NORMAN LEE JOHNSON

THE APPLIED SCIENCE OF COLLECTIVE INTELLIGENCE:

SOLVING THE GRAND CHALLENGE FACING HUMANITY

Dr. Norman L. Johnson is currently Chief Scientist of Referentia Systems. He retired from Los Alamos National Laboratory in 2005 after 25 years as a senior scientist and program manager and is a sought-after speaker on the importance of diversity in organizations, epidemiology, and cybersecurity. norman@SantaFe.edu

Failure Mode	Solution Method: Single expert	Team lead by an expert	Team of experts	Teams of teams	Advanced collective methods
Isolation	✓✓✓✓✓	✓✓✓✓	✓✓✓	✓	X
Herd thinking	X	✓✓✓✓✓	✓✓✓✓	✓	✓
Group conflict	X	✓	✓✓✓✓✓	✓✓✓	method dependent
Inefficiency	✓	✓✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓
Hitting the complexity barrier	varies by problem complexity				
Diversity Level	✓	✓✓	✓✓✓	✓✓✓✓	✓✓✓✓✓

FIGURE 1 - *The frequency of failure modes and diversity levels for different classes of solution methods.*

DO YOU DRIVE THE SOLUTION OR DOES IT DRIVE YOU?

DO YOU SOLVE PROBLEMS THAT YOU WANT TO solve? Or do you solve the problem that you think you can solve? The significance of this inquiry became evident to me during a visit to a US agency responsible for tens of billions of dollars of research for the public good. I was invited to give a talk to about 100 program managers overseeing this research, on the importance of diversity in solving hard problems. To better understand their world, I began with polling them on the perceived problem difficulty of their portfolio, from routinely easy to a grand challenge where experts are in disagreement. What I learned shocked me. None of the program managers believed they were addressing the grand challenges in their research area.

Why is it that we are not taking on the challenges that could really change the world? And if we knew the answer to this question, what are the resources that we are not embracing to address these challenges? These are the questions I will address.

WHY WE DON'T ADDRESS THE GRAND CHALLENGES

While the main goal in this article is to share my revelations on new, possibly radical, approaches to solving the hard problems, we need an understanding of why we've painted ourselves into a corner and possibly feel trapped by our solution methods. What I learned during my visit to the US agency will likely be similar to your experiences.

To understand if the program managers' solution methods were limiting their choice of problems, I polled them on the column headings in FIGURE 1. The first three methods from the left are easily recognizable: a plumber fixing your drain, a plumber overseeing a team fixing your septic system, and a group of experts remodelling your home. The "Teams of experts" method is a common approach to solve high complexity problems or inquiries, for example, a National Academy of Science study. "Teams of teams" method is when teams both compete with each other and share common resources and best practices. The "Advance collective methods" approach is a catchall for the modern collective methods, such as crowdsourcing and prediction markets. The program managers' response was that 95% of them used the first three methods, with the large

majority using the first two. The selection of the methods on the left wasn't because there weren't success stories on the right: one of the portfolios has a "teams of teams" success story that has easily saved 1000s of lives worldwide and benefited millions more.

Listed in the rows of FIGURE 1 are different failure modes of solution methods, with the following descriptions. The failure mode of "Isolation" is from not having access to sufficient information or skills to solve the problem: if you had these resources, then you could solve the problem. "Herd thinking" is when everyone in the group has the same contributions. "Group conflict" is when internal disagreements or conflicts prevent a group from reaching a conclusion, even though all the necessary resources are present to solve the problem. "Group inefficiency" is when a group decision process takes too long, relative to the time required for a solution, even though there are no internal conflicts and all the needed resources are present. Group inefficiency is a common failure mode for the dreaded company meeting. "Hitting the complexity barrier" is when the individuals or group hit a barrier of difficulty that can't be surmounted, where the problem is too difficult for the resources available. The complexity failure mode depends on the problem difficulty and is discussed in more detail shortly. The last row captures their perception on how much the different methods utilize diversity – no surprises here.

I then asked the crowd to select the likely failure modes that caused each solution method to fail, based on their experiences. The darker the box and number of checks indicate the greater the response of the crowd. What stands out in these crowdsourced responses is that some failure modes tend toward the single expert side and others favour the collective side. For example, isolation failures favour the lone expert, but inefficiencies favour the collective methods. And, there are abrupt transitions and peaks: group conflict failure rapidly increases and peaks for the team of experts and then declines.

From the viewpoint that experts are the best resource to solve problems, I found these results surprising. A team of experts should be the optimal resource to solve a hard problem, particularly a grand challenge. Yet, if we sum the failure checkmarks by columns, the team of experts is most likely to fail, despite the preponderance of the expertise present.

What can we conclude from these results? Because this agency isn't solving grand challenges, they are using the solution methods that work best for their types of problems. But if they wanted to solve a grand challenge from the perspective that experts are the best resource, they perceive a failure barrier that limits the likelihood of success. Hence, they solve problems they think they can solve, rather than problems they want to solve. My experience as a citizen aligns with these perceptions: our institutions do not attempt to solve the grand challenges impacting us all, mainly because we think they are unsolvable by the methods available, particularly in the presence of biases and conflicts.

CI: THE WIZARD BEHIND THE CURTAIN

Collective intelligence (CI) is defined as an outcome where a collective solves a problem better (typically more accurately) than the average individual, and often better than any individual (the expert). CI captures the increased intelligence from one level–the individual, to another–a collective. The two levels can be an individual within a group, a group within an organization, an identity group within a society, or even an information technology within an information system.

As defined, CI captures many forms of collective decision-making, both the traditional ones of a century ago, such as the smart outcome of a juried decision or an election in a democracy, to modern examples, such as an accurate outcome in a prediction market or online recommender system. The science of CI studies how diverse information is combined to achieve a collective solution, using abstracted or idealized models. The following summarizes the highlights of mainstream science of CI research in order to establish a foundation to expand the applicability and capability of CI. Readers will find more resources in other articles within this special issue on CI and in the following references: a review of forty years of research on collective processes in organizations (Williams and O'Rielly, 1996) that capture a traditional view of diversity, particularly the challenges; the extensive and self-consistent analysis by Scott Page and his collaborators (Hong and Page, 2001, Page, 2005[1], Page, 2007, Hong and Page, 2011, Shalizi, 2005), a review of modern web-based collective decision methods (Watkins and Rodriguez, 2008); and how the Internet may finally realize the full potential of the collective ideals of the Age of Enlightenment (Rodriguez and Watkins, 2009).

When individuals or groups solve problems, they use different preferences, biases, experiences, or heuristics in their solution to the problem, thereby, introducing a collective diversity of solution approaches and contributions. To be specific, we define collective diversity, or just diversity, because diversity is a property of the collective–not the individual, as an

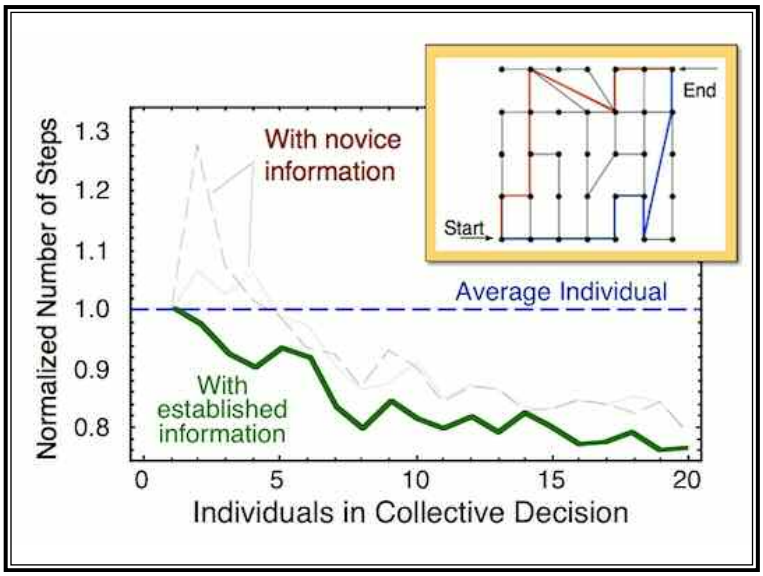


FIGURE 2 ~ *The number of steps in the collective divided by the average individual steps (12.8) for collectives of different sizes. The insert shows the problem being solved.*

aggregation of the expression of unique differences of individuals relative to the group.

Many CI model problems remarkably have in common two conclusions or observations that establish the foundation of the science of CI:

~ *The diversity factor*: The greater the expression of the diversity of the collective, the more accurate the collective solution.

~ *The individual ability factor*: Individuals in the collective must have a minimum degree of ability in solving the problem in order for the collective solution to be accurate.

A major contribution of Scott Page to the science of CI is the proof that these two factors are quantitatively coupled for certain types of problems (Page 2007, Hong and Page 2011), called the *Diversity Prediction theorem*: *Collective error = Average individual error - Collective diversity.*

The following observations illustrate the importance of this theorem. 1) As the diversity increases, the collective error decreases, capturing the importance of diversity in CI. 2) Because the collective error cannot be negative, the contribution of the collective diversity is bounded, or there is a limit to the beneficial effect of diversity. 3) When the average individual becomes an expert or the problem is relatively simple and all individuals solve the problem, then the average individual error and the collective error go to zero, independent of the level of diversity. These qualitative relationships appear to hold for all CI problems and are the foundation for the rest of this article.

To better appreciate the types and sources of diversity, consider the model problem I studied (Johnson, 1998): the solution of a maze (see insert in FIGURE 2) by a group of non-interacting, myopic individuals. Note that the maze has multiple optimal paths – two are shown in FIGURE 2. To study the problem, each individual solves the maze with a set of rules (heuristics) that eliminate unproductive loops and dead ends, but do not explicitly select a short path (they don't count steps or have GPS). Although each individual uses the same heuristics, a diversity of preferences at a node are created, because the myopic individuals have no reason to choose initially one path over another. When an individual uses these learned preferences to solve the maze again, the loops are eliminated and the individual path is shortened. For the collective, the preferences of a group of individuals are combined, and the same individual heuristics provide the collective solution.

FIGURE 2 shows how collectives with larger numbers solve the problem better than the average individual, demonstrating the Diversity Prediction theorem, because diversity increases with the number of individuals, while the average individual error is constant. Note that Hong and Page (2001) examined collectives with diverse heuristics in a different model problem and found the similar conclusions. The reason for the collective improvement in the maze study is found to occur from the closure of unproductive but unclosed loops in the individual solutions[2]. The collective curves with novice information in FIGURE 2 are based on preferences that include the loops in the individual solutions, while the established information results are for preferences without the loops. Because the diversity is lower for the collectives of novice individuals compared to a collective with established individuals, the collective error for the established group is lower, even though the individual error is the same for both groups.

These results illustrate how the quality of information that the individuals contribute to the collective can affect the collective solution: the novice preferences are more "noisy" than the established preferences. The study looked at many different ways that the individual can filter or modify their contributions to the collective, for example, selecting only the dominant preference or providing all preferences with equal weighting, and found that, except for filtering the novice noise, any reduction in an individual's contribution caused a decline in the collective performance. Finally, and the most remarkable, is that the collective always

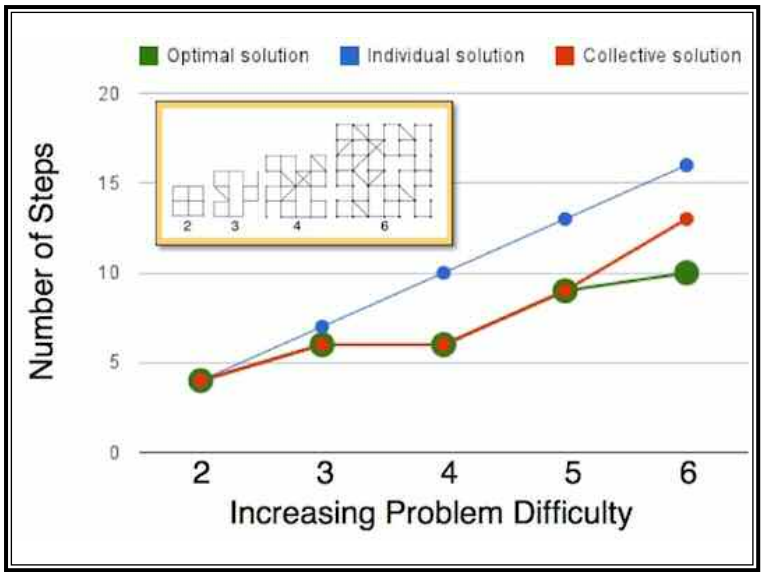


FIGURE 3 ~ *Performance of the average individual and a large collective, compared to the optimal solution. The insert shows the mazes, where #5 is in* FIGURE 2.

finds one of the minimum paths, even though the individual heuristics do not include any concept of a shortest path. This is an example of an emergent solution and is a result of the individual heuristics and the structure of the maze (White and Harary, 2001). The significance of this for CI and grand challenges is discussed in a later section.

While the above results are not controversial or unexpected, there are additional CI model results that are counterintuitive to most beliefs about collective performance. One example is a study on the CI of teams of different individual performance (Hong and Page, 2004, Hong and Page, 2011). Hong and Page studied a hill-climbing problem with many local maxima, and the goal was to find the optimal global maximum. What they found was that diversity trumps ability: "[…] when selecting a problem-solving team from a diverse population of intelligent agents, a team of randomly selected agents outperforms a team comprised of the best-performing agents. This result relies on the intuition that, as the initial pool of problem solvers becomes large, the best-performing agents necessarily become similar in the space of problem solvers. Their relatively greater ability is more than offset by their lack of problem-solving diversity." Hence, in this model problem when experts optimize their methods, they become similar, and therefore, can be "trumped" by a diverse collective. For later reference, we note that this problem doesn't capture our grand challenge definition where experts disagree.

The results of a related study that I did[3] are even more counterintuitive. Similar to Hong and Page (2004), I found that a group of randomly selected individuals of all performance levels did better than a collection of high performers, but this random group only did marginally better than a group of relatively poor performers! Remarkably, the team of poor performers contained a diversity of solutions (paths in the maze) that when combined found a better solution, even though their individual solutions were relatively poor. In a separate study of the same maze problem[4] with individuals using different heuristics, I concluded that as long as the individuals had some ability – they did not solve the maze using a random walk – the diverse collective solution outperformed the average individual, again agreeing with the Diversity Prediction theorem.

Overall, the above results for the science of CI are a powerful statement of the collective's ability to amplify weak "true" signals or diverse structures of the individuals into a robust and accurate collective solution, even in the case when the individuals are poor performers. Unfortunately, this conclusion is weakened by the restrictive assumptions in many of the CI model studies above. For example, assumptions for the minimum performance level of the individual – such as in the Condorcet's Jury Theorem (Dietrich, 2008), the ability of the individuals to accurately communicate with each other (no or minimal miscommunication), the absence of bias (a preferential inaccuracy), a common understanding of the problem, and a common goal. Clearly these assumptions and others like them made in popular CI books (Surowiecki, 2004), while simplifying the model analysis, are not often realized in real problems, particularly the hardest problems. Yet, the above studies suggest that a group of poor performers still can express CI, so these assumptions are likely too restrictive.

BREAKING THE COMPLEXITY BARRIER

In 1998[5], I did a study where I kept the individual heuristics fixed and then challenged the individuals and collective with larger, more difficult mazes. FIGURE 2 shows the results of the study as the difficulty of the maze increased from left to right. Not surprising for the least complex maze in FIGURE 3 (#2), all the individuals and the collective solve the maze optimally. As the maze becomes more complex, the average individual performs more poorly, as captured by the increase in the difference between the number of

steps in the average individual solution and optimal solution. The collective solution continues, though, to find the optimal solution until the most complex maze (#6) is attempted. Not shown are results for even more complex mazes, in which the trend continues: the average individual solution gets worse, followed by the collective solution also getting worse, until both solutions do no better than a random walk solution – the lowest performing heuristic.

These results provide additional insight into the Diversity Prediction theorem when problem difficulty increases. Because the results in FIGURE 3 are for collectives of 500 individuals, the collective diversity is at a maximum for all of the maze solutions. To test this, I increased the number of individuals to 1000, but found the results in FIGURE 3 unchanged. Hence, there is a limit to the difficulty of problem that can be solved by increasing the number of individuals in the collective. And, the collective error remains zero or small as the difficulty increases, even though the average individual error increases. Then, at a certain level of problem difficulty with fixed individual heuristics, the average individual error exceeds the collective diversity, and then the collective error begins to increase – this defines a collective complexity barrier. As the maze becomes more complex, the average individual error exceeds the collective diversity, the collective error is at a maximum, and then the average individual and the collective perform equally poorly.

The main conclusion from the above results is that while a collective can outperform the average individual, there is a limit to what level of difficulty can be solved for a given collective method. We can now fill in the missing row in FIGURE 1, the "Hitting the complexity barrier." If the difficulty of a grand challenge is below the collective complexity barrier, then we can attempt a collective solution. But, if the complexity of the problem is beyond the collective complexity barrier, then we have the following options using the Diversity Prediction Theorem: 1) increase the diversity by increasing the number in the collective, 2) increase the individual capability, or 3) develop a collective solution method that makes better use of diversity. Because increasing the number in the collective is relatively easy with modern information resources such as crowdsourcing and because the collective diversity becomes saturated for a given method, the first option is less interesting here. Because traditional approaches focus on improving individual performance by education, training, experience to get better solutions, the second option is already being addressed. Therefore, the rest of this paper examines the last option of examining methods that make better use of diversity, by extending CI methods to more extreme forms of diversity (biases, different goals, conflicts) or by enabling emergent collective solutions.

BIASED COLLECTIVES: BREAKING THE OBJECTIVITY BARRIER

The first extension of CI methods does have precedence in other areas of research and applications, reflecting the shortcomings of requiring objectivity (a solution without bias) or generality in a complex world. For example, in mathematics, there are two historical geometries based on different starting assumptions about parallel lines: Euclidian where the parallel lines remain parallel and non-Euclidian where parallel lines diverge or intersect at infinity. Both geometries are useful representations of a "reality" such as your desktop and great circles on the surface of the earth, respectively. Yet, an objective and general geometry exists that encompasses both but is too complex to be useful. Hence, each of the biased geometries is useful by being tailored to its environment, yet is fundamentally incompatible with the other. And, the objective representation is too complex to be useful.

Now suppose that an individual uses one of the "biased" geometries to make a conclusion about their local reality. From an objective viewpoint, the individual is using a biased method, yet a collective solution can use the conclusion from the biased reasoning to capture a diversity of realities to obtain a higher truth, similar to the prior examples of CI. Therefore, even though individuals use biased heuristics to obtain a local truth, the collective can amplify the local truths to obtain an objective solution. The only requirement is that the different biases are not correlated in such a way that they corrupt the collective solution, the failure mode of herd thinking.

We can generalize the above observations, restated for the complexity of modern world. A system of beliefs can evolve to be functional and self-consistent, situated within their complex environment, but may not be objective because of biases. Certainly many cultures can be viewed from this perspective as they provide consistency and conformity (Bednar et al., 2010). Furthermore, each evolved belief system may not be compatible with other systems of beliefs. One culture is often not compatible with other cultures at a fundamental level. And – this is the most insightful – in order to extract a piece of the embedded truth, we often attempt to remove the truth from a system of beliefs to make it objective or unbiased, but in the process we may lose the context

Level	Type of Diversity	Source of Bias	Source of Conflict
1	Common social identity	Correlated preferences	Minimal conflicts possible
2	Shared goals and worldview, but without shared social identity	Correlated preferences	Miscommunication, misunderstanding,
3	Shared worldview, different goals	Goals don't represent problem	Opposing goals
4	Unbounded diversity, not associated with social identities	Correlated preferences, goals, ethics, …	Conflicting worldviews, goals, …
5	Unbounded diversity with opposing social identities	Polarization	Conflicts possible in all dimensions

TABLE 1 ~ *Operating guide of managing collective systems: possible levels of diversity, bias and conflicts.*

and meaning of that truth within the system of beliefs. Other fields have arrived at similar conclusions. For example, artificial intelligence in the 1980s achieved a major breakthrough by a situated and embedded approach to robotics, after three decades of failing to develop a general and objective intelligence model (Pfeifer and Scheier, 1999). In this example, a robot with relatively simple rules evolved in a complex yet real environment outperforms a general intelligence applied to the same environment.

These observations about non-objective, biased methods can be aligned with the earlier conclusions about collectives and diversity. When a problem is sufficiently complex, beyond the point where an expert has utility, diverse individuals capture portions of the truth as weak signals or structures that the collective can amplify and bring forth as a strong truth. Within this perspective, we claim that diversity can include biased representations of the problem, even though they may be incompatible with other individuals. Not surprising, this claim is in contradiction to all of the assumptions of the CI model studies cited earlier. Prior CI studies, both abstracted and applied, make the assumption that the individuals in the collective have shared goals and compatibility of shared information. Within this restricted viewpoint, diversity is expressed only by exploring and solving a common problem in the absence of bias and conflicts, but not including diversity as it occurs in more complex domains, for example, by allowing fundamental disagreement on options or miscommunications in understanding.

To advance this argument, an approach is needed to manage biases and conflicts as they occur in social groups. In the following, I prefer to use social group identity instead of culture as the more common way of capturing the dynamics of consistency and conformity in social groups (Bednar et al., 2010). Social group identity is a general concept that includes culture, in addition to the human tendency to develop social group identity from minor or random similarities that may not easily be described as culture (Ben-Ner et al., 2006; Akerlof and Kranton, 2000). A working definition of group identity is if someone does something to a person in your identity group, you feel like it was done to you. For example, if someone attacks a member in your family, you feel attacked.

Groups, organizations, societies with a common social identity have characteristics that are highly relevant for the management of diversity in a collective:

- *A common worldview*, meaning they agree on options, but can have different individual preferences of these options. In the prior maze study, all individuals agree on the connectivity of the maze, but may have different preferences at each decision point.
- *A common understanding and vocabulary of the world*, meaning they can communicate about the world around them without misunderstanding or conflict.
- *Uniform and tacit knowledge* that is not accessible to "others" outside of the identity group. Often tacit behaviour may be incomprehensible to others and seem irrational.
- *A unifying response to uncertainty or threats* that occurs by triggering the expression of social identity and causing individuals in the group to distinguish strongly between "self as a group" and "other." And when triggered, the identity group will coordinate behaviour (herd thinking) and actions, including acting irrationally (Cialdini, 2001, Wooten and Reed, 1998, Tesser, Campbell and Mickler, 1983). When triggered, the messenger is more important than the message.
- *Reinforcing social influence within the group and reactive influence between opposing groups*, particularly when in a triggered state. For example, conflicted identity groups will pick opposing actions, largely without rational choice[6].

From this list, you can see that a social identity group largely satisfies the prior CI assumptions and

restrictions, particularly on compatibility of goals, knowledge, communication, and actions. Therefore, we can use the concept of social identity to guide us when collective methods are likely to work, when and how they fail, and how to create methods that minimize the failure modes of collective processes in FIGURE 1.

Using the concept of social identity, TABLE 1 has levels of possible diversity, bias, and conflicts that can be expressed by individuals within collectives. The qualification of "possible" is added because different methodologies at each level can encourage or discourage the expression of diversity, biases, or conflicts. The table starts from highly aligned individuals at level 1 to individuals that are likely to have biases and conflicts, but may represent the full diversity of the problem.

The main insight from TABLE 1 is that diversity (unique contributions of individuals in a collective) is expressed at all levels, but is more likely to be aligned at the top and in opposition at the bottom. Likewise, biases (features of individuals that do not represent "truths") can potentially occur at all levels, but are more extreme and unchanging in the lower levels. And, the same is true for potential conflicts (features of the individuals that can cause friction in coordination): conflicts occur at all levels, but are more severe in the lower levels. Also note that each level can express the potential diversity, biases and conflicts of the levels above it. For example, level #3 can express biases in correlated preferences from level #1 and #2. In general, biases and conflicts of lower levels are much stronger and detrimental than in upper levels.

At the top level of the list (#1), a social identity group has the characteristics described earlier, so the diversity expressed at this level is largely in different preferences of options, but with no disagreement on those options. Biases and conflicts if they occur at level #1 are limited to preferences. Level #2 removes the restriction of a shared group identity, and consequently there may be biases and conflicts due to incompatibilities of communication, language, etc. Level #2 is expressed, for example, by a smaller organization with uniform activities and common goals, but without a company social identity. Level #3 releases the commonality of goals, but retains the common worldview (agreement on options at a decision point). Level #3 is expressed, for example, by a larger organization with a variety of activities and goals, but which has agreement on options. The last two levels capture types of diversity where the members of the collective have biases (disagreement on options), but without and with opposing social identities, respectively. For example, Level #4 describes when experts "agree to disagree", while Level #5 describes the failure mode of group conflict where experts strongly disagree, as might occur from a history of opposition, expressing opposing social identities in conflict (Ben-Ner and Hill, 2008).

TABLE 1 is an operating guide for managing collective systems and solutions. The type of diversity is largely determined by the problem and system of interest, and thereby indicates which level is active. Once the level is determined, the bias and conflict possible is then identified.

We now consider the evidence that each level in TABLE 1 can express CI. Most abstracted and applied studies of CI assume explicitly or implicitly the first two levels of diversity – capturing the requirement of a collective made up of individuals with common goals and some level of implicit coherence and compatibility in their worldviews.

In the prior studies of diversity and in the consideration of extensions of CI to biased systems, there is one requirement that must guide the following results and discussion: the random contributions of diversity must be uncorrelated, otherwise a correlated contribution may overcome the weak "true" signals or structures contributed by the individuals. Because bias is by definition a correlation in the contribution of an individual toward a certain behaviour, preference, option, or goal, in order for any individual contribution to not appear in the collective solution as bias, the diversity in each level of TABLE 1 must be sampled such that the contribution is uncorrelated. This requirement cannot be over emphasized.

The first evidence for the extension of CI methods comes from an evaluation of the robustness of the collective solution in the maze study[7] where I replaced valid preferences in the individual contribution with random noise, thereby creating false information. For the individual solutions, the addition of random noise was disastrous above a 30% replacement, essentially causing the individuals to relearn the maze. But the collective solution was very robust. At 30% replacement of valid information from the individuals, there was no change in the collective performance, and at 75% replacement, the collective solution recovered the optimal solution, requiring only twice the number of individuals in the collective. Only at a 95% replacement did the collective solution degenerate to a random walk solution (the worst heuristic).

These results are a powerful indicator that the collective solution can tolerate high levels of noise or false information and still retain a high level of performance. The only limitation, as noted above, is that the individual noise must be uncorrelated, in order not to overwhelm the collective "truth." The source of robustness was found to derive from a broad spec-

trum of contingency solutions that eliminate any sensitivity to false information. As the noise study above illustrates, these contingencies are very persistent, surviving high degrees of degradation. These results provide encouraging evidence that the collective solutions can tolerate high degrees of biases and conflicts, as more diverse systems are considered lower in TABLE 1.

Also in 1998, I did a study[8] where 100 individuals in the initial learning phase were divided into three groups, each with a different goal in the maze. Then, a collective used the aggregate information from these three groups to solve for each of the three goals. Hence, this is an example where a collective made up of individuals with experience of three conflicting goals tries to solve the three different problems, based on each of the goals. One might predict that because each subgroup of individuals only make up a third of the total, their contribution to the collective to find their goal would likely be overridden by the other individuals, so therefore the collective should perform poorly. The results are remarkable and contrary to this intuition.

The average individual performance was 39.6 steps when seeking the three different goals as individuals, compared to 12.8 steps when only the individuals were trained on a single goal. The large degradation in the individual performance is because an individual is trying to find the solution for two goals in which they have no experience. Remarkably, the average collective performance for these three goals was 12, compared to the average minimum number of steps to the three goals of 8.3 steps. Although the collective does not robustly find the optimal solution, as for the case when there is only one goal, I concluded "the experience of individuals with different goals still contains information useful to the collective, even though they result from a quite different goal. Said another way, while the goals for learning may differ, the connectivity on the problem domain is common"[9].

This demonstration suggests that individuals with experience from different goals, a source of extreme diversity, can still improve a collective solution, one that can far outperform the average individual. This supports the hypothesis that a collective of individuals having different goals still expresses CI and the Diversity Prediction theorem remains applicable. Hence, we can add collectives with conflicting goals of level #3 in TABLE 1 as a candidate for applied CI systems, greatly increasing the prior understanding of the applicability of CI.

In order to explore the collective performance for diversity level #4 in TABLE 1, I redid the maze simulations for this article using a collective of individuals that did not agree on options, examining the effect of strong local bias – one individual sees a corridor, where another sees a wall. Essentially, each of the individuals are exploring and solving different mazes, which have nodes in common, but have different options at the nodes. From a social identity viewpoint, a node could represent the act of eating, where a type of food is an option for one individual, but is forbidden to another.

In the simulations of conflicting options, I examined different levels of conflict by randomly eliminating options at decision points for each individual. When the level of conflicts in options was below 30% (3 in 10 decision points had conflicts), the individual solutions showed a minimal drop in performance of 5%, indicating that the individuals easily accommodated the changes in the maze. Similarly, the collective solutions still found the optimal path, and only required larger numbers of individuals in the collective for higher levels of conflicting options. Above 30%, both the individual and collective performance dropped, primarily because at 30% closure of options in the maze in FIGURE 2 caused the maze to be much more difficult to solve, as redundant paths are removed.

I also examined when conflicts in options occurred by subgroups rather than in all individuals, by creating 10 groups of 10 individuals, each with the same set of options, as might occur in 10 different identity groups. I observed that there was no difference between the two ways of distributing the conflicts in options. These results suggest that CI in this model problem is not highly sensitive to a poor sampling of biases (only three in this demonstration). Based upon these results, we can conclude that we can add diversity level #4 in TABLE 1 as a possible candidate for applied CI systems.

The final level of diversity, #5, is deeply challenging as conflict negotiators will share, because opposing social identities, when triggered, will act to subvert each other to the point of irrational, self-destructive behaviour. An abstracted model of this level of diversity would require the model to include behaviour, and none of the current computational behaviour models include social identity (Balke and Gilbert, 2014). The applied example of CI in the section after next shows how modern elicitation methods can address the deep conflicts of level #5.

One way to view the above expansion of diversity in CI systems is to observe that each level in TABLE 1 becomes another class of diversity that must be managed in the CI methods. For example, within each group of individuals with a common bias or goal or social identity, there is diversity in how these individuals solve the problem. And, for each of these levels of diversity,

we must be inclusive of all the variations. For example, if only individuals of one biased group are included, then the collective solution will reflect that bias as a failure mode of group thinking. Said another way, the sampling of diversity at each level must include sufficient variations. In CI applications, this requirement may prove challenging, because the different types of variation, such as bias, may not be evident or even knowable.

In the prior section, we concluded that the utility of CI depended on problem difficulty, the level of diversity, level of individual ability, and the how the collective amplifies the individual's weak signals. What we have suggested in this section is that the previous limits on CI are too restrictive, and CI methods can be applied to biased and conflicted individuals. Because the studies of these types of CI systems are still immature, this section is intended to open a new area of research and application that can significantly extend the applicability of CI methods to grand challenges. In the section after next, I provide an applied example of how modern expert elicitation and risk technologies can address all the diversity levels in TABLE 1, primarily by elicitation methods that do not trigger social identities and where everyone feels they are heard and included, even if their contributions are motivated by different goals, highly biased, or in conflict with other contributors.

EMERGENCE: WHERE DOES THE ARROW LAND WHEN THE ARCHER IS BLIND?

Unlike the last section that identifies an extension of CI by removing the assumptions and restrictions on prior CI applications, the extension of CI in this section goes far beyond releasing assumptions to opening fundamental philosophical questions about CI.

The classic example of emergent problem solving is when an ant foraging for food contributes its local solution to a collective solution, thereby enabling the collective of ants to robustly find the shortest path between the food source and the nest. The process by which the shortest path is discovered is not by picking the best performer (an expert selection paradigm), but is found by the synergy of a diversity of contributions (a CI paradigm), similar to the collective performance mechanism in the earlier maze studies. Because high diversity is essential to this collective performance (if all the ants took the same path, the collective can only take the common path) and the ant must have some level of ability to solve the local problem, the Diversity Prediction theorem would appear to be applicable. But a philosophical question arises: how can the average individual error be posed when the individual does not have a perception of the global problem and therefore of its own error. Only a researcher with a global perspective can evaluate the individual or collective error in an emergent problem. And, there is an even deeper quandary to the ant foraging problem: how is the shortest path found when the ants do not have the means or goal of finding a shorter length path in their own solutions?

As described earlier, the individual heuristics for the maze problem that I studied is to eliminate extraneous loops or dead ends, but not to find a shorter path. The discovery of a shortest path by a collective that has no goal to find a shortest path is what I called an emergent problem definition (Johnson, 1998), one step beyond an emergent problem solution. In my maze studies, the emergent problem definition and solution is a result of the structure of the maze in combination with the local individual heuristics (White and Harary, 2001).

Why is an emergent problem definition a philosophical quandary? In all the prior models for CI discussed, except for my maze studies, the goal of the CI problem is stated up front ("how many beans in the jar?" or "Who will win the Academy Awards?") and is understandable by the individual. Even in the situation of recommender systems, the concept that my purchasing history may provide good recommendations to others is stated and a methodology is created to achieve that goal. In an emergent problem definition, the goal is an emergent property of the system and is not understandable or defined from the level of the individual. This lack of connection of goals between levels could be deeply problematic. What if the emergent problem definition is not the "right" one or what if it doesn't have the "right" ethics? For example, individual ant heuristics could have generated, not a shorter path, but a longer path, for a given environment. A collective solution using these individuals would be disastrous to the ant colony. Clearly the ants' heuristics have evolved to provide the best collective outcome. But, in future emergent CI system, how do we create or direct the emergent problem definition or its emergent ethics?

Many researchers and practitioners of CI use collective wisdom in the place of CI, almost interchangeably (Hong and Page, 2011). Many of the aspects that researchers or practitioners attribute to a wise crowd arguably are also associated with an intelligent crowd. By introducing the concepts of emergent problem definition and problem solving to the CI discussion and resources, the possibility arises that collective intelligence and wisdom could provide both solutions and goals that are not expressed or expressible by the individuals in the crowd. This opens CI methods to unimaginable

opportunities. For a full discussion of the issues and opportunities that arise within the context of leadership, see the paper by Jennifer Watkins and myself (Johnson and Watkins, 2009). There are social expressions of emergent problem solving in human history, for instance, the fall of the Berlin wall caught the world and the intelligence community by surprise, mainly because it arose outside the normal power structures (Lohmann, 1994). Another example is the distribution of water in ancient Bali (Lansing, 2006).

Unlike the extension of CI proposed in the last section, the inclusion of emergent problem definition and solution as a resource for CI is barely appreciated, let alone understood or studied. The opportunity is similar to that of developing emergent or generative models that can express features or capabilities that go beyond the model itself, a common area of study in complex adaptive systems (Miller and Page, 2007). Until progress is made in understanding emergent systems, there are no recipes for what environments and local heuristics create the desired emergent functionality. What can be stated is that in the same way that the individual ability is amplified by the collective in traditional CI, likely the same is true for emergent collective problem definition and solution: the ethics and abilities of the individual will determine the emergent collective ethics and abilities. And, based on the discussion in the prior section, there is hope that even with bias and conflicts among the individuals, the emergent collective solution may represent the "best" of the individuals and not their "worst" attributes.

A GRAND CHALLENGE SOLUTION WITH BIASES AND CONFLICTS

The following is an example of the CI extensions discussed above, demonstrating that they can be used to solve a grand challenge. In 2004, President Bush released an Executive order, Biodefense Homeland Security Presidential Directive (HSPD-10), calling for a comprehensive, defensible, and transparent risk assessment to guide biodefense investments across research, development, planning and preparedness, impacting 100s of billions of dollars of US federal funding. While the goal was of national importance, nothing like this had ever been attempted before, largely because it was considered too difficult, partially because of the complexity and scope of the problem, but also because of the special interests of the political and scientific groups in maintaining the status quo. Said another way, while everyone agreed this was a grand challenge worth solving, the scientific and political experts disagreed on all aspects of the problem. In fulfilment of the order, I led one of three national efforts: the high-cost, high-risk, high-payoff option. The following is my account of the lessons learned. This is the first time I've used this as an example of advanced methods of CI.

By the end of the project, the effort required over 40,000 expert elicitations from more than 60 subject matter experts, across all technical and operational domains. And many of these "experts" were in deep disagreement on fundamentals, such as the range of parameters in infectious models, the proper treatment of specific illnesses like Ebola, or proper public intervention strategies during an epidemic.

The technical and operational approach evolved over a four-month period, until the following guidelines were used in the final project during the next 9 months. Interestingly, we were driven by the need to solve the grand challenge, which in turn created the use of CI extensions above, rather than any awareness that the CI extensions were needed to solve the problem. Although no published documentation of the project exists, other researchers have arrived at similar conclusions (Hallin et al., 2013).

1) *Use a methodology that captures the full expression of the problem domain, including possible biases and uncertainties.* The technical approach was a fuzzy-set data capture on a logic or inference tree. An inference tree, similar to the maze model described earlier, captured decision points that are connected logically from beginning to end, creating sequences of actions and decisions, including multiple paths. The fuzzy-set elicitation at the decision nodes allowed for multiple responses, enabling an individual to express uncertainty. Then the fuzzy logic provided risks (probability of a loss) for each decision path (a scenario).

2) *Use a methodology and elicitation that reduced or eliminated conflict between experts.* Because of the fuzzy-set elicitation and the comprehensiveness of the inference tree, each expert could contribute her elicitation independently from other experts.

3) *Use small group elicitation.* By using small group elicitation, conflicts that arise in large groups where individuals feel the need to defend their specific social or expert identities were avoided. Studies show that competition can lead to loss of cooperation even within small group (Barker, et. al., 2012). But, because each expert could express and see their contribution is included, competition generally was eliminated and conflicts were minimized. No attempt was made to filter biases or apparent inaccuracies.

4) *Engage as many stakeholders as possible.* The complexity of the problem required that all stakeholders were included. But a diversity of stakeholders of one expertise was also required in order to overcome technical biases and conflicts. The diversity of input

enabled uncorrelated biases to cancel, so that the "truth" from the biased diversity would arise in the collective aggregation.

5) *Use a methodology that didn't force a solution, but enabled surprise and innovation.* Because the methodology was process and outcome neutral, global solutions could arise, essentially connecting parts of the problem that weren't previously identified, providing solutions that were innovative and often unexpected. These surprises could be considered emergent solutions, although once identified, they were understandable due to the transparency of the method. An example of a surprise outcome was that for a broad class of respiratory infections that require ventilators in treatment, the shortage of ventilators in local health facilities created a major inability to respond to even a minor epidemic.

At the time we did not identify or appreciate how the above approach was an example of CI, and I only recently appreciated that the methodology also enabled biased and conflicted experts to contribute to a collective truth. This is an excellent example of how expediency drives innovation, which is only later appreciated.

We learned the following major lessons. The quality of the outcome was directly a result of the diverse and comprehensive contributions, without selection or elimination of biases. We learned that a process, which included all of stakeholder diversity, led to better solutions (higher performance) and were more robust and resilient (performed well with changes). Had we started by choosing the "best" experts to contribute, we would have replicated our biases, and the results would have suffered, or even been unusable. Also, by using a process where all stakeholders participated from the beginning, the involvement in the process and acceptance of the final outcome was high. The full involvement of stakeholders also had the additional advantage that the deployment benefited from broad support. This is a major lesson in solving grand challenges: a good idea or program can fail by not engaging the diverse stakeholders from the beginning. We found that even if stakeholders didn't agree with the conclusions of the project, they could see how the results were obtained from a transparent process and could identify how their contributions were included. This increased acceptance of the outcome and reduced conflicts, even when the results were contrary to a special interest or a paradigm.

OPTIMISM FOR SOLVING HUMANITIES GRAND CHALLENGES

We began this exploration with reflections on how program managers of a multi-billion dollar federal agency choose not to solve grand challenges, because it apparently perceived that within an expert paradigm, collective expert methods are deeply challenged. Hence, it solves problems that they think they can solve, rather than ones they want to solve. While this generalization is probably unfair for a complex organization that undeniably is serving the public interest, these perceptions of the failure of expert collective systems and of the reluctance of organizations to address grand challenges are our common experience. Juxtaposed with these perceived limitations, the mainstream science of CI, of which I was an integral player, offers attractive alternatives of diverse collectives outperforming experts and collectives of experts, but where the requirements of the abstracted studies and popular CI champions are unlikely to be met in real world grand challenges. Most pointedly, CI methods are not expected to be applicable when the problem domain contains conflicting goals, biases, or conflicts between opposing groups.

We saw that this dismal observation on the state of CI applicability is likely to be inaccurate, after a review of the remarkable fringe CI research on how groups of low performers, noisy individuals, conflicted individuals, and biased individuals can express robust CI. A radical perspective then arises on how collectives of biased and conflicted individuals embedded in their situated environments can be resources for CI, without first extracting their objective or unbiased contributions. Furthermore, in the most difficult grand challenges that are poorly defined in understanding and goals, CI methods that employ emergent problem definition and solution can provide resources that truly solve the most challenging problems facing humanity. Indeed, this emergent resource may be the wizard behind the curtain that has repeatedly saved humanity at many ancient and historical transitions.

In order to better manage this new inclusion of diversity in grand challenges applications, the concept of social identity groups is introduced, both putting into context the mainstream CI research and well as the CI extensions needed to solve grand challenges. In order to show that the ideas presented are achievable with current methodologies, an example is given of a grand challenge project that successfully addressed a national problem where experts deeply disagreed and were often in conflict. All together, the concepts presented and discussed provide reasons to be optimistic that humanity can address our grand challenges, not by relying on our experts, but by fully embracing humanity's full diversity. The more complex problems of our modern times will require new resources that are collectively enhanced, capturing our greater understanding of applied methods of CI in the presence of biases and conflicts.

[1] This is an earlier draft of Scott Page's book "The Difference", and is more technical than the final book.

[2] Johnson, 1998: 22-24.

[3] Johnson, 1998: 32-33.

[4] Johnson, 1998: 26-28.

[5] Johnson, 1998: 34-36.

[6] This is an excellent example of why social identity is a clarifying concept: while many behavioral theories include social influence, the effect can be negative or positive depending on social identity groups.

[7] Johnson, 1998: 28-29.

[8] Johnson, 1998: 33-34.

[9] Johnson, 1998: 34.

♦

BIBLIOGRAPHY

Akerlof, G. A. and R. E. Kranton (2000). "Economics and Identity", *Quarterly Journal of Economics* 115: 715-753.

Balke, T. and N. Gilbert (2014). "How Do Agents Make Decisions? A Survey", *Journal of Artificial Societies and Social Simulation* 17(4): 13 <http://tinyurl.com/ld5ycxz>. [retrieved 1 Nov 2014].

Barker, J. L., P. Barclay, and H. K. Reeve (2012). "Within-group competition reduces cooperation and payoffs in human groups." Behavioral Ecology 23: 735-74.

Bednar, J., A. Bramson, A. Jones-Rooy, and S.E. Page (2010). "Emergent cultural signatures and persistent diversity: A model of conformity and consistency", *Rationality and Society* 22(4): 407-444.

Ben-Ner, A. and B. P. McCall, and M. Stephane, and H. Wang (2006). "Identity and Self-Other Differentiation in Work and Giving Behaviors: Experimental Evidence", FEEM Working Paper No. 103.06 (August 1, 2006) <http://tinyurl.com/mtgylb2> [retrieved 1 Oct 2014].

Ben-Ner, A. and C. A. Hill (2008). "Reducing the Negative Consequences of Identity: A Potential Role for the Nonprofit Sector in the Era of Globalization", *Annals of Public and Cooperative Economics* 79(3-4): 579-600 <http://tinyurl.com/mgod58e>.

Cialdini, R. B. (2001). *Influence: science and practice* (Needham Heights: Allyn & Bacon).

Hallin, C.A., T.J. Andersen, & S. Tveteraas (2013). "'Fuzzy' Predictions for Strategic Decision Making: A Third-Generation Prediction Market", *Center for Global Strategic Responsiveness Working Paper Series*, No. 2 December 2013 <http://tinyurl.com/n8shvp2> [retrieved 1 Nov 2014].

Hong, L. and S.E. Page (2001). "Problem Solving by Heterogeneous Agents", *Journal of Economic Theory* 97:123-163 <http://tinyurl.com/mofnard>.

—— (2004). "Groups of diverse problem solvers can outperform groups of high-ability problem solvers", *Proceedings of the National Academy of Sciences* 101(46): 16385-16389.

—— (2011). "Some Microfoundations of Collective Wisdom", unpublished paper, <http://tinyurl.com/kr9q6fv> [retrieved 1 Sept 2014].

Johnson, N.L. (1998a). "Collective problem solving: Functionality beyond the individual", Technical Report (Los Alamos, NM: Los Alamos National Laboratory) <http://tinyurl.com/n4rmv2p> [retrieved 1 Oct 2014].

Johnson, N.L. and Watkins, J.H. (2009). "The Where-How of Leadership Emergence (WHOLE) Landscape: Charting Emergent Collective Leadership" <http://tinyurl.com/lgrkbw7> [retrieved 1 Sept 2010].

Lansing, J.S. (2006). *Perfect order: Recognizing complexity in Bali* (Princeton: Princeton UP).

Lohmann, S. (1994). "The Dynamics of Informational Cascades: The Monday Demonstrations in Leipzig, East Germany, 1989-91", *World Politics* 47(1): 42-101 <http://tinyurl.com/lfuza26>.

Miller, J.H. and S.E. Page (2007). *Complex Adaptive Systems: An Introduction to Computational Models of Social Life* (Princeton: Princeton UP).

Page, S.E. (2005). "A Logic of Diversity: Why Diversity May Trump Ability", August 3, 2005. Earlier draft of Scott Page's "The Difference" (2007).

—— (2007). *The Difference: How the Power of Diversity Creates Better Firms, Schools, Groups, and Societies* (Princeton: Princeton UP).

Page, S.E., and L. Hong (2012). "The Foundations of Collective Wisdom", H. Landemore and J. Elster (eds), *In Collective Wisdom* (New York: Cambridge UP).

Pfeifer, R. and C. Scheier (1999). *Understanding Intelligence* (Cambridge: MIT Press).

Rodriguez, M.A. and J.H. Watkins (2009). "Revisiting the Age of Enlightenment from a Collective Decision Making Systems Perspective", *First Monday* 14(8).

Shalizi, C. (2005). "The Logic of Diversity: The Complexity of a Controversial Concept", *Santa Fe Institute Bulletin*, 20(1): 34-38.

Surowiecki, J. (2004). *The Wisdom of the Crowds* (New York: Doubleday).

Tesser, A., J. Campbell, and S. Mickler (1983). "The role of social pressure, attention to the stimulus, and self-doubt in conformity", *European Journal of Social Psychology*, 13: 217-233.

Watkins, J.H., M.A. Rodriguez (2008). "A Survey of Web-based Collective Decision Making Systems," in R. Nayak, N. Ichalkaranje, and L.C. Jain (eds.), *Studies in Computational Intelligence: Evolution of the Web in Artificial Intelligence Environments*: 245-279. (Berlin: Springer).

White, D.R. and F. Harary (2001). "Collective Pathfinding and Coevolution: A Graph Theoretic Model", Unpublished paper, <http://tinyurl.com/n2vqfgl> [retrieved 7 May 2013].

Williams, K.Y. and C.A. O'Rielly (1996). "Demography and Diversity in Organizations: A review of 40 years of research", *Research in Organizational Behavior* 20:77-140.

Wooten, D.B. and Americus Reed II (1998). "Informational Influence and the Ambiguity of Product Experience: Order Effects on the Weighting of Evidence", *Journal of Consumer Psychology* 7(1): 79-99.

JIM ROUGH

THE CIRCLE:

STRUCTURING FOR COLLECTIVE INTELLIGENCE

Jim is a professional facilitator, social innovator, author and director of the Center for Wise Democracy (www.wisedemocracy.org). He originated Dynamic Facilitation (www.dynamicfacilitation.com) and the Wisdom Council, and is principal facilitator for the seminars Dynamic Facilitation and the Wisdom Council, *which are widely known all over the world. Jim is author of the book* Society's Breakthrough! Releasing the Essential Wisdom and Virtue of All the People. *Largely, in his career Jim has worked independently helping organizations and people spark deep systemic change. He also worked as an internal consultant within Boeing, Xerox, IBM, and Simpson Timber Company. His education includes a BA in physics from Occidental College, MSEE and MBA degrees from Columbia University, plus years of independent study in Jungian psychology. He can be reached at jim@WiseDemocracy.org .*

THE STORY

Once upon a time... a continent of people came together as "We the People" to consciously structure a new system of governance. The new structure focused on making individual lives better, but the process of creating it was an exciting example of collective intelligence. We the People were thoughtful together, determining a structure that was best for all. Then, for two hundred plus years, subsequent generations lived by that structure. And, even though the system was oriented to promote individual happiness, collective intelligence improved as well.

Eventually however, as people became more interdependent, the system began breaking down. It was based on competition, the pursuit of self-interest at the expense of others, and adding up individual judgments for voting. Conversation was not its strong suit. The system was left in charge of itself, directing the energies of people toward mindless economic growth and consumption at the expense of the planet, human health, and community values.

What was needed in that dire situation is obvious now. The people needed to talk together. They needed to come together in respect and make intelligent choices, just as their Founders had done. But this seemed impossible to them. The Founders seemed like special people living in a special moment.

The people didn't recognize their collective potential, their capabilities as "We the People." Many acted in service of the whole by fighting to influence legislation or compassionately helping others. But the real need was for all to take "time out," talk, and act together. Social innovations were available to do this.

Generally they did not question the system of which they were a part. Instead they tended to deny the existence of collective problems, or relied on elected officials, the marketplace, experts, or the Founders themselves to address them. Most people thought that the problems arose because society had departed from the original vision of the Founders. But this was wrong. The time of the original Founders had come and gone. These problems required that all become involved, that all work together on a regular basis. This simple step would mean a new system of economics and politics, a new set of Founders and a new "We the People." To shift from collective stupidity to collective intelligence, turning back the clock was not an option. Instead, it was up to a few people to understand how this change could be facilitated, to convene the conversation, and to invite all the people to participate.

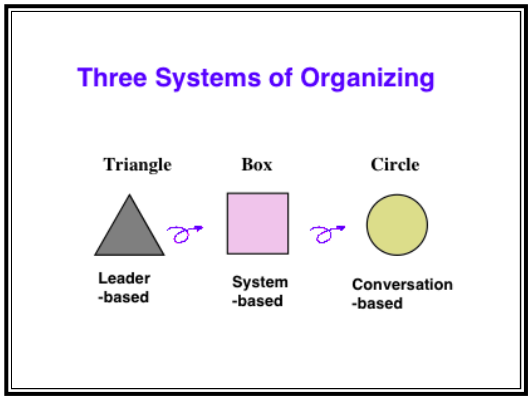
This story is more accurate than most people might think. The main inaccuracy with it is that the first version of "We the People," words that began the US Constitution, wasn't a real "We the People." It didn't include slaves, women, Native Americans and non-property holders. But the rest of the story is pretty accurate. We really do live in a system that is in decline, taking us where no one wants to go. There really is a set of practical social innovations by which the people can be facilitated to come together as "We the People." Just a few people, plus financial resources, can use those social innovations to set the process in motion. And just the addition of this new "We the People" conversation would shift to a new level of collective intelligence, a new system of democracy.

THREE SYSTEMS OF ORGANIZING

For over twenty years I've been teaching seminars on "Dynamic Facilitation," a strategy for helping leaders evoke the best from people. In the seminars participants practice Dynamic Facilitation skills in small

groups helping others address impossible-seeming problems, often issues from society like war, health care, or money-in-politics. In these conversations people often experience breakthroughs in understanding. A frequent breakthrough occurs, no matter what issue people address… *This problem is caused by our system. To address it, we need to change our system.*

There are three fundamental systems of organization whether in a school, corporation, hospital, government agency, or society. The three systems are: 1) Triangle, based on hierarchy, where one leader is ultimately in charge; 2) Box, where a prescribed set of agreements like a constitution is ultimately in charge; and 3) Circle, where the ultimate authority is a creative conversation of everyone seeking what's best for all. Today many people desire the Circle System, where employees, citizens, or organizational members evolve common understandings and shared vision, and where the best talents and skills of everyone are evoked. But the Circle is difficult to achieve.



Each of the three Systems is best in a different setting, has a different structure, promotes a different attitude in people, requires different leadership competencies, generates different results and evokes a different kind of conversation.

The Triangle, with a charismatic leader and a hierarchical structure, works well for organizations in crisis, like in a war or a catastrophe. The collective intelligence of the organization is limited by the capabilities of the leader. People in the organization contribute to the shared effort, but limit their contributions by never questioning the leader or anyone of higher status.

The Box System works well when people are independent and there are plenty of common resources available, like farmers and fishers in North America in the 18th century. Then there can be a clear set of rules that are fairly enforced. People can just go into the world and make their fortune independently. This system encourages innovation through competition rather than cooperative efforts toward what's best for all.

When people are equal and inter-dependent and the issues are complex, the Circle is best. Seemingly this applies to unions, cooperatives, membership organizations, and societies where democracy is the aim. But in practice, these organizations are often rigid Boxes or even Triangles because the Circle has proven so difficult to achieve. Small organizations are most capable of achieving a Circle because everyone can gather and know one another. But as corporations grow to become publicly traded, for example, the organization often reverts to the Box or Triangle.

Western democracies are currently structured as Boxes, where we assume everyone is to operate as a free individual within the law. Voting and the marketplace are structured in place for collective decisions, so there is little need for conversations about the well being of the whole. But as inter-dependence grows we need all the people to engage in this conversation and to become part of the answer. A majority vote is not enough. And it is no longer acceptable for corporations to maximize profits at the expense of the commons.

So naturally today, given that we are embedded in the Box system, we face a growing number of collective problems like an environmental crisis, an L-curve distribution of wealth, rapid depletion of natural resources, mindless consumption, periodic banking crises and wars, etc. From within the Box system these problems all seem impossible to solve. We look to solution strategies like making people aware of the problems, educating them, pressing for legislation, or raising individual consciousness. But these within-system strategies won't make the needed difference. However, if we could facilitate a Circle system into place then we'd all be caring about one another and working together to address these problems. Then many impossible-seeming problems – like racism, partisan gridlock, bullying, and lack of shared purpose – would start going away. And finally we could begin restructuring our institutions to address issues like climate change, the mal-distribution of wealth, and depletion of vital natural resources. Key to achieving a Circle system is to recognize the special kind of conversation that's needed.

CHOICE-CREATING IS THE ESSENTIAL CONVERSATION

Each of the three systems generates a different kind of conversation. In the Triangle people learn to suppress their own ideas and enthusiasm in favour of what the leader thinks and feels. The conversation

revolves around who is speaking and their status rather than the merit of ideas. To make a difference in the organization people look to someone in a position of authority, or to gain authority.

The Box limits our thinking as well. In it people veil their attention to focus on extrinsic goals, rules, and the game-like field of play. Their thinking is directed to their own lives and strategies for getting ahead rather than what they really want, or what the society needs.

In the Box we are directed to use our judging minds more than our creative minds. We call it "decision-making." Voting is the ultimate expression of decision-making and of what we call "democracy," yet we see that the results of elections and our collective decisions can't make that much difference. If any conversation exists in the Box it is likely to be an argument over simplistic strategies that benefit special interests, rather than respectful attempts to determine and implement solutions in the public interest.

Shifting to the Circle system requires a type of conversation that is different than the kinds of conversation used in "decision-making," like debate, agree/disagree discussions, arguing, or power struggle, where one option wins. Even with "deliberation," people thoughtfully weigh different options before choosing one.

There is another kind of conversation needed. It is like what happens sometimes in a crisis, or a "time out." People drop their roles and their blind adherence to rules and norms. They become authentic with one another and face the important issues sharing their feelings. They work collaboratively and creatively together and reach shared perspectives. Unlike collective decision-making, everyone needs to be included in the process and unity is the only possible result. We call this form of conversation "choice-creating."

With choice-creating groups often overcome challenges that seemed impossible beforehand… by redefining the problem, transforming themselves, gaining clarity about what needs to happen, or by inventing new and better solutions that all support. Although people often confuse "decision-making" and "choice-creating," the two are almost opposites because judgment and creativity cannot co-exist. In decision-making judgment is used while in choice-creating people engage one another with heartfelt creativity until the choice comes into view.

The ultimate answer is to convene a new system-wide conversation in the spirit of choice-creating. And if we make this to be ongoing, we restructure our system of thinking so that it's normal to face the collective problems and become empowered as "We the People."

TO RELIABLY EVOKE CHOICE-CREATING

Dynamic Facilitation (DF) is a way to facilitate people to address issues in the spirit of choice-creating. It is guided by the energy of how much they care about the issue, their fears, or the passion of their advocacy, more than by extrinsic factors like guidelines, roles or an agenda. It provides a way people can release their creativity, face impossible-seeming issues, and achieve breakthrough progress and group unity. This natural unity only seems unnatural and difficult to achieve because we live in a decision-making context.

The DF'er invites each person to speak naturally yet holds the space in such a way that they talk and think in the spirit of choice-creating. The DF'er might set up the room with a half-circle of chairs facing four charts – Solutions, Data, Concerns, and Problem-Statements. These charts are used to protect people from judgment and to build a story of group progress from all comments. For example, if one person is describing an idea, the DF'er will be writing that down on the chart of Solutions. Then if someone else starts to disagree, the DF'er might ask the person who is interrupting to direct his comment to her, rather than to the person with whom he is disagreeing. She will then record the comment as a Concern, not as a disagreement, and invite him to offer his Solution as well, "So what might be an even better answer?" This comment is added to the list of Solutions. Then the DF'er can go back to the first person and help him finish articulating his solution.

Using this approach, no one is judged. There is no agreeing or disagreeing. Each comment is valued and added to the charts as an interesting piece of the puzzle. People grow in curiosity and creativity seeking to solve the puzzle. Shifts and breakthroughs naturally result and all come to embrace the final result.

I once had the opportunity to DF a weekly meeting among angry and frustrated employees in a sawmill. Over the course of many meetings they began to work in the spirit of choice-creating. Productivity and quality took off! The energy of frustration became the energy of community. They became more cooperative, curious, informed, and observant. They understood more, trusted more, risked more, and achieved more. Working together in this way these low level employees transformed the management system, culture and performance of the mill.

TRANSFORMING FROM TRIANGLE OR BOX TO CIRCLE

Witnessing this bottom-up transformation helped me to recognize a strategy for how we as a society could transform ourselves from Box to Circle. In 2002 I

wrote *Society's Breakthrough! Releasing Essential Wisdom and Virtue in All the People** about it, describing how a seemingly innocuous US Constitutional Amendment could spark a national and global coming together of "We the People." I called the process within the Amendment the "Wisdom Council." Now, years later there have been many experiments with the Wisdom Council in organizations, communities, cities, conferences and even states. We know that this process can work. It can spark the necessary whole-system choice-creating conversation. And we know it's something a few of us can set in motion at a national and global scale without needing an Amendment.

In the Wisdom Council, every four months or so, twelve people are randomly selected and gathered as a microcosm of all. Each Wisdom Council meets for a couple of days with a dynamic facilitator. They choose an important issue or are given an issue and reach shared conclusions through shifts and breakthroughs. The Wisdom Council then presents this unity and the story of how it was developed back to everyone. Then all the people are invited talk in small groups, face to face, over the telephone, or via the Internet about what they have heard and what they think. Resonance builds. Those who hear directly tend to say, "Yes, I think so too!" ... and they help continue the conversation, taking up where the Wisdom Council left off.

The Wisdom Council process achieves this magic, where large groups create the choice together, because choice-creating is the form of thinking it emphasizes, even among those in the larger audience who were not dynamically facilitated. People in the larger system tend to build on what is happening more than they judge it. For instance, if someone in the audience differs with the Wisdom Council conclusions, they have an unusual perspective. Others are interested to know more about that perspective. They listen and seek ways to incorporate it. This is not how a normal political conversation works, where you go back and forth agreeing and disagreeing and where those with minority views become excluded. In a Circle system, different perspectives are valued.

This level of change might seem unrealistic or scary. But it works and it's safe. One way of looking at it is… we just randomly select a small group of people every few months, who are dynamically facilitated, who give a talk and go away. Another way is to realize that adding the Wisdom Council process to national society or to global society doesn't directly change anything. It just adds a new conversation to what already exists. But in this conversation we finally start talking about the big issues we face, that we have largely been ignoring. And we talk in a way that we can be ourselves, and be heard and respected, and where we start making real headway.

For example, in the heart of Bregenz, a city on Lake Constance at the westernmost edge of Austria, is a parking lot. Over the years it's been difficult to develop any key parcel of land like this because each development proposal generates a political battle. To move the project ahead without the usual battle the mayor convened a "Wisdom Council." The twelve random citizens met briefly to listen to the latest project proposal. Then the door was closed and they were dynamically facilitated. At the end the Wisdom Council expressed their unity, which was powerfully resonant in the community. They said … *People want to be more closely linked to the lake and this project offers a once-in-a-lifetime opportunity to do this. We could take advantage of this opportunity if the centre of gravity for the project were moved to the second floor and there was a wide bridge over the highway and railroad, with a sweeping set of steps to the lake.*

The Wisdom Council presented this perspective to investors, architects, city planners, activists, and citizens. Then each Wisdom Council member spoke how enjoyable and rewarding it was to be on the Council. The audience turned their chairs and met in small groups to consider this perspective. The evening presentation was more like a celebration because everyone was on board, including the developers who proceeded to modify the project plans.

In Ashland, Oregon three citizens organized a Wisdom Council in their county. They arranged for a randomly selected group of registered voters to come together for a day and a half and be dynamically facilitated. The Wisdom Council presented some simple points to the community that resonated widely… "We need to wake up, recognize that our society isn't working, take charge, make politicians more accountable, and we need to start implementing common-sense actions, like adequately funding education." This was just a one-time experiment but it generated a new momentum in the community with many important developments. A number of citizens said the experience was life changing for them. They began a citizens' movement that reshaped the town charter.

In another example, one division of the Department of Agriculture of Washington State initiated a Wisdom Council, which lamented how the Department no longer had the spirit of community it once had. With the Internet and emails people were working more in silos. From that one experience the people of the division found themselves reconnecting with one another in new ways. Later Wisdom Councils were expanded to include the whole Department, state-wide, where employees exclaimed they had finally "bridged the

Cascade Mountain Barrier," which had always kept the department in two separate cultures.

So, more and more we are inter-dependent with others. Yet we are structured as though we are independent. This means we ignore how life really works and assume, for instance, that we can increase our collective intelligence by increasing the individual intelligence of people. No. Not necessarily. And it assumes we can vote on the best decision and ignore the minority, when really we need to create the choice together. The longer we ignore the new reality the more dangerous and stupid our collective actions become, like to threaten the well being of our children with climate change, species extinction, resource depletion, poisons in our diet, etc.

This article presents a safe, practical way to keep our current systems in place but to facilitate the needed shift in collective intelligence so we can deal adequately with our problems. But the ideas expressed here are new, not part of the Box paradigm around which we have structured our identities. So even though this approach proposes a practical safe strategy for change at the collective level, it tends to fade quickly from memory without reinforcement. We hope the reader will continue to develop an understanding of this approach after reading this article and will suggest some possible actions going forward: 1) notice how the game-like structure of our system undermines collective intelligence; 2) notice that the distinction between decision-making and choice-creating is valid and that making it opens doors of possibility for individual and collective intelligence; 3) explore how Dynamic Facilitation can reliably evoke choice-creating in small groups; 4) remember the Wisdom Council process, this out-of-the-box solution strategy, when talking with others about societal problems; 5) look for opportunities to support or get involved with convening a Wisdom Council process.

Oh, and one thing more… the Wisdom Council process is proving to be fun. For people randomly selected to be on Wisdom Councils, many have said, "This the best political conversation I've ever been in." Or, "If you get randomly selected, do it!" It's also fun for the conveners.

⊙

---

* (Ed's N.) ~ Jim Rough (2002). *Society's Breakthrough! Releasing Essential Wisdom and Virtue in All the People* (Bloomington, IN: AuthorHouse).

⊙♦⊙