what I meant." The professor is getting a bit annoyed. "I want to go to a food market where people trade eggs."

"Do you want to buy eggs?" The driver is more confused.

"I want to see how much money the eggs cost in this city."

The driver was then able to take the professor to the local food market.

…

The words used by the professor—economy, Gene coefficient, market—are either not making sense to the driver or being misperceived. The professor's brain is operating at a higher Jaquesian Stratum with many intangible thinking units, the driver at a lower stratum, who needs concrete, specific information about where to go. In some situations of this type of miscommunication, conflict would be inevitable unless one of the communicators "translates within the same language" to express on a different Jaquesian Stratum, in this case, the professor. Some people can do this intuitively, some cannot without explicit understanding of this principle.

Conclusion

I believe that there will be more interesting scenarios to discuss once this topic is raised among scholars interested in communication issues. Here, I would only present this principle in human communication that might be previously unnoticed: *On the Jaquesian Cognitive Capacity Strata, it is necessary for the person on a higher stratus to make extra efforts to explain/translate his/her mental model for the person (or P-individual) on a lower stratus, using the language/mental model available at the lower stratus.* Shortly speaking, a concept of "inner-language translation"—saying your meaning in other words that are understandable by the other side—is a needed strategy. Without such translation, the person on a lower strata cannot cognize the mental model being used and will misunderstand, therefore effective communication cannot be achieved. The existence of such limitations may explain a number of interesting social and organizational phenomena, beyond explaining communication difficulties.

Possible applications areas of the Law of Requisite Cognitive Capacity may include:

- Improvement in communication effectiveness and efficiency at all levels;

- Improvement in conflict resolution;

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Improvement of consensus building among groups;

- More realistic goal-setting in vision/mission building within organizations;

- More effective organizational development;

- More rationality in cross-cultural communication.

For example, consider the task of how to eliminate a totalitarian system with peaceful means, or how to reform an existing non-democratic political system into a better or more humane one through peaceful means. The first thing people would notice is that all totalitarian system are built upon, and rely on, violence and cheating, and are deeply trapped into a vicious circle of relying on such means to govern. In light of the principle revealed in this paper, we can see both violence and cheating as means to achieve (forced or manipulated) behavior coordination (or compliance) when true understanding is not possible—or when effective communication is not possible. This situation may be caused by conflict of interests or by inability to communicate between the ruling and the ruled groups—between the regulator and the system being regulated in Ashby's terms.

That is to say, without effective communication to build a shared understanding (of anything) in a society, there are only two ways left to achieve behavioral coordination (i.e., conflict resolution and cooperation solicitation in organizational processes needed to maintain the society as a whole): Via trust (which might be blind trust), or via fear (which might be stated through violence). Therefore, the only organizational means for a (non-communicative) totalitarian political regime, when they are not able to obtain trust from those being ruled, has to be violence threat and cheating (information control). Without a democratic system, they have no other means to overcome the immanent communication limits (identified by the Law of Requisite Cognitive Capacity) to obtain cooperation among those being ruled.

So, a related question is that, if more understanding through effective communication could be built between interests groups, would the freedom of speech, freedom of press, and freedom from violent threat be increased? A wild guess is that, by drastically improving the effectiveness and efficiency of communication between different interests groups, a peaceful evolutionary path might be found to replace the possible chaotic revolution to release the social tension for the societies under totalitarian rule. I shall stop here before this example goes too far, and invite the readers and discussion about other possible use of the Law of Requisite Cognitive Capacity.

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