Complexity and policy making

Stop pretending that an economy can be controlled

by Angel Gurría, OECD Secretary-General

The crisis exposed some serious flaws in our economic thinking. It has highlighted the need to look at economic policy with more critical, fresh approaches. It has also revealed the limitations of existing tools for structural analysis in factoring in key linkages, feedbacks and trade-offs – for example between growth, inequality and the environment.

We should seize the opportunity to develop a new understanding of the economy as a highly complex system that, like any complex system, is constantly reconfiguring itself in response to multiple inputs and influences, often with unforeseen or undesirable consequences. This has many implications. It suggests policy makers should be constantly vigilant and more humble about their policy prescriptions, act more like navigators than mechanics, and be open to systemic risks, spillovers, strengths, weaknesses, and human sensitivities. This demands a change in our mind-sets, and in our textbooks. As John Kenneth Galbraith once said, “the conventional view serves to protect us from the painful job of thinking.”

This is why at the OECD we launched an initiative called New Approaches to Economic Challenges (NAEC). With this initiative we want to understand better how the economy works, in all its complexity, and design policies that reflect this understanding. Our aim is to consider and address the unintended consequences of policies, while developing new approaches that foster more sustainable and inclusive growth.

Complexity is a common feature of a growing number of policy issues in an increasingly globalised world employing sophisticated technologies and running against resource constraints.

The report of the OECD Global Science Forum (2009) on Applications of Complexity Science for Public Policy reminds us of the distinction between complicated and complex systems. Traditional science (and technology) excels at the complicated, but is still at an early stage in its understanding of complex phenomena like the climate.

For example, the complicated car can be well understood using normal engineering analyses. An ensemble of cars travelling down a highway, by contrast, is a complex system. Drivers interact and mutually adjust their behaviours based on diverse factors such as perceptions, expectations, habits, even emotions. To understand traffic, and to build better highways, set speed limits, install automatic radar systems, etc., it is helpful to have tools that can accommodate non-linear and collective patterns of behaviour, and varieties of driver types or rules that might be imposed. The tools of complexity science are needed in this case. And we need better rules of the road in a number of areas.

This is not an academic debate. The importance of complexity is not limited to the realm of academia. It has some powerful advocates in the world of policy. Andy Haldane at the Bank of England has thought of the global financial system as a complex system and focused on applying the lessons from other network disciplines – such as ecology, epidemiology, and engineering – to the financial sphere. More generally, it is clear that the language of complexity theory – tipping points, feedback, discontinuities, fat tails – has entered the financial and regulatory lexicon. Haldane has shown the value of adopting a complexity lens, providing insights on structural vulnerabilities that built up in the financial system. This has led to policy suggestions for improving the robustness of the financial system.

Closer to home, Bill White, Chairman of our Economic and Development Review Committee (EDRC) has been an ardent advocate of thinking about the economy as a complex system. He has spoken in numerous OECD meetings – in part as an explanation and in part as a warning – that systems build up as a result of cumulative processes, can have highly unpredictable dynamics and can demonstrate significant non-linearity. As a result Bill has urged policy makers to accept more uncertainty and be more prudent. He also urged economists to learn some exceedingly simple but important lessons from those that have studied or work with complex systems such as biologists, botanists, anthropologists, traffic controllers, and military strategists.

Perhaps the most important insight of complexity is that policy makers should stop pretending that an economy can be controlled. Systems are prone to surprising, large-scale, seemingly uncontrollable, behaviours. Rather, a greater emphasis should be placed on building resilience, strengthening policy buffers and promoting adaptability by fostering a culture of policy experimentation.

At the OECD, we are starting to embrace complexity. For several years we have been mapping the trade "genome" with our Trade in Value Added (TiVA) database to explain the commercial interconnections between countries.

We have examined the possibilities for coupling economic and other systems models, for example environmental (climate) and societal (inequalities). Our work on the Costs of Inaction and Resource Constraints: Implications for Long-term Growth (CIRCLE) is a key example of linking bio-physical models and economic models to gauge the impact of environmental degradation and climate change on the economy.

We are also looking at governing complex systems in areas as diverse as education and international trade policy. And we are looking at the potential for tapping Big Data – an indispensable element of complexity modelling approaches. But there remains much to do to fully enrich our work with the perspectives of complexity.

The OECD is delighted to work with strong partners – the Institute for New Economic Thinking (INET) Oxford, and the European Commission to help policy makers advance the use of complex systems thinking to address some of the most difficult challenges.

An important question remains. How can the insights and methods of complexity science be applied to assist policy makers as they tackle difficult problems in areas such as environmental protection, financial regulation, sustainability or urban development?

The Workshop on Complexity and Policy in September 2016 at the OECD helped find the answer – stimulate new thinking, new policy approaches and ultimately better policies for better lives.

Useful links

The original article on OECD Insights, including links and supplementary material, can be found here: *http://wp.me/p2v6oD-2Dz*

The full series can be found here: *http://oecdinsights.org/?s=NAEC+complexity*

It's not just the economy: Society is a complex system too

by Gabriela Ramos, OECD Chief of Staff and Sherpa to the G20

Income and wealth inequality is not a new phenomenon. On the contrary, it seems that it is a permanent feature in human history, and over the years, its causes and consequences have become more numerous and more interconnected. The same is true for many social phenomena, and even though the world looks more complicated today, it is not. What is different is the increased number of domains where public policy is expected to play a role. Regarding inequalities of income and wealth, governments have to make decisions on several interlinked areas such as taxes, education or health.

Unfortunately, the tools at the disposal of policy makers have not always been updated fast enough to cope with these challenges and with their interlinkages. Moreover, policies are often designed within the narrow confines of one issue, without taking into account their consequences elsewhere.

Economists have tried to simplify and abstract from reality with limiting assumptions like the representative agent and general equilibrium. They have also given primacy to the goal of effectiveness, in detriment to other important considerations such as fairness. Yet, the use of aggregate data obscures the distributional consequences of policies: an economy as a whole may be doing well, but – as we have seen in recent years – there are severe consequences for social cohesion, and ultimately growth itself, if large groups are excluded from the benefits of economic prosperity. In defining growth policies that aimed only at increasing GDP per capita, inadequate attention was paid to institutions, human behaviour, and culture. These approaches failed to adequately account for the realities of markets, consumer decisions, and the interconnectedness of economic, communications and societal networks.

In stark contrast to the assumptions of neo-classical economics, socio-economic systems are not stable, but in constant flux. Complexity science generates new insights and furnishes us with the analytical tools and instruments to help us, as individuals and societies, to navigate this new understanding of the economy. It addresses some of the limitations which constrain conventional economics and ultimately it is helping us to do a better job in advising governments and public institutions.

For example, taking a complexity-based approach we can begin to recognise that the causes and consequences of inequalities and major economic and societal problems are intertwined. Besides contributing substantially to the increase of wealth inequality, the financialisation of the economy also led to increased systemic risks where a problem in the subprime markets led to a major economic crisis that has set additional hurdles in the way of the most vulnerable groups all over the world.

Just like the financial system and its major risks, our social systems are complex and vulnerable. Considering the increased fragmentation and divisions in our societies (and adding the challenge of integration of migrants and marginalised groups) more attention should be paid to social stability. In this vein, policies to address societal problems, should not only rely on traditional economic tools and measures, but broaden them to bring insights of useful disciplines.

This more realistic approach to how people and the economy actually work is needed – an integrated inclusive growth agenda which also considers unintended consequences, trade-offs and complementarities between policy objectives.

Indeed, I believe that economists – and the policy makers they advise – can do better by listening to and learning from others. It's not easy for an organisation that has "Economic" in it is name, but we need to break the monopoly of economics over policy – looking to other disciplines such as physics, biology, psychology, sociology, philosophy and history. Societies and economies are not static features that can be predicted, but evolutionary systems with breakpoints and changes that need to be better characterised.

At the OECD, we recognise the potential of new economic thinking, drawing on complexity theory, and evolutionary and behavioural economics. Technological and analytical innovations are driving a revolution in the physical sciences, biological sciences, and social sciences, breaking down the barriers between disciplines and stimulating new, integrated approaches to pressing and complex challenges. Advances in computing power are opening up new possibilities for integrating systems models, agent-based modelling and network analysis. It is only by properly utilising these new approaches that we can strive to create social and economic models that provide a more accurate representation of the world around us. These tools also allow us to get away from average representations, or to look at stocks and not only at flows in the economy (income vs wealth inequality).

And indeed, economics is starting to incorporate insights from other disciplines. For example, expectations may be admirably rational in traditional models, but by combining psychology and economics we are designing policies based on how real people actually behave, not on limited assumptions about how some fictional average person should behave. Taking a problem-based approach, we can design policies to influence people and nudge them in the right direction in areas such as consumer policy, regulation, and environmental protection.

The OECD is part of this revolution and we are already transforming our policy thinking and acting. With the New Approaches to Economic Challenges (NAEC) initiative, we are taking a hard look at our analytical methods, our data and policy advice.

Many articles in this series have argued that the economy is a complex adaptive system. Society is a complex system too. It is formed by the interaction and mutual dependence of individuals, and is pursuant to their spontaneous, natural behaviour. Since the emergence of hunter-gather societies inequalities have threatened to undermine and weaken the fabric of the social system. If we are to overcome the pernicious effects of these inequalities, we need to think about the interactions between our social and economic systems – which follow their own logics –

and design policies which help our economies to grow. But growth isn't an end in itself. It has to be inclusive to ensure that all segments of our societies prosper.

Systems thinking can lend us a hand to fight inequalities and develop an agenda for inclusive growth. As we draw out the interlinkages between different policy areas, we begin to understand how the economic system interacts with other systems, as well as with the history, politics, and ambitions of countries. Our task now is to put this growing comprehension to good use, in order to make the economy work better for all people.

Useful links

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The full series can be found here: *http://oecdinsights.org/?s=NAEC+complexity*

A new role for science in policy formation in the age of complexity?

by Vladimir Šucha, Director General, European Commission, Joint Research Centre

The recent financial crisis was a wakeup call for both scientists and policy makers. It exposed new and unknown links between economic magnitudes but also between various parts of our modern, globalised world. It further helped to reveal the limitations of some approaches in economics as well as social sciences which proved to be unsuitable for this new world.

The crisis, above all, showed that the economy is a highly complex, dynamic and evolving undertaking, with the potential, at times, to produce unpredictable (and often undesired) outcomes. Finally, it showed the need to embrace more appropriately this complexity in the science underlying policy analysis as well as in the policy-making process itself.

So, eight years on from the beginning of the crisis, have scientists and policy makers moved out of their comfort zone? Are new ways of thinking being embraced? Are they being applied in practice? What do we have to do to ensure that they result in better policies and, ultimately, fairer and more resilient societies?

As the European Commission's science and knowledge service, the Joint Research Centre (JRC) is supposed to bridge the gap between science and policy makers, as is the OECD. Based on our experience, we believe that a good deal of progress has been made. However, there is still a lot of work to do if the science dealing with such complexity is to deliver its full potential.

Complexity science, of course, has been around for some decades now. It is the scientific study of complex systems, where many components interact producing a global conduct that could not easily be predicted using simple models only which are based on the ordinary interaction between the individual constituent elements of such systems. Since such systems can be found in many areas of life, complexity science is used in a number of different fields, including biology, social sciences, computer science, transport, energy and critical infrastructure protection.

It has developed quickly in the last few decades. Concepts such as non-linearity, self-adaptation, emergence, chaotic dynamics and multiple equilibria, are now firmly established. Valuable tools have been developed, such as sensitivity analysis, scenario modelling and foresighting, network science and dynamic systems modelling, which allow these concepts to be applied appropriately.

Economics was relatively late to embrace these concepts and tools. However, following the crisis, there is an increased interest in applying them, particularly to financial markets.

The JRC is moving in this direction. For example, our researchers employ network science to estimate interlinkages between the banking sector and other institutional investors and how shocks could propagate within the system.

However, our impression is that, in spite of the stronger interest in recent years, complexity economics still needs to spread more widely among economists. It should not be the preserve of a small number of outsiders only.

We also feel that it is still not as useful as it could be for policy making. This is because it remains rather abstract. In many cases, it can help us to understand the theoretical characteristics or basis of a phenomenon but it is still difficult to use it for practical problem solving. This may either be because the related models are not sufficiently detailed or because the data used are not sufficiently adequate for the problem under consideration.

There are, of course, many novel sources of data available. The task is to develop innovative paradigms for their collection, and also new methods for their analysis, since large amounts of data can often obscure rather than clarify an issue if the appropriate techniques for interpreting and making sense of them are not available.

Scientists, therefore, need to develop new approaches for gathering and organising data, such as how to deal with Big Data or else text and data mining. They also need to explore models and tools for data analysis in a policy context, including indicators, innovative visualisations and impact evaluation methods.

The good news is that policy makers are now opening up, at least to some extent. Most of them now realise that attention to the interlinkages between policy areas and the related objectives, and improving evidence on the simultaneous movement of various targets and policy levers, is essential.

They know that the impact of regulation cannot be judged only on the basis of its specific achievements inside a given context but that it may also produce unintended (and undesired) consequences in other areas outside the context under consideration. There is therefore a potential demand for the greater use of complexity science to understand such wider linkages in complex systems.

However, it can be difficult to explain counter-intuitive results to politicians and policy makers.

Equally, while scientists must make policy makers aware of the complexity of the systems they are dealing with, it is important not to overburden them. If they feel that these systems are so complex that no one can possibly understand or influence them, the result will be inertia and defeatism.

Moreover, there is little point in using complexity science to understand the linkages in systems, unless policy makers are prepared to strive for integrated solutions working with one another, across silos. All are committed to doing this in theory but it does not always happen in practice. DG JRC sees part of its role as organising forums on complex issues, where policy makers from different fields can meet, along with scientists from different disciplines.

It is also important to involve those stakeholders most affected by the phenomena under review. DG JRC is experimenting with new ways of directly involving stakeholders in the "co-design" of public interventions. This is all part of developing a multi-faceted perspective.

Finally, there is a job to do in helping policy makers and politicians to develop simple messages to persuade the public of the merits of the solutions arrived at using complex science.

These are only some very basic reflections on why DG JRC welcomes this event. We are keen to further extend our co-operation with the OECD and the Institute for New Economic Thinking in the area of Complexity and Policy. By co-operating more closely, we believe that we can further improve the role of science in policy formation in our current world of ever increasing complexity.

Useful links

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The full series can be found here: *http://oecdinsights.org/?s=NAEC+complexity*

Ants, algorithms and complexity without management

by Deborah M. Gordon, Department of Biology, Stanford University

Systems without central control are ubiquitous in nature. The activities of brains, such as thinking, remembering and speaking, are the outcome of countless electrical interactions among cells. Nothing in the brain tells the rest of it to think or remember. I study ants because I am interested in how collective outcomes arise from interactions among individuals, and how collective behaviour is tuned to changing environments.

There are more than 14 000 species of ants, which all live in colonies consisting of one or more reproductive females, and many sterile workers, which are the ants that you see walking around. Although the reproductive females are called "queens", they have no power or political authority. One ant never directs the behaviour of another or tells it what to do. Ant colonies manage to collect food, build and maintain nests, rear the young, and deal with neighbouring colonies – all without a plan.

The collective behaviour of colonies is produced by a dynamical network of simple interactions among ants. In most ant species, the ants can barely see. They operate mostly by smell. As an ant moves around it briefly contacts other ants with its antennae, or it may contact a short-lived patch of a volatile chemical recently left behind by another ant. Ants smell with their antennae, and when one ant touches another with its antennae, it assesses whether the other ant is a nestmate, and sometimes what task the other ant has been performing. The ant uses its recent experience of chemical interactions to decide what to do next. In the aggregate, these simple interactions create a constantly shifting network that regulates the behaviour of the colony.

The process that generates simple interactions from colony behaviour is what computer scientists call a distributed algorithm. No single unit, such as an ant or a router in a data network, knows what all the others are doing and tells them what to do. Instead, interactions between each unit and its local connections add up to the desired outcome.

The distributed processes that regulate the collective behaviour of ants are tuned to environmental conditions. For example, harvester ants in the desert face high operating costs, and their behaviour is regulated by feedback that limits activity unless it is necessary. A colony must spend water to get water. The ants get water by metabolising the fats in the seeds they eat. A forager out in the desert sun loses water while out searching for food. Colonies manage this trade-off by a simple form of feedback. An outgoing forager does not leave the nest until it meets enough returning foragers with seeds. This makes sense because each forager searches until it finds food. Thus the more food is available, the more quickly they find it and return to the nest, stimulating more foragers to go out to search. When food is not available, foraging activity decreases. A long-term study of a population of colonies shows that the colonies that conserve water in dry conditions by staying inside are more successful in producing offspring colonies.

By contrast, another species called "turtle ants", living in the trees of a tropical forest in Mexico, regulate their behaviour very differently. The turtle ants create a highway system of trails that links different nests and food sources. Operating costs are low because it is humid in the tropical forest, but competition from other species is high. These ants interact using trail pheromones, laying down a chemical trail everywhere they go. An ant tends to follow another and this simple interaction keeps the stream of ants going, except when it is deterred by encounters with other species. In conditions of low operating costs, interactions create feedback that makes ongoing activity the default state, and uses negative feedback to inhibit activity. Thus this is the opposite of the system for desert ants that require positive feedback to initiate activity.

What can we learn from ants about human society? Ants have been used throughout history as examples of obedience and industry. In Greek mythology, Zeus changes the ants of Thessaly into men, creating an army of soldiers, who would become famous as the Myrmidons ready to die for Achilles (from myrmex – μ μ – ant). In the Bible (Proverbs 4:4), we are told to "Look to the ant" who harvests grain in the summer to save for the winter. But ants are not acting out of obedience, and they are not especially industrious; in fact, many ants just hang around in the nest doing nothing.

Ants and humans are very different. Power and identity are crucial to human social behaviour, and absent in ants. Ants do not have relations with other ants as individuals. As an ant assesses its recent interactions with others, it does not matter whether it met ant number 522 or ant number 677. Even more fundamental, an ant does not act in response to any assessment of what needs to be done.

However, we may be able to learn from ants about the behaviour of very large dynamical networks by focussing on the pattern or structure of interactions rather than the content. While we care about what our emails say, the ants care only about how often they get them. It is clear that many human social processes operate without central control. For instance, we see all around us the effects of climate change driven by many different social processes that are based on the use of fossil fuel. No central authority decided to pump carbon into the atmosphere, but the CO_2 levels are the result of human activity. Another obvious example is the internet, a huge dynamical network of local interactions in the form of email messages and visits to websites. The role of social media in the recent US election reflects how the gap between different networks can produce completely disparate views of what is happening and why.

The most useful insights may come from considering how the dynamics of distributed algorithms evolve in relation to changing conditions. The correspondences between the regulation of collective behaviour and the changing conditions in which it operates might provide insight, and even inspire thinking about policy, in human social systems. For ants or neurons, the network has no content. Studying natural systems can show us how the rhythm of local interactions creates patterns in the behaviour and development of large groups, and how such feedback evolves in response to a changing world.

Useful links

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The full series can be found here: *http://oecdinsights.org/?s=NAEC+complexity*

Navigating wicked problems

by Julia Stockdale-Otárola,
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Knowing there is a single clear solution to any problem is certainly a comforting idea. As children we would raise our hands in class to answer increasingly difficult questions – always hoping that we would "get it right". But sometimes the question itself is ambiguous and the list of potential solutions endless.

Such is the case with wicked problems.

The term isn't a moral judgement. Wicked problems are dynamic, poorly structured, persistent and social in nature. Difficult to define, highly intertwined with other social issues, and involving many actors, wicked problems reflect the complexity of the world we live in. For example, think of policy challenges such as climate change, immigration, poverty, nutrition, education, or homelessness. Each issue involves multiple drivers, impacting various policy domains and levels of government. To further complicate matters, any intervention could set off a chain of new unintended consequences. That's a lot of moving parts.

All these factors make it difficult for anyone to agree on what the actual problem is, where it is rooted, who is responsible, and how to best address it. The scope of the problem is also vague. Entire systems can be involved in a seemingly local or regional problem like mass transit.

Clearly coming to grips with the issue is challenge enough, so how do we go about making decisions? So far, traditional approaches have proven unsatisfactory. In fact, many of these wicked problems seem to only get worse as we try to solve them.

The complexities involved force us to rethink our problem-solving strategy. Instead of trying to find a final solution we need to recognise that these challenges can, generally speaking, at best be managed but not solved. At least, not solved in a static sense. That doesn't mean the situation can't be improved. To some, it might even be "solved" depending on how the problem is defined. The bottom line is that we need to become more flexible to better manage the challenges posed by wicked problems. Policies should be adaptive, so that they can change as the issue evolves over time. We also need to avoid becoming too attached to our own solutions. They need to be dynamic, to change along with the problem at hand.

From the outset we need to look at problems more holistically. An increasing number of new approaches are developing in different fields to offer solutions. Complexity science is naturally adaptive as it looks at the way in which systems interact. To date this strategy has been helpful for example in improving traffic management. To improve traffic safety analytics techniques are applied to anticipate risks and traffic jams, and improve flow. Implementing pilot projects can also be useful in addressing wicked problems, when affordable, as they involve continuous monitoring and opportunity for adjustments. Though no magic formula exists, these approaches can help capture some of the intricacies of wicked problems.

Governments have already started using some of these adaptive strategies. Singapore's government has introduced a mix of policy approaches to tackle wicked problems. For example, a matrix approach was implemented to help departments better share information and work horizontally; new departments reflecting the thorniest issues were established; and a computerised tool to help mitigate systemic risks was introduced. Though the island has the advantage of size, facilitating the implementation of new approaches, their experiences may provide some useful insights into best practices.

The OECD has also been looking at policy challenges as wicked problems. In a 2009 workshop on policy responses to societal concerns, Sandra Batie and David Schweikhardt of Michigan State University analysed trade liberalisation as a wicked problem. In this case, the role of stakeholders is typical of a wicked problem: different groups are likely to have differing ideas about what the real problem is and what its causes are. Some would say the issue is making the economy as open as possible while for others national sovereignty or protecting local producers may be more important.

Unlike a tame problem where scientifically based protocols guide the choice of solution, answers to the question of whether more trade liberalisation is needed depend on the judgements and values of whoever is answering. Many stakeholders will simply reject outright arguments to justify trade liberalisation based on neoclassical economics. Batie and Schweikhardt argued that the role of science, including economic science, is not to narrow the range of options to one (in this case trade liberalisation), but rather to expand the options for addressing the issue(s), and to highlight the consequences, including distributional consequences, of alternative options.

Wicked problems remind us that it isn't always easy, or even possible, to "get it right". There isn't always a solution that can be implemented once and last forever. But that's okay. We just need to stop thinking about achieving optimal solutions and learn how to sustain adaptive solutions.

Useful links

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The full series can be found here: *http://oecdinsights.org/?s=NAEC+complexity*

Out of complexity, a third way?

by Bill Below, OECD Directorate for Public Governance and Territorial Development

The perennial curmudgeon H.L. Mencken is famously misquoted as saying: “For every complex problem there is an answer that is clear, simple, and wrong.” The ability to simplify is of course one of our strengths as humans. As a species, we might just as well have been called homo redactor – after all, to think is to find patterns and organise complexity, to reduce it to actionable options or spin it into purposeful things. Behavioural economists have identified a multitude of short-cuts we use to reduce complex situations into actionable information. These hard-wired tricks, or heuristics, allow us to make decisions on the fly, providing quick answers to questions such as ‘should I trust you?’, or ‘Is it better to cash in now, or hold out for more later?’ Are these tricks reliable? Not always. A little due diligence never hurts when listening to one’s gut instincts, and the value of identifying heuristics is in part to understand the limits of their usefulness and the potential blind spots they create. The point is, there is no shortage of solutions to problems, whether we generate them ourselves or receive them from experts. And there’s no dearth of action plans and policies built on them. So, the issue isn’t so much how do we find answers? – We seem to have little trouble doing that. The real question is, how do we get to the right answers, particularly in the face of unrelenting complexity?

There’s a nomenclature in the hierarchy of complexity as well as proper and improper ways of going about problem solving at each level. This is presented in the new publication *From Transactional to Strategic: Systems Approaches to Public Challenges* (OECD, 2017), a survey of strategic systems thinking in the public sector. Developed by IBM in the 2000s, the Cynefin Framework posits four levels of systems complexity: obvious, complicated, complex and chaotic. Obvious challenges imply obvious answers. But the next two levels are less obvious. While we tend to use the adjectives ‘complicated’ and ‘complex’ interchangeably in casual conversation, the framework imposes a formal distinction. Complicated systems/issues have at least one answer and are characterised by causal relationships (although sometimes hidden at first). Complex systems are in constant flux. In complicated systems, we know what we don't know (known unknowns) and apply our expertise to fill in the gaps. In complex systems, we don't know what we don't know (unknown unknowns) and cause and effect relations can only be deduced after the fact. That doesn't mean one can't make inroads into understanding and even shaping a complex system, but you need to use methods adapted to the challenge. A common bias is to mistake complexity for mere complication. The result is overconfidence that a solution is just around the corner and the wrong choice of tools.

Unfortunately, mismatches between organisational structures and problem structures are common. Institutions have specific and sometimes rather narrow remits and often act without a broader vision of what other institutions are doing or planning. Each institution may have its specific expertise yet few opportunities for sustained, trans-agency approaches to solving complex issues.

Thus, top-down, command-and-control institutional structures breed their own resistance to the kind of holistic, whole-of-government approach that complex problems and systems thinking require. This may be an artefact of the need for structures that adapt efficiently to new mandates in the form of political appointees overseeing a stable core of professional civil servants. Also, the presence of elected or appointed officials at the top of clearly defined government institutions may be emblematic of the will of the people being heard. Structural resistance may also stem from competitive political cycles, discouraging candidates to engage in cycle-spanning, intertemporal trade-offs or commit to projects with complex milestones. In a world of sound-bites, fake news and scorched earth tactics, a reasoned, methodical and open-ended systems approach can be a large, slow-moving political target.

And that's the challenge of approaching complex, 'wicked' problems with the appropriate institutional support and scale – there must be fewer sweeping revolutions or cries of total failure by the opposition. Disruption gives way to continuous progress as the complex system evolves from within. It is a kind of third way that eschews polarisation and favours collaboration, that blends market principles with what might be called 'state guidance' rather than top-down intervention.

Global warming, policies for ageing populations, child protection services and transportation management are all examples of complex systems and challenges. Complex systems are hard to define at the outset and open ended in scope. They can only be gradually altered, component by component, sub-system by sub-system, by learning from multiple feedback loops, measuring what works and evaluating how much closer it takes you to your goals.

General Systems Theory (GST), that is, thinking about what is characteristic of systems themselves, sprang from a bold new technological era in which individual fields of engineering were no longer sufficient to master the breath taking range of knowledge and skills required by emerging systems integration. That know-how gave us complex entities as fearful as the Intercontinental Ballistic Missile and as inspiring as manned space flight. Today, the world seems to be suffering from complexity fatigue, whose symptoms are a longing for simple answers and a world free of interdependencies, with clear good guys and bad guys and brash, unyielding voices that 'tell it like it is', a world with lines drawn, walls built and borders closed. Bringing back a sense of excitement and purpose in mastering complexity may be the first 'wicked' problem we should tackle.

In the meantime, we need to find a way to stop approaching complex challenges through the limits of our institutions and start approaching them through the contours of the challenges themselves. Otherwise too many important decisions will be clear, simple and wrong.

Useful links

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