March 5, 2003

SPECULATIONS ON THE EVOLUTION OF GENIUS

Since the time of Thales, the first Greek scientist, man's ultimate unit of intellectual performance has been individual genius. However, the 20th century as seen the environment change. Today we are confronted with deep multi-disciplinary challenges where no individual can grasp all aspects and nuances of a field like quantum mechanics. Perhaps man's intellectual processes need to evolve in response to this new multi-disciplinary environment. This paper suggests that we must learn how use tightly integrated teams of experts to think more effectively.

Let us narrowly define "genius" as a particular type of intellectual performance: the ability to synthesize elegant new ideas that have a profound impact on our civilization. There are two parts to this definition: performance and impact. Remarkable intellect alone, or remarkable performance in some obscure niche, does not count.

By this definition, genius is the highest expression of successful inductive reasoning; the reorganization of a diverse assortment of facts into an elegant new pattern that reveals Nature's fundamental beauty. Civilization has benefitted from genius, not only in science, but in a wide range of fields throughout history. In 600BC Thales taught that the world is not controlled by gods and demons but follows natural law that man is capable of understanding. With this idea, Thales and his peers sparked the golden age of Greece. More recently, the scientific accomplishments of Newton, Darwin, Einstein clearly place them into our genius category.

WHAT HAS GENIUS ACCOMPLISHED LATELY?

The twentieth century saw extraordinary progress in science and technology: quantum mechanics, computers, biotechnology ... And yet most of the progress has come from a large number of small steps rather than from great intellectual leaps. While progress has been massive, it has been evolutionary, small steps optimized to local conditions. The nature of our progress during the last half of the twentieth century has been qualitatively different than the great insightful leaps at the turn of the century.

A good transition example is quantum mechanics, hailed as one of the great intellectual achievements of the twentieth century. And yet, there is something missing. Quantum mechanics is a set of equations that work extraordinarily well. We can calculate the magnetic moment of the electron and compare it to experimental data to an accuracy of nine significant places. And yet after 80 years, the conceptual model, the physical reality that is represented by these equations, continues to elude us.

If our ability to think has limits, how would we know?

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A conceptual model underlying quantum mechanics is critical to a true understanding. It is the model the provides the basis for inferring new concepts. When Einstein published his theory of special relativity, he did not invent a new set of equations, they already existed (the Lorentz Contraction). Einstein's accomplishment was the conceptual model. He replaced the concept of ether with variable space and time. It was his conceptual model that led to general relativity and black holes.

FRUSTRATION METAPHORS

This qualitative shift in the effectiveness of our intellectual progress has not gone unnoticed. On occasion, perceptive practicing scientists express their frustrations, sometimes through allegory or metaphor. Their thoughts are noteworthy because they offer occasional clues.

- David Mermin, a Cornell University quantum physicist, uses lighthearted allegory to express a serious concern.[1] His fictional professor Mozart looks at all of the accomplishments since WW II and concludes: *"I have to admit that particle physics over the last 40 or 50 years has been a disappointment. Who would have expected that in a half century we wouldn't learn anything really profound."*

- In *Dreams of a Final Theory*,[2] Steven Weinberg, a Nobel Laureate in physics, is more serious but also very perceptive. He suggests a cause: *"In our hunt for the final theory, physicists are more like hounds than hawks; we have become good at sniffing around on the ground for traces of the beauty we expect in the laws of nature, but we do not seem to be able to see a path to the truth from the heights of philosophy."*

- Robert W. Luckey, an IEEE editor, was asked to edit material for a new edition of an encyclopedia in the field of communications theory.[3] While the biographies contained the familiar pioneers, there was nobody after 1950. Who to add? He was shocked to realize that aside from Claude E. Shannon, there was no one. *"... now there is a cast of millions, doing such important but forgettable things as creating small variations on the details of protocols."*

- John L. Casti, a mathematician at the Sante Fe Institute, wrote a review of John Horgan's *End of Science* book for the magazine *Science*. While disagreeing with Horgan's thesis, Casti writes: "*There is one genuinely interesting point struggling to emerge from this whole debate. It is not whether science as we know it is coming to an end. Rather, it is whether the real world may be just too complex for the human mind to comprehend.*"[4]

Casti points to an intellectual limit. Weinberg characterizes that limit as an inability to achieve the view of the hawk, perhaps an inability to simultaneously achieve the view of the hawk and the hound. We get other clues by looking at complex man-made systems such as a 747 airliner. A remarkable aspect of the 747 is that nobody understands how it works – that is, no one person understands to the same depth that the Wright Brothers understood all aspects and nuances of the Flyer.

MULTI-DISCIPLINARY HYPOTHESIS

These frustration metaphors provide a partial basis for inferring a multi-disciplinary hypothesis:

The most gifted individual is unable to draw inductive inferences
when the multi-disciplinary roots are sufficiently broad and deep.

This hypothesis is consistent with the Gestalt theory of problem-solving.[5] Gestaltists teach that the primitive elements of some problems are so interrelated that the whole problem must be solved at once – the process of insight. Furthermore, they teach that a precondition to insight is the intellectual capacity to grasp all aspects and nuances of the problem in depth.

By the definition of a multi-disciplinary problem, different people understand different facets. In some form or fashion, the solution of multi-disciplinary problems requires multi-disciplinary teams.

OBSTACLES TO INSIGHT via MULTI-DISCIPLINARY TEAMS

The past 50 years have seen the emergence of remarkable two-person collaborations. Crick and Watson beat Linus Pauling in the race to discover DNA structure because they avoided conceptual errors made by Pauling. This would suggest that we can overcome multi-disciplinary limits by forming effective groups. If two is better than one, why not three? Why don't we see remarkable three-person collaborations? One answer lies in the psychology of how people interact with each other. The introduction of a third person changes the nature of the communication.[6] Groups larger than two need some mechanism for co-ordinating their efforts, a leader. Maier pointed to leadership as the critical factor in determining whether or not groups can outperform individuals.[7]

A second factor inhibiting the formation of effective groups is cultural. Science cultivates individual genius. The basis for this is the historical fact that most of the great conceptual leaps have been made by individuals working alone with the right combination of talent, passion and drive. The resulting individualistic culture of science has become highly competitive with rewards and grants are made on the basis of the quality of ideas. The best idea wins. What better way to discourage the deep sharing of ideas and speculations.

Modern communication networks result in the fast efficient sharing of information. Everyone pursues similar lines of inquiry and there are very few isolated individuals pursuing truly unique directions. Multi-disciplinary work has become the superficial sharing of information. Participants approach the multi-disciplinary team from the perspective of how can the other guy's work help me win. One result is patchwork theory that resembles a family farmhouse with rooms added over the generations without an overall plan (e.g. quantum mechanics).

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NEW DIRECTIONS

Physicist David Bohm defined **dialogue** as an intimate form of discourse.[8] According to Bohm, dialogue integrates individual views to establish a "pool of common meaning." Strengths and weaknesses are exposed and debated in an intellectually open, honest search for meaning. The full depth of each participant's experience is explored to develop coherent concepts. The objective is to understand. Scientists have tasted Bohm's dialogue — in rare one-on-one collaborations that begin to have a life of their own, taking them in directions and discovering ideas that never could have been imagined or planned in advance.

In recent years, psychologists have learned something about the cognitive processes that produce extraordinary insightful leaps. Genius is no longer viewed as an extraordinary process but rather as exceptional application of ordinary cognitive processes.[9] Analog and metaphor is providing a theoretical basis for insightful mental leaps.[10]

The interesting question is whether balanced small groups of experts can outperform gifted individuals in the synthesis of elegant, tightly integrated ideas. The fact that we cannot point to past success does not mean the approach is wrong, rather it could be that we have not figured out how to implement it effectively. Simply assembling groups of smart people clearly does not stimulate the discovery of ideas. It would appear that we need to learn more about how to cultivate and expand Bohm's dialogue. Participants can compete with the rest of the world as a group. Within the boundaries of the group, participants with suitable support can search for dialogue – sharing of speculations, hopes and dreams, doubts and fears. It is important to recognize that each participant has only a piece of the puzzle. The productive struggle is to adapt and fit these pieces into overarching concepts. The business world recognizes this. Trainers are now able to deliberately establish deep dialog in small groups of high performance experts.[11]

Man has evolved in many different ways over the millennia. Perhaps our intellectual processes now need to evolve in response to the deepening multi-disciplinary intellectual environment.

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