

SOME CONSIDERATIONS REGARDING COLLECTIVE INTELLIGENCE

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Summary : Collective intelligence is a form of intelligence that emerges from the collaboration and competition of many individuals. It is therefore vital to understand, among other things, how collective intelligence processes can be expanded by digital networks. It is one of the keys to success for modern societies.

Keywords : Collective intelligence, digital networks, group effects, human system, free flow of information

Some consideration regarding collective intelligence

1. WHAT IS COLLECTIVE INTELLIGENCE?

Collective intelligence has existed for at least as long as humans have. Tribes of hunter-gatherers, nations, and modern corporations all act collectively with varying degrees of intelligence. And, from some perspectives, even collections of bacteria, bees, or baboons can also be viewed as collectively intelligent (e.g., Bloom 1995).

But this ancient phenomenon is now occurring in dramatically new forms. With new communication technologies-especially the Internet-huge numbers of people all over the planet can now work together in ways that were never before possible in the history of humanity (e.g., Malone 2004). It is thus more important than ever for us to understand collective intelligence at a deep level so we can create and take advantage of these new possibilities.

Collective intelligence is a form of intelligence that emerges from the collaboration and competition of many individuals. Collective intelligence appears in a wide variety of forms of consensus decision making in bacteria, animals, humans, and computers. The study of collective intelligence may properly be considered a subfield of sociology, of business, of computer science, and of mass behavior, a field that studies collective behavior from the level of quarks to the level of bacterial, plant, animal, and human societies.

As our society becomes more and more knowledge-dependent, this collective ability becomes of fundamental importance. It is therefore vital to understand, among other things, how collective intelligence processes can be expanded by digital networks. It is one of the keys to success for modern societies.

The above definition has emerged from the writings of Peter Russell (1983), Tom Atlee (1993), Pierre Lévy (1994), Howard Bloom (1995), Francis Heylighen (1995), Douglas Engelbart, Cliff Joslyn, Ron Dembo, Gottfried Mayer-Kress (2003) and other theorists.

Collective intelligence is the intelligence of connections, of relations. Some also define it as connective or relational intelligence. The heart of collective intelligence is harmonizing connections. These connections induce co-operations which constitute matérialisation of collective intelligence. The collective intelligence, in its operational dimension in a company, is the capacity of an organization, of a collective to ask questions and to seek the answers together.

To put it into practice, it is necessary to develop intellectual co-operations in the organization. That implies that someone wants to cooperate, another knows how to cooperate and another has the power to cooperate. To create wanting to cooperate, one needs values and beliefs which converge towards co-operations. For example, values of division, respect, responsibility. We have to believe that people have a share of selflessness and are not only selfish.

The knowledge to cooperate supposes that one adopts behaviors, a knowledge of being co-operative which consists in helping the others and to seek help rather than to reinvent warm water by oneself. That also supposes managers knowing how to induce cooperation. How to create co-operations in a team? There are methods and tools related to management of collective intelligence.

One must cooperate because it is the only manner to obtain a collective performance higher than the sum of the individual performances in our company of information. We can function on a "Command and Control" logic on a line production in a factory because the share of information is weak in the performance. This is not true when the heart of our activity is valorization of an immaterial capital. To perform well, one then needs the ideas and knowledge of all, to innovate and quite simply to work! One cannot order another to have an idea. It is necessary to obtain their voluntary co-operation in order to have it. It is thus necessary to pass to a "Connect and Collaborate" logic.

Pierre Lévy defined collective intelligence as the capacity of human communities to co-operate intellectually in creation, innovation and invention. He insisted on the four axioms of collective intelligence:

Universally distributed: nobody knows everything, everyone knows something, knowledge is in people and not in a transcendent entity which would organize its distribution in society.

Constantly enhanced: the human collective thus organized would have as its central wealth, the human being. Pierre Lévy insists on the basic concept of *economy of human qualities*. Thus, each member of the collective would be carrying a wealth that no one could neglect and which would ensure him a single place and a contribution within the intelligent collective.

Coordinated in real time: the reference is made here to the cyberspace, tool of support and support of collective intelligence, which, it alone, allows a large-scale media communication.

Resulting in the effective mobilization of skills: Collective intelligence is not only a theoretical or philosophical concept. It can underlie a new effective and efficient social organization, based on skills, learning and

knowledge. Collective intelligence favours empowerment (“to empower” - namely the creative potential which exists in each one of us) rather than power (which, contrary to the empowerment, isolates, divides and weakens). “Empowerment makes something possible, power stops it”: Pierre Levy invites “to disinvest the hierarchies” and introduces the notion of “*démodynamique*” (demodynamic) (of the Greek *dunamis*: power, force) against democracy!

In conclusion, according to Pierre Levy, collective intelligence is an intelligence universally distributed, constantly enhanced, coordinated in real-time, which leads to an effective mobilization of skills.

2. THE CHARACTERISTICS OF COLLECTIVE INTELLIGENCE

Some characteristics of collective intelligence are:

- decentralization of the knowledge and skills,
- autonomy of enhanced individuals as creators of meaning ,
- expansion of an intersubjective space free of economic and governmental constraints,
- constant interactivity between the individuals and their environment (technical, economic, ecological...) whose modifications are perceived and controlled in real-time,
- disintegration of massive structures (that the author calls "molar") to the benefit of autonomous, small and convivial entities,
- the appearance of a new conviviality and a new ethics...

We can speak of three forms of collective intelligence:

- 1) natural collective intelligence (migratory birds, ants: a natural model of problem solving, termites and self assembling) ;
- 2) artificial collective intelligence;
- 3) collective intelligence in human societies;

In our society, there are many different kinds of collective intelligence, including:

- the collective intelligence generated by high quality conversations among diverse people working together ;
- the collective intelligence generated by independent consumers in a market
- the collective intelligence of global information systems we reach through computers ;
- the psycho-spiritual fields of collective intelligence we can reach through meditation and deep dialogue ;
- the collective intelligence of whole societies who weave all of these into their cultures and into their political, governmental and economic institutions.

3. LIMITATIONS OF COLLECTIVE INTELLIGENCE IN HUMAN SOCIETIES:

Some of the flaws of this field are:

- group decisions, as the members do not dare to say what they think;
- passive acceptance of a situation which the individual may believe to lead to a catastrophe (ex : the Challenger space shuttle);
- discussions on the choices and consequences of decisions are often confusing and amount to nothing ;
- the expert's opinion without consequence facing the opinion of a group of people who are wrong,
- democratic votes may place a dictator at the head of a country;
- the collective representations which normalize behavior at the expense of one class or another (leading for example to a very high suicide rate among women in China).

Collective intelligence is thus limited by effects of the group (conformism, fear, closing, absence of procedure, ideological homogeneity), so much so that the individual alone can perfectly be more intelligent than a whole group because they can preserve better their critical thought better than under the influence of the group.

To note in addition that the concept of intelligence applies to the cognitive or even emotional faculties of an individual. The application of this concept to a group cannot have the same meaning, because it is impossible to say where would faculties of representation, of creation and learning higher than those of the isolated individuals appear.

4. SOME FACTORS WHICH SUPPORT COLLECTIVE INTELLIGENCE

There are probably hundreds of factors we could identify as important for the generation of collective intelligence in different types of human systems. Some factors which support collective intelligence: diversity, synergy, commonality, authenticity, freedom, free flow of information, memory, trust, discernment, chaos/order, appreciation of complexity, feedback, possibility-testing , people feeling fully heard, power equity.

4.1 Diversity

To the extent everyone is the same, their intelligence cannot collectively add up to something more than any of them individually. Diversity enriches possibilities, through increased information, perspective, stimulation, and re-combination, among other factors. The infinite forms of human diversity (class, personality, opinions, experience, cognitive style, etc.) are a study unto themselves; and all are relevant as potential contributors to collective intelligence. We need to concern ourselves with how we handle existing (presenting) diversity, and also with the inclusion of adequate diversity (e.g., the presence of certain stakeholders) for the purposes of a specific collectively intelligent activity. This valuing of diversity means that efforts at collective intelligence tend to have a bias towards inclusivity and all voices being heard (modified by "discernment" below). Included in this "diversity" factor are other forms of dissonance such as dissent, challenge, and change -- as well as outsiders, fringe elements, "the Other," "the Shadow," and other normally rejected parts of the whole picture.

4.2 Synergy

Synergy is generative, productive relationship that produces a whole greater than the sum of its parts. It usually features cooperation but under the right circumstances can involve competition or even pitched battle. Synergy is the key factor that determines whether diversity leads to greater collective intelligence or collective stupidity.

4.3 Commonality

Shared humanity, language, values, goals, purpose, ground rules, etc., provide common ground on which to stand while creatively using our diversity. If we hold too much in common (e.g. unexamined assumptions), or if we value commonality to the exclusion of diversity (i.e., conformity), collective stupidity (groupthink) will likely result. Shared purpose, vision and inquiry are among the most powerful tools for self-organization and, if other collective intelligence factors are in place, for collective intelligence.

4.4 Authenticity

To the extent people and things are what they appear, they can interact toward desirable outcomes. If part of the collective is deceiving another part, it is difficult for the whole to comprehend reality and find desirable outcomes. Furthermore, to the extent people are grounded in their deep authentic selves (rather than ego), they will also be grounded in universal realities and motivations which serve collective intelligence. Such grounding can be stimulated on an ad hoc basis by process and facilitation, or nurtured as a personal and group capacity by psychospiritual practices.

4.5 Freedom

To the extent parts of the collective are both connected and autonomous (independent), they will be able to manifest their diversity, authenticity and creativity as part of collective intelligence. One of the most valuable forms of freedom for collective intelligence is free flow of information.

4.6 Free flow of information

Intelligence is closely tied to the processing of information. In collectives, information must be able to move from one part of the whole to other parts in order for this processing to happen well. This implies a level of openness which, in turn, is related to authenticity. Among the most powerful forms of information flow for collective intelligence is sharing the wisdom that emerges from the collective with the whole collective (a form of "feedback")

4.7 Memory

Storage of information, knowledge, and experience accessible to all parts of the collective. While consciousness is possible without memory, functional intelligence is not. Social memory is stored and accessed through records (including databases and libraries), stories (including myths), media, educational activities, etc.

4.8 Trust

Threats from other people undermine one's authenticity, freedom, initiative, relationship and openness. For optimum collective intelligence, we should face significant challenges together in a context of minimal threat

from each other. This sense of safety can be generated initially by culture, by agreements and by facilitation, and it grows through sharing and living safely through vulnerability.

4.9 Discernment

High intelligence requires high ability to discern differences, similarities and relevance, and to weigh potential outcomes in light of values and goals. Diversity (and other factors), used well, can enhance collective discernment by reducing blind spots. (Qualifier: to maximize the benefits of diversity, we can use "relevance-plus" which means including the full appropriate range of relevant information, inquiries, options, participants, etc., plus, ideally, some that are random or of borderline relevance.)

4.10 Chaos/order

Too much chaos destroys through dispersal. Too much order destroys through inflexibility. Life gravitates to the realm between order and chaos. Collective intelligence requires a healthy balance of order and chaos (structure and freedom, predictability and creativity, knowledge and uncertainty, convergence and divergence, etc.) or dynamics through which each can evolve into the other.

4.11 Appreciation of complexity

Diversity of data and information invites us to confront a more complex picture of reality. Seeing this as a resource, instead of resisting it through comfortable oversimplifications, is a resource for collective intelligence. This includes an ability to hold multiple-viewpoints, both/and logic, a tolerance for ambiguity and paradox, and insight into the fractal nature of reality in which patterns (including opposites) can contain each other at different levels of observation. It also involves contextual sensitivities such as cultural contexts, systems thinking and what we might call "depth of field" (deep time, deep place, deep causality, deep humanity, deep ecology, deep psychology, etc.) which strive to expand comprehension outwards towards the ideal "whole picture." Visual representations that bring some coherence to complex situations, possibilities or arguments can provide a common ground for collective encounters with complexity.

4.12 Feedback

Learning from experience involves outputs feeding back as inputs, especially feeding back the results of action as information for reflection or correction. All intelligence needs this dynamic, but it is particularly vital , and possible , with collective intelligence, thanks to the presence of multiple viewpoints and collective means for gathering feedback.

4.13 Possibility-testing

Any means that can be used to help people consider diverse options and scenarios in light of their values and goals can enhance collective intelligence. This includes not restricting deliberations to one or two proposals and pro/con thinking, but openly exploring choices and their consequences.

4.14 People feeling fully heard

More than anything else, this opens people up and reduces dysfunctional assertiveness and defensiveness. It is essential for dialogue, and some facilitation methods focus on it.

4.15 Power equity

If any parts or members of the collective have the power to dominate the system, the chances are high that diversity, information, freedom, feedback and many other factors needed for collective intelligence will be degraded. Social power comes in many forms which cannot be mechanically balanced, but the non-domination test can warn us when we have wandered too far from equity. In democratic political systems, this factor can be addressed by making any necessary concentration of power answerable to those over whom it is exercised.

5. SOME FACTORS WHICH INHIBIT COLLECTIVE INTELLIGENCE

5.1 Narrow bandwidth among members

Cramton suggests that narrow bandwidth, such as that caused by geographically distributed teams, results in difficulty in sharing mutual knowledge. She further classifies this failure into 5 types:

- failure to communicate and retain contextual information
- unevenly distributed information
- difficulty in communicating and understanding the salience of information
- differences in speed of access to information
- difficulty interpreting the meaning of silence.

5.2 Cultural boundaries

Blau among others, contend that a main barrier to collaboration may be the difficulty in achieving agreement when diverse viewpoints exist. This can make effective decision-making more difficult. Even if collaboration members do manage to agree they are very likely to be agreeing from a different perspective. This is often called a cultural boundary. For example: a culture where rank or job title is important makes it hard for a lower rank person who may be more qualified than their superior for the job it had to collaborate. The lower rank person is told what to do. This is not collaboration "stranger danger"; which can be expressed as a reluctance to share with others unknown to you "needle in a haystack"; people believe that others may have already solved your problem but how do you find them "hoarding"; where people do not want to share knowledge because they see hoarding as a source of power "Not Invented Here"; the avoidance of previously performed research or knowledge that was not originally developed within the group/institution.

5.3 Self-interest and the free-rider problem

Olson propose that individuals' self interest might hinder the emergence of collective action. He believes that group size reduces the cost of not participating .Further, group size reduces the share of benefit but increases the cost of participation (the interest of the individual is less aligned to the group average, and there is higher cost of organizing a large group).

5.4 Implementation issues

Bikson and Eveland describe CSCW (computer-supported collaborative work) implementation issues which might also be pertinent to implementation of collective intelligence systems. Among their key findings of their qualitative study at the World Bank:

- Change in social and technical systems (the former like work groups, jobs, interdependencies; the latter like hardware, software, networks)
 - Implementation has as strong an influence as technology on outcomes
- Outcomes evolve over time.

5.5 Market failure

Market failure is especially important in inhibiting the proper function of prediction markets.

1. Overly restrictive or unclear specification of event to be predicted. For example, a 2006 Tradesports contract on whether North Korea conducts a missile test specifies that the US Department of Defense as a confirmation source. But on this event, the DOD does not confirm the incident, even though it has been widely reported on in the media.
2. System downtime during critical betting periods. For example, one user alleges that Tradesports' site is down during the last one minute of a crucial SMC/USF game on Feb 19, 2007.
3. Involvement of biased parties, and cornering the market.
4. Predictions of extreme events.
5. Long-lived contracts? SimExchange uses infinite-life contracts in a prediction market for video game sales. Some observers suggest that this might work only for play money.
6. Affiliation bias. Koleman shows evidence that New York betters in the Iowa prediction market favor the Yankees.

We also conjecture that many factors that inhibit healthy development and functioning of traditional asset markets, such as the stock market, might inhibit collective intelligence. Such factors include:

Manipulation, insider trading, thin markets, herding, poor rule of law, limits to arbitrage, if traders are agents for other principals .

5.6 Biases

Many of the above seem to also appear at the group level. There are biases that are unique to groups :

1) In-group bias. Individuals favor their own group members. The bias appears to be reduced with the size of the group.

2) Out-group homogeneity bias. Individuals see members of other groups as more homogeneous than those in their own groups. The bias seems to be independent of the size and number of groups, and is not due to the relatively less interaction between the individuals and out-group members.

3) Groupthink, bandwagon effect, herd behavior. This is the tendency to do what others do.

4) Facilitation and loafing . A version of this is the contrast effect. For example, a person placed next to a less appealing one is viewed as more appealing than normal, but when placed next to a more appealing one, is viewed as less appealing than normal.

5) Group polarization. This is the tendency for groups to adopt more extreme or riskier positions after discussion. Indeed, the positions are often more extreme than each individual would want. One probable cause is the desire to conform.

6) Biased use of information and the common knowledge effect..

7) Risky shift.

8) Distortions in multi-level group decisions. When there are multi-level group decisions, such as in a democratic political process, the "people's preference may be very distorted if we use a fair majority social decision scheme. In practice, such distortions might be corrected with minority reports and interest groups. But we are aware of no data that permit a test of the distortions-by-levels argument."

6. PERSPECTIVES ON COLLECTIVE INTELLIGENCE

One way to integrate the different perspectives on collective intelligence is to identify the:

1) commonalities: how each maps onto the generic components common in collective intelligence,

2) discipline-specific contributions: what are the key relevant concepts and theories.

Hopefully, the commonalities spur deeper thinking about the foundations of collective intelligence, and the discipline-specific contributions suggest cross-fertilization of ideas across disciplines.

The table 1. provides examples from each perspective.

In addition to the above discipline-specific perspectives, some other perspectives have multi-disciplinary origins, but are becoming perspectives in their own right, and we list them in table 2.

Table 1.

Perspective	Actors	Resources	Actions and their bases	Results	Evaluation and measures	Factors inhibiting CI
Sociology	Humans	Status, power	Persuasion, conformity	Motivation, learning, conflict	Experiments, sociometry	-
Economics	Firms, consumers	Wealth, goods	Trade, pricing incentives	Efficiency, monopolistic power	Welfare monetary units	Arrow's imposib. theorems
Cognitive neuroscience	Neurons, codons	Weight of connections	Neural firing	Mental representations, mind-body problem	Two-photon microscopy, calcium imaging	-
Organization theory	People	Resources	Resource allocation	Productivity	Productivity	Differentiation and integration
Computer science and artificial intelligence	Computers	Computational cycles, storage	Computation	Computational solutions	Speed and accuracy of results, transmissions	Byzantine Failure, impossibility of distributed consensus
Biology	Organisms	Energy, free will, sensory capacity	Decision-making	-	-	-
Political philosophy	Humans	Status, power	Decision-making	Motivation, learning, conflict	Experiments, sociometry	-

Table 2.

Perspective	Actors	Resources	Actions and their bases	Results	Evaluation and measures	Factors inhibiting CI
Social psychology	Humans	Status, power	Persuasion, conformity	Motivation, learning, conflict	Experiments, sociometry	-
Computer supported collaborative work	Humans	Productivity	-	-	-	-
Prediction markets	Humans	Information, money	Votes	Voting result	Count of votes, variances	-
Economic sociology	Humans and organizations	Trust, identity, organizational demography	Relationships as constraints	Node-level profitability, mortality	Profits, hazard rates	Strong ties

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