II. KONDRATIEFF MEDAL: WINNERS' SPEECHES*

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Multiplicity and Divergence Challenge the Social Sciences

GOLD MEDAL

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Members of the Russian Academy of Sciences, Directors of the International N. D. Kondratieff Foundation, and members of the jury, thank you for this wonderful honor. There are many more to whom I want to express my deepest gratitude – following a few remarks about current challenges to the social sciences.

We are living in a world of multiples: multiple products, multiple industries, multiple careers, multiple cultures, multiple stakeholders, and multiple connections (Phillips 2008). Fukuyama's (1993) prediction of the end of history was too simplistic. Human societies are both converging and diverging. Ashby's Law (1956) implies that these multiplicities – which constantly re-arrange themselves – cannot be researched through a single analytic lens. On the contrary, we need multiple perspectives, as advocated by our mentor Harold Linstone (2010).

Unifying the Social Sciences?

This in turn implies that calls to unify the social sciences (*e.g.*, that of Gerring 2005) are misplaced. I hope such unification will not happen, because we need multiple perspectives contributed by various social sciences – even though these perspectives are sometimes contradictory, and though we do expect some convergence of perspectives as scientists from the various disciplines succumb to the lure of 'big data'.

A passage from Linstone and Mitroff (1994) brilliantly illustrates:

> Consider… the problem of drug use and addiction…. [To an **educator**] the problem is one of educating young people and their families to the

* This section presents the speeches of Kondratieff Medal laureates of 2017.

> dangers of drug use…. In the language of **economics**, the problem is the huge profits associated with the production and consumption of illegal substances…. In the language of **social work**, the problem is the breakdown of the family, the lack of male role models, and so on. In **medical** terms, the problem is one of treating the physiology of drug addiction. For the **criminal justice** system, the problem is… money for policing. For **psychology**, [it] is the despair of people in inner cities and the associated problems of low self-esteem…. Each [discipline] uses different variables to structure the 'problem', and consequently collects very different kinds of data.
>
> Action taken to advance one group's success metrics will exacerbate the problems as they are seen by the other groups. The social worker's free meal center for street addicts will, from the perspective of the **city planner**, make an already undesirable neighborhood even less attractive to business investment, and, to the economist, create a disincentive to gainful employment.

Duncan Watts (2017), a sociologist at Microsoft Research, recently dubbed this the 'incoherency problem' of social science. I see it instead as an opportunity to hold a multi-disciplinary dialogue – before attacking a problem – on *what would constitute a solution*. (Or, failing that, *what would constitute an improvement.*) This has never been tried. We cannot expect total agreement. Nonetheless, our challenge as social scientists is to reconcile, or at least benefit from, these multiple views *post hoc,* rather than restrict them *a priori*. *Technological Forecasting & Social Change* board member Nebojša Nakićenović (2007) at IIASA has made progress on the *post hoc* reconciliation task.

Interconnections, Complexity and Nonlinearity

We have long known that qualitative research techniques are right for structuring new areas of inquiry – for discerning categories, assigning nomenclature, beginning to hypothesize relationships, and formulating questions that the researcher hopes will later be answered by quantitative and confirmatory methods. Quantitative methods prevail in more well-established areas of inquiry.

We are now realizing that mature areas of inquiry do not wither and die, as traditional life cycle theory might predict, but rather they connect with other disciplinary areas and via these connections become more complex. One example in industry is the demise of 'stand-alone' software packages. It is unprecedented but not surprising to see software companies joining INCOSE, the professional association of systems engineers (Roth 2017), in order to understand how to connect their product to multiple platforms, to multiple intermediaries like Akamai (the Internet most definitely did not 'eliminate the middlemen'!), to multiple add-on providers, and to multiple OEMs, as well as to their industry and national cyber-security apparatuses.

Kondratieff medalist Tessaleno Devezas (2004) called this 'digital Darwinism' and offered a way to comprehend it: 'As systems increase in complexity, it becomes necessary to draw upon social experiences to provide the necessary analogies'. Researching this stage of development requires combining qualitative and dialogue techniques with such quantitative methods as may be applicable, and – very cautiously – using the tools of complexity theory.

I once glibly wrote (Phillips and Kim 1996) that future researchers will use maximum likelihood estimators and the Lyapunov exponent in tandem. However, they must proceed cautiously because:

- Chaotic transitions are exquisitely sensitive to initial conditions, which we may measure more precisely in physics but only loosely in social sciences.
- Deterministic, chaos-generating processes may exist in the social world, but as physicist Max Born (1949) remarked, chance (at least in the form of measurement error) is still king.
- Devezas (2004) added, 'The more complex and intangible the system, the more useful is the resort to metaphors'. In the absence of rigorous correspondence rules – and they are usually absent – ideas like 'edge of chaos' when applied to social systems are only metaphors (Phillips and Su 2013). As we are taught in school to avoid reasoning by analogy, social scientists must step lightly when applying the tools of complexity theory.

Step lightly, but realize that Schumpeter and Kondratieff (Grinin, Devezas, and Korotayev 2014) were correct: socio-economic processes are nonlinear. Massive inter-connections ensure it. We must learn how to deal with it.

Climate change is perhaps the most important case in point. Climate change, subject to multiple feedback loops, will proceed at different rates and have differential impacts on diverse geographies. The physical, biological, and social sciences are challenged to decide what to measure (Phillips 2014a) and, on the social science side, to deal with resulting migrations and changes in diets, lifestyles, and health that will eventuate.

Less apocalyptically but also perplexing, the nonlinearity implies an uncertainty principle of market segmentation: a radical new product cannot be targeted to a customer's usage situation, as Clayton Christensen (2003) would have it, because *the product changes the situation* (Phillips 2016).

Bridging Obsolete and Yet-to-Come Strategic Theories

Multiple inter-connections, and especially the digital convergence, have destroyed much of the received wisdom of strategy, as the interconnections and convergence have dissolved industry boundaries. After all, we can hardly maintain a sustainable competitive advantage when we do not know who the competitors are or will be. The ideas of the philosopher of science Karl Popper suggest a bridging tool that can help guide organizations until new strategic theories emerge (Phillips, Lin H., and Lin S. n.d.).

Another philosopher, Daniel Dennett (2017) distinguished Popper's approach by defining four grades of *umwelt*, or organismic experience. Dennett's first two grades are instinctive 'Darwinian creatures', capable of no adaptive behavior, and 'Skinnerian creatures, who… adjust their behavior in reaction to "reinforcement"', with adaptive but random behaviors being reinforced. The third and fourth in Dennett's taxonomy are:

3. 'Popperian creatures, who… pretest hypothetical behaviors offline, letting "their hypothesis die in their stead", as Karl Popper once put it. Eventually they must act in the real world, but their first choice is not random, having won [competitive] trial runs in the internal environment'.

4. 'Gregorian creatures, named in honor of Richard Gregory, the psychologist who emphasized the role of "thinking tools"…. The Gregorian creature's *umwelt* is well stocked with thinking tools, both abstract and concrete: arithmetic and democracy and double-blind studies, and microscopes, maps, and computers'.

Theories and firm, well-structured knowledge are Gregorian. Experience-based hypotheses and exploratory experimentation are Popperian. In the absence of well-structured strategic knowledge, but with the help of computers, governments and companies can conduct multiple experiments across multiple geographies and multiple divisions, sharing information about what works under what conditions, and matching solutions over there with problems back here. (Popper called this 'piecemeal engineering'.) This procedure offers the best chance for organizations to maintain themselves until new strategic theories emerge and Gregorian thinking again becomes practicable.

Outliers and Risk

I now turn to the word 'divergence' in the title of my talk, with special reference to 'big data' and sustainability.

Big data: Attending to outliers

In a world of multiples, analytics researchers should focus on identifying outliers and new trends, rather than on the averaging and classifying functions well known in classical statistics. This is one of the unique potentials of big data, relative to small-sample statistics; more data means more outliers and greater chances that some of them are meaningful. Big data will finally allow us to comprehend the world's great diversity, rather than simply compute regressions to the mean. For many decades, statistical analysis has been about minimizing sums of squared deviations from a mean – but not about recognizing the meaning of the deviations. And the 'standard deviation' is a clumsy representation of diversity.

With big data, this can now begin to change. Rather than throwing away 'troublesome' data points, we may track them and investigate them. Computers will continue to lack the contextual knowledge that enables an experienced hu-

man to judge whether an anomaly is a data error or a new and significant phenomenon. Efficiency requires that human-computer interactive systems be designed to deal with the huge volume of 'exceptions' that sleep in big data repositories (Phillips 2017).

Innovation for sustainability

It should be clear that innovation is needed to bring new technologies to bear on the question of environmental sustainability, and that this innovation is often provided by new ventures, many of them quite risky from a market perspective. This is not allowed in the very conservative Brundtland (World Commission 1987) definition of sustainability, which prohibits bequeathing increased risk – even financial risk – to future generations. Since I pointed out this idea in a talk to the World Technopolis Association (Phillips 2014b) and in the proceedings of the systems society (Phillips 2013), it has been taken up by my friend Sten Thore (Thore and Tarverdyan 2016) (teacher of economics Nobel laureate Finn Kydland) and by a number of other authors now forging links between entrepreneurship and sustainability. Risk is normally treated as a statistical variance, so the risk and promise of new ventures also fit my theme of 'divergence'.

The Knowledge Society: It is About Power

In the 1970s, a famous economist lectured about the hypothetical emergence of an exchange economy between two sailors stranded on a desert island. I asked 'What prevents one sailor from hitting the other on the head and simply taking the goods?' The lecturer answered, 'Well, we *assume* he won't'. This reply endowed me with some skepticism about economic theory. It seemed to me that the central question is power, not price.

As Mr. Piketty (2014) has demonstrated, economic inequality – another kind of divergence – is growing, and probably menaces the social fabric. What might the rich do with their money? The disastrous 'Citizens United' US Supreme Court decision provides an avenue: The rich use money to buy elections. Money is a means; power is the end.

Marx, Schumpeter, and Drucker all believed that knowledge would overtake capital as the dominant factor of production. It is coming to pass. In several US high tech companies, rank and file knowledge workers – who are very difficult for the companies to replace – dictate the firm's political stance. The employees' influence in this regard outweighs that of the capital investors on the company's board. The companies locate their headquarters not for the convenience of the CEO, as was the practice in the past, but where the local quality of life will attract knowledge workers.

Capital and knowledge now share, and compete for, power. The balance is shifting toward knowledge. In 1993 Drucker lamented that we do not have a theory for a knowledge economy; it remains true in 2017.

Marx, Schumpeter, and Drucker were well-versed in sociology as well as economics. Understanding the knowledge revolution will require the multiple perspectives of the various social sciences.

Challenges and Champions

There are other challenges facing social sciences. One of the most important, it seems to me, is the following: Despite many decades of research in organizational behavior and organizational development, most business firms remain terribly dysfunctional, suffering from office politics and strategic misalignment, and surviving only because their competitors are even less competent. The same is true of many government agencies, NGOs, and universities. We are not sure whether this is due to principal-agent problems, the demise of job security, inability to assess job candidates, shortcomings in management education (Golden *et al*. 2016), or any of a host of other issues.

We might conjecture that organizational dysfunction is *partly* explained by the *multiplicity* of human motivations, and the *divergence* between those motivations and the firm's strategic goals. However, time has allowed me to focus today only on challenges more centrally related to multiplicity and divergence – challenges which I believe are surmountable with sufficient good will and computer advances. Organizational dysfunction, though extremely troubling, will have to wait for another occasion.

The list of earlier Kondratieff medalists shows the names – Marchetti, Devezas, Modelski – that have been closely associated with the journal *Technological Forecasting & Social Change.* I mention also Andrey Korotayev and Leonid Grinin, who have lent their enthusiastic support to the journal. Without doubt, I am wearing the Medal today in large part due to the high regard the Academy and the Foundation hold for this journal which has been the outlet for so many Kondratieff studies.[1] The authors and editorial board of *Technological Forecasting & Social Change* have helped further internationalize this international journal and raise it to its current impact factor of 2.625 (5-year factor =3.226), quite a remarkable number for a journal that is not affiliated with a professional association.

I would not be here today if not for my very outstanding mentors. My PhD advisor Abraham Charnes, founding director of the Center for Cybernetic Studies at the University of Texas, which he named after the laboratory of Yablonsky and Lyapunov here in Russia. William W. Cooper, who with Charnes

[1] A search of the journal's 48-year history returns 106 *TF&SC* articles mentioning 'Kondratieff', 48 more using the spelling 'Kondratiev', and 175 mentioning 'long waves'.

was a pioneer in operations research and a co-winner of the Von Neumann Medal. George Kozmetsky, 2nd-generation Russian-American entrepreneur, educator, and winner of the US National Medal of Technology; and Hal Linstone, founding editor of *Technological Forecasting & Social Change*. Each generation of scholars works in a different era, using newer tools to attack newer problems. Though we may wish to, we cannot exactly emulate our teachers. We can only thank them for their achievements, for their formative influences on us, and for allowing us to stand on their shoulders. We can only hope they would be proud of us.

I close with a few words of appreciation to my dear family– my parents, my wife, and my two daughters. Their support, their understanding – and their varied perspectives! – have helped lead to this day and this celebration.

Thank you.

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