

**CSC “Managing in Complexity Series” Lecture on  
"Complexity in Biology - Lessons for Today's Organisations"**

**by Professor Edison Liu, Executive Director,  
Genome Institute of Singapore, A\*Star**

**18 November 2009**

Prof. Edison Liu began his lecture highlighting the fundamentals of genetic science and biology and their importance towards life. He then addressed the two principles of the survival strategy of a biological species, i.e., adaptability and diversity, principles which he considered applicable for organisational excellence. Adaptability is the key for survival at the organismal and the population level while generating diversity is an essential strategy to create adaptability.

There are two broad ways to create solutions - engineering and evolutionary - which are pertinent in civil service and public policy:

| <b>Engineering Solutions</b>           | <b>Evolutionary Solutions</b>                      |
|--|--|
| Identify the problem                   | Start with a minimal unit                          |
| Parameterize the components            | Generate Diversity                                 |
| Devise a solution from known templates | Allow all mistakes to be possible                  |
| Test against the challenge             | Select those even with marginal survival advantage |
| <b>Characteristics:</b>                | <b>Characteristics:</b>                            |
| Focused                                | Experimental                                       |
| Linear problem solving                 | Optimizing many components                         |
| Minimize error rate                    | Random errors are good                             |

Different organisms use varied strategies to survive. Every organism generates mutations in their DNA as they evolve in generations. Low organisms adapt very quickly with their great number of mutations due to their short life span. Higher organisms however, do not produce mutations as quickly and have to adapt the environment to them to survive.

For example, insects adopt diverse approaches to endure. A cockroach is a simple animal that reproduces quickly and adapt by genetically changing. Bees are individually simple, but function as a complex community with genetically predetermined specialization. Mammals also use different strategies to succeed. Cheetahs are fast enough to be solitary hunters, while dogs and wolves are not so fast but they work well as a team of pack hunters. Buffalos adapt herd mentality and generate protection in numbers.

What is the basis for Darwinian success? First, there should be a hospitable niche. This is not necessarily a geographical niche, but also a functional niche. For example, being the first carnivore in an abundance of herbivores is a niche advantage. An organism then adapts by optimizing their function in this niche. Second, a successful organism exploits mutual benefit with other species. What is waste for a species is food for another. The successful members then must expand in numbers.

## **Application of Biological Principles to GIS management**

The Genome Institute of Singapore (GIS) adopts biological principles of Darwinian competition. It first looked for a hospitable niche, which was Singapore. GIS pursued the field of transcriptional genomics which was virgin territory and allowed for newcomers to be competitive. It then identified the scientists GIS needed with the best potential and developed an ecosystem with interactive diversity by grouping scientists with different skills together. There is collective reasoning in GIS but with an “alpha dog” holding the pack together. GIS developed a structure that is highly adaptive – they work as a team like pack hunters. Prof Liu also explained that GIS’ manpower policy does not involve any tenure for its scientists, to encourage improvement and discourage mediocrity, similar to evolution. Its policies also ensure that those who underperform were removed from the organisation. In successful evolution, it is not necessary to only allow the very top segment to survive. It can be even more favorable to remove the lower 10% repeatedly. This is less disruptive to the “pack” but progressively improves the “stock”.

The conceptual niche of GIS is to pursue integration via the fields of genomics, cell biology, medicine and populations genetics. It focuses on transcriptome and transcriptional regulation and balances technology and biology. Genome-to-systems strategy to biomedical investigations is the approach to the conceptual niche. GIS is able to address important questions that span from fundamental sciences to population studies through the integration of technologies with biology and medicine. This benefits the Singaporean intellectual ecosystem (improving the niche).

GIS generates competitive advantage through their technologies, their ability to work together through teams and collectives. Their integration, flexibility, and speed through biology, technologies and informatics also gave them a lead.

### **On Culture**

Culture is one of the most important aspects of organisational excellence in GIS. Prof. Liu commented on two opposing forces in management, excellence and collegiality. There would be no excellence if the emphasis is always on collegiality. Too much emphasis on excellence however, may result in a hostile environment that impedes excellence in the long run. He added that GIS encourages a strong culture of sharing knowledge since they function as a team of pack hunters.

To maintain the culture and balance of excellence, collegiality, and cooperation, GIS adopts a basket of measures. For instance, there are biannual performance evaluations of all PIs by the executive director. The evaluations place equal importance on collegiality, individual excellence of work, self motivation and knowledge sharing, rather than the number of papers published. There are also biannual presentations to the external Scientific Advisory Board (SAB) and a personal review by the SAB every three years, which functions as a form of external calibration.

## Project Management

Prof. Liu further elaborated on his leadership approach in GIS, listed below:

1. Be fair, be consistent
2. Be transparent
3. Have a clear vision that needs to be repeated over again
4. Be firm
5. Be flexible, but decisive
6. Be humble – employees are referred to as colleagues
7. Develop and encourage talent – your success is my success

In times of emergency, GIS adopts a “swarming” and “convergence” approach similar to that of a bee colony. Akin to rugby, scientists within the GIS pass the ball from one to another. The goal is not who carries the ball but to simply score the try, competing as a collective of individual experts.

The “swarm” organisational management has a decentralized process of advancement and a command structure that is based on communication and information organisation. There are common goals and culture within the organisation with communication as the focus. The teams form easily and are nonlinear and adaptive with flexibility being the key. Job functions are around capabilities, individual will, and results. Prof. Liu cited an example for SARS that demonstrated GIS’s adaptability. Although it lost to competitor Canada in sequencing speed, it adapted quickly by working on other areas.

## Other Q&A Points

*On what he would say to the Head of Civil Service if he could only make one suggestion*

For the civil service to improve, Prof. Liu remarked that it should reduce its dependence on the government scholarship system, as it may encourage a monoculture in the service with a large proportion of its leadership being selected on the basis of school grades. Although a monoculture is effective in the military or other sectors where goals are clear-cut, it is not as valuable in the civil service where targets are tentative. The civil service needs a diverse culture to continue to innovate.

Prof Liu added that the key to cultivating culture is to build trust. If there is no trust, you rely on rules which are the difficult to manage. In GIS, colleagues need to trust that the leadership's decisions on difficult issues are made for the best of everyone. Trust however, does not come easily. It is earned with a track record of making the right decisions. Changing an organisation's culture is tough and complex. While Singapore has done well in the past, its premise of growth has been an engineering approach and times have changed. It might need to start shifting towards an evolutionary method. Prof. Liu cited a Chinese proverb – "In chaos, there is order. In uncertainty, there is benefit." The key is how to extract benefits from uncertainty.

*On where to draw the line between innovation and performance in education*

In Prof. Liu's view, this depends on how wastage (underperforming students) and pressure points within the system are defined. Singapore society might be defining "wastage" in education in a way that makes it difficult for a late bloomer to recover and to reenter into the system. Examples have emerged where an "early failure" can become significantly successful in other fields. The majority of Nobel laureates would not have made the threshold of a Singaporean scholar. Some are indeed, late bloomers. Students that may not meet expectations at a certain stage should be given more chances and options elsewhere. The Singapore education system has been a practical system but needs to be continuously challenged and refined. There has been too much emphasis on grades as the only measure of excellence.

Recorded by: Bernard Ting  
Research Associate, Centre for Governance and Leadership  
Civil Service College