



The Scientist and Prigogine's *futur créateur*

DIALECTIC

M. Prigogine and T. Patterson

INTRODUCTION

Upon the near collapse of the post-Kyoto meeting in Buenos Aires last December, EU head delegate, Dutch environment secretary Pieter van Geel summarized, stating: 'A lot of people are afraid of discussing the future.' His words referred to the failure of the meeting's intentions to determine worldwide cooperation to reduce global warming following the first 15 Kyoto years to 2012. These objectives failed in no small part due to policy's demands on science with respect to certainty and measures of determinism. Social expectations such as these persist despite scientific advances, most notably made by Nobel Prize winner Ilya Prigogine and his numerous collaborators, which show that rigid dependence on these conditions do more to paralyze collective action than enable it. As a result, policy has yet to effectively harness the most powerful aspect of science with respect to resolving the major challenges of the global future—its creativity.

Ilya Prigogine laid scientific and philosophical foundations in the time-reversible, symmetric world of theoretical physics for rigorous study of irreversible, far-from equilibrium phenomena, such as that of living systems and therefore the frontiers of theoretical ecology. As such, his work ethic, creative drive and ethos provide a beacon for those who would combine ecological theory with evolutionary physics. Here, his wife, Maryna Prigogine discusses with Trista Patterson, a post-doctoral researcher in Ecodynamics at the Italian University of Siena, issues of ecological theory and Prigogine's *future creative*.

This article takes an atypical scientific form. 'Dialectic' usually refers to either the Socratic method of cross-examination, Hegel's model of history. 'Dialectics' can also refer to an understanding of how we can or should perceive the world (epistemology), an assertion of the interconnected, contradictory

and dynamic nature of the world outside our perception of it (ontology), or a method of presentation of ideas or conclusions. The back-and-forth (dialectic) of causation implies a dynamic process, and reflects the spirit of ecodynamics research.

INTERVIEW

T. Patterson: Thank you for your time, Madame Prigogine.

M. Prigogine: You're welcome. I enjoyed my trip to Siena, Italy, to award the Prigogine Medal in Ecodynamics last summer.

T. Patterson: The Journal of Ecodynamics was initiated by a group of scientists who felt that advances in evolutionary physics were being complimented by recent advances in theoretical ecology, and that these synergies were among the most exciting advances in resolving major issues of global concern. The time was right, they felt, to provide a venue for exchange of information which could support rigorous study of *ecodynamics*. Ecodynamics is the study of ecological complexity based in rigorous foundations such as the laws of thermodynamics. Your husband's evolutionary approach, of course, is noted for being the origin of this line of research.

Your contribution continues to be valuable as you have been central to the organization and dissemination of your husband's work throughout his life. More than a calculating look at the proofs he devised, I believe the editors asked me to consult you because a more intuitive approach to his work was desired. That kind of perspective, as you're aware, is very difficult to bring out of a scientific document. Your contribution is seen as valuable to inspiring other contributions to the journal which emphasize creative and intuitive approaches—not just limited to pure science, but also to provide a venue which could be combined with art, philosophy, etc.

M. Prigogine: Yes, well, that 'intuition' was something incredible about my husband. Already in 1937 at the age of 20 in 'Les Cahiers du Libre Examen' (Cercle d'Etude de L'Université Libre de Bruxelles) he wrote:

Contemporary experiments in physics, biology and psychology show us the whole universe obeying deterministic law. But it is with some reluctance that our mind accepts this conclusion, one in such contradiction with our life experience, that permits us to believe in the possibility of unarbitrary choice between different conduct. [1]

We see then that from the beginning he could not accept that the whole human experience would be in contradiction with the fundamental laws of nature which were deterministic and reversible in time. And the quest for an answer to this problem became the centre of his search during all his life.

T. Patterson: (laughs) Well, I suppose there's a lesson there, but of course, it takes courage to discuss ideas at the age of 20 when you are not sure how to go about the proof of what you intuitively know to be true. There's a courage in that, and personal conviction, he wrote frequently of *passion* in science stating:

People tend to think of science as something very dry and dispassionate, but there is a great deal of passion involved ... I have always thought that science has two aspects: to understand the world around us but also to understand our own position in the world. The latter problem in particular can never be a neutral one. We are involved in scientific research like we are involved in a political movement. Passion is as much a part of science as it is of politics.—I. Prigogine [2]

M. Prigogine: Oh good, so you've read that article. Yes, he believed in the role of passion in processing knowledge. This seems to be a paradox as science by definition is beyond passion.

He wrote ‘... how can we accept as Einstein did, the idea that determinism reigns absolute and at the same time the idea that the creation of theory is due to the free play of the human mind? I think this is an example of an emotional attitude that clearly marks the limits of reason.’ [3]

T. Patterson: Do you suspect, that this kind of courage, passion, etc., is what is needed for science to contribute to overcoming the major social roadblocks of our time? What comes to mind is your husband’s courage to speak about the future. I sent you that quote, I believe, from the close of the Kyoto meetings. I was discouraged that nothing happened there, and the contrast struck me that they said it was because people were afraid to speak of the future. Your husband didn’t seem to have that fear.

M. Prigogine: Well, no. But you know, nobody wants to accept the responsibility for forcing us to act in the way we should. It’s not popular! They are thinking about the very near future.

T. Patterson: Your husband had some interesting things to say about the distant future, surprising, I found especially with respect to utopias. Scientists don’t speak of utopias so frequently, but in his work they seemed to have a very definite role:

The future of mankind is most often seen in one of two ways. One view is that mankind is making progress with respect to self-determination and human dignity, etc. The other view is that mankind is running straight toward catastrophe. I believe that both attitudes are too extreme and have to be corrected. We do not live in a deterministic system. We cannot extrapolate from our present state what the future will bring ...

I prefer to look at this question a different way. I believe that what we do today depends on our image of the future, rather than the future depending on what we do today. We build our equations by our actions. These equations, and the future they represent, are not written in nature. In other words, time becomes construction. Of course, we have some conditions that determine limits of the future but within these limits are many, many possibilities ...

Therefore, since no deterministic prediction is likely to be valid, visions of the future—utopian vision—play a very important role in present conduct ...

I like very much the fact that instability opens up a horizon of possibilities, since our actions at a given time depend on the way in which we view the future. If we looked on the horizon and saw only death, pollution and decay, I think it would erase any argument for reasoned, ethical action today.

I am more afraid of the lack of utopias. —I. Prigogine [4]

M. Prigogine: Yes that’s exactly it. Furthermore, he really believed in the role of the individual, the role of everybody to imagine and take part in acting which creates the future. This conviction came from his study of the behaviour of systems far from equilibrium. He showed that far from equilibrium complex systems are capable of creation of the new structures. There are many possibilities, but only one is realized. And the kind of bifurcation realized depends strongly on the fluctuation realized. And here we come to the role of individuals in creating the conditions which would permit the bifurcation that will bring us to the future which we would like to have.

T. Patterson: Some have cited as your husband’s work as evidence of freedom and ethical responsibility in an asymmetric universe. I remember in another of his articles, he seemed to speak directly to young researchers, emphasizing the difference between being and becoming. I wonder if this isn’t at the core of how uncertainty paralyzes society in working for future collective good? Do you think

it's that the idea of *being* is something definite, tangible and *becoming*—the mechanisms and one's role in how the future comes about is so much less clear? He wrote 'I try to work out the transition between being Being and Becoming—Being is always a stage of Becoming' [5]. He thus referenced the role of bifurcations throughout history, and the importance of individual action in instability. At that time he was referring to social fluctuations and microscopic structures which precipitated major world events—but it seems this idea could be applied to so many contemporary realities.

The world is based on probability and the history of society is most definitely based on probability. The hope I would like to give young people is that probability lends importance to these fluctuations. History is not made, it is being made. ... history is still in its early stages—we only have 10,000 years of history. Man will change, man is only at his early stage. There are still so many people who have no involvement in their culture, who are still hungry. Is this necessary, is it inevitable? I don't believe it is. ... it is important that young people play a greater role. They must fight against resignation and the sense of powerlessness.

M. Prigogine: Well, being and becoming, that is a difficult, difficult issue. He was very certain in his ideas of utopias. It's not a linear development, you know. When you say you want to go somewhere, it's never direct ... He insisted that the young would have the conviction ... 'you must believe'. He was speaking and believing that each one person must take their own responsibility.

You see, he pursued his ideas because he believed that the reality in which he lived (following the Russian revolution, the son of a family who had to emigrate from Russia) was not the only possible reality, that it could be influenced in a different way and give a different bifurcation.

I think Einstein and my husband lived at roughly the same time, and were exposed to many of the same conditions. It is amazing that they turned out so differently. Einstein was a pessimist, he used science as a way to escape the world; he used it as a way to escape realities. My husband was totally opposite. He wanted to change the world as it was.

T. Patterson: I've heard people say that your husband had Einstein rolling in his grave! Their views were so different; where did he get that courage? Did your husband have to think Einstein was out of his mind with his ideas?

M. Prigogine: No, no! On the contrary! He had a great admiration for Einstein, you know. And he also had a great regret. One of his friends at University asked him once if he wanted to meet Einstein, and he said 'Oh, yes!' ... they went to the University, but when they got to the door he thought, and changed his mind. He went home instead, thinking 'I'm not prepared to discuss with him', and turned away, thinking 'I will do it next time' ... But then you know 'the next time' never came, because Einstein died. Yes, I suppose there's a lesson there.

T. Patterson: For procrastinators like myself, I suppose (laughs). Let's go back a bit. I want to clarify something ... you'd said your husband cited Aristotle, Newton, Laplace, Einstein, Kant,¹ especially when it seemed he felt that social policy was demanding and/or relying too much on science for determined, certain, objective answers. When, in fact, his work proved that the laws of nature were, in effect, creative, and irreversible processes that played an active rather than parasitic role. In the lectures you sent me he would state:

Laws of nature are no more leading to certitudes, the only express 'possibilities'. In the early stage of the world the world was like a small child which could become a musician, lawyer or whatsoever; but not all at the same time. Similarly, the laws of nature whether they are

¹ See also Tiezzi [7] p. 10 for a more complete discussion of epistemology, science and technoscience, and Tiezzi [8] for a discussion of the deterministic and mechanistic theories in driving ecological deterioration in the 20th century.

classical, quantum or relativistic are no longer expressing deterministic situations, they express possibilities ... there are not only laws, but also events.

and

The world is a historical world, that there are instabilities, fluctuations, going on at all levels ... Nature is not only a geometry, it contains a narrative element, more like a novel ... Time is a 'construction', and being a construction, creativity becomes part of the laws of nature, something in which we participate. [6]

If the role of the scientist is traditionally thought to be one of cold, calculating, dispassionate objectivity, this couldn't have been an easy position for him to take

M. Prigogine: Yes, of course not! The idea that laws of nature are no more leading to certitude but that they only expresses possibilities is still not easy to accept for some scientists. As far as we go to the past, as soon as the conscience appeared in the human mind, humans became anxious about the future. The deterministic laws gave us a sense that it was possible to foresee the future. This is certainly one of the reasons why Newton's law was so well accepted.

T. Patterson: Do you think that this natural difficulty in taking personal responsibility is why scientists are often reluctant to adopt the creative role necessary to resolve the theoretical problems posed to the future by environmental crisis? I mean, doesn't it seem there are two extremes between which one is trapped? Either one is believing that they are insignificant and therefore can't do anything, or one is fearful of the power and responsibility one would have if they could bring about the deepest change? You'd mentioned a few moments ago that social action was blocked because of fear of unpopular decisions



Madame Prigogine, on the occasion of the Prigogine Awards 2005, presenting the Medal to Professor Jørgenson.

M. Prigogine: Yes, well, fear of that and fear of the future. It's a cultural attribute, one which can only be described by comparing different cultures. My husband was always very interested in other civilizations, particularly pre-Columbian.

Pre-Colombian peoples believed that the world was created by self-sacrifice of the gods. This sacrifice created the world, it's sustained it and as it sustained it, it transformed it. But their gods were not strong, they had to be helped by peoples. The Mesoamericans were obsessed by the responsibility for keeping the cosmos in movement. They believed that the universe was in eternal danger of stopping, and thus perishing. To avoid this catastrophe man must've nourished the sun with his blood. The gods needed the human beings as the human beings needed the gods. Anxiety and fear are principle images in their art, so you can see many many examples of it. They believed, in the constructive role of time and in their role to influence the world.

The Chinese vision of the world was completely different. The very existence of deterministic laws had no place in Chinese thought. To think of nature as submissive to universal, deterministic laws seemed to many ancient Chinese scholars as a contradiction in terms. They shared the common Chinese view of natural processes as something spontaneous, submissive only to internal regulation. In this context, Chinese scholars thought of the man-nature relationship in terms of resonance or coexistence more than in terms of control or domination. The very confirmation of this relation you can find in Chinese art—in the place which is given to the human being in the painted landscape for example. The association of nature with the idea of complexity was very strong in Chinese tradition and was very near to the vision of my husband. This is probably the reason why when he was invited in 1980 to give the series of lectures, after the first lecture, they told him that he was not to explain from the beginning because they already knew it. They asked him to speak about more recent work. They were more attuned to his work than we had imagined.

Now, speaking about European culture, traditionally in European culture we have developed the idea of a strong god. Humans were considered somewhere between nature and god, a sort of place of privilege. There was this belief that god was protecting us. This is why it was so well accepted—the deterministic vision of the world, Newton's laws, etc. It was very comfortable and gave a great impression of security. However, today the modern science suggests a different conception of the world which is curiously much nearer to the beliefs of pre-Columbian peoples, the conception in which a human being is no more considered an automaton with no responsibility but rather a part of nature with the capacity to influence nature and to create a new future. Also, more recently we are seeing an emergence of interest in the study of complexity of nature in European science, in part bringing it nearer to the perspective the Chinese have long held. My husband identified very much with the harmony of their approach.

T. Patterson: I've heard that when written in Chinese, the word 'crisis' is composed of two characters—the first one represents danger and the second one represents opportunity.

M. Prigogine: Why yes, I think my husband would have agreed very much in this description, that any given event is capable of becoming a catastrophe or something wonderful. I think he would've liked this description very much indeed.

Anyway, there are influences and applications of the work of my husband in many fields. Recently we had a wonderful meeting organized by the Solvay Institute (Bruxelles) to commemorate him. All of his colleagues from throughout his lifetime came—people that I hadn't seen in 20 years! And the applications and connections are being made in all different fields, philosophy, art, social sciences ... it's amazing. I think the connections will go on for a long time, there are many questions.

You know, my husband said to me five days before he died 'You know, I wasn't so gifted. I took 50 years to prove the ideas I had when I was 20.' ...

T. Patterson: Well that certainly puts the tasks at hand in perspective, doesn't it?

M. Prigogine: (laughs) Yes, well, there is a lot to do.

CONCLUSION

Bertrand Russell, in his 'History of Western Philosophy' wrote 'To teach how to live without certainty, and yet without being paralyzed by hesitation, is perhaps the chief thing that philosophy in our age can still do for those who study it.' In this light, probably one of the greatest ecological philosophers was one who was not known to be an ecologist at all.

Ilya Prigogine bridged the gap between the old determinacy of physical science (laws extending from non-living, reversible, closed systems) and the new indeterminacy of complex, living, irreversible, systems. In doing so, he offered an alternative way to reconcile the findings of prior notable physicists with the living, dynamical, far from equilibrium realities of our world.

The work Ilya Prigogine left behind is fundamental to the greatest ecological challenges yet to be advanced. We began this interview speaking about the intuitive approaches which might break the paralysis that uncertainty places on collective social action, and have discussed some of the ways Ilya Prigogine appreciated the different facets of these questions. He saw the world as somewhere between a deterministic world (completely governed by laws) and a completely arbitrary world (completely governed by events), the events being a combination of probability and irreversibility. Irreversibility, Prigogine explained, is the origin of free will, creativity and novelty, and thus, life.

Despite the findings of Prigogine and those after him, emphasis is still placed in perfect certainty. Science has a continuing battle to do with the mistaken assertion that all partial truths are in the end compatible, that they are part of a universal rational predetermined certainty. Science must actively assist policy in striking the balance between personal freedom and social good, and that the dynamics of events and evolution must be accounted for in adjusting political decisions to both. Prigogine felt from an early age that determinism did not describe well the conditions of life. His work reminds us of the importance of each person in creating conditions, contributing to fluctuations and bearing witness to the bifurcations which lead to futures we can now only conceive of as utopia.

The difference is between basing the laws of nature on possibilities versus on certitudes. This is no trivial difference for using ecological theory to construct the present and confront the future. This challenge requires emphasis on process versus emphasis on structure, non-equilibrium over equilibrium, evolution versus permanency, individual creativity over collective stabilization.

There is a slightly odd notion in environmental science today that things are moving so fast that ecological theory, as a strategy, becomes an obsolete idea. That everything is determined and all we need as humans to be is flexible or adaptable. This is a mistake. One cannot substitute agility for strategy. If ecological theorists do not look to the future and shed light on a strategy with respect to the world's biological resources, humanity faces the future with an abbreviated set of starting conditions from which the future will arise. Without the benefit of ecological theory, inadequate or no value at all is assigned to crucial, complex and powerful interdependencies among species. As it inclines to be only reactive (not proactive) to external circumstances, ecology emerges as an ever less powerful science.

In the 21st century, the scientific imagination has potential to heal this rift. Ilya Prigogine has demonstrated that creativity in nature leads, through infinite bifurcations or decision points, to an unforetold plurality of possibilities, not a predestined fate for man or molecule. There are objective laws and structures, to be sure, but there is also choice. Those choices, in society and nature, affect outcomes in complex interactions within ever changing structures in which everything is related to everything else. As Ilya Prigogine suggested, the model for the social sciences should be not be to deliver Newtonian laws for society, where according to Kant everything can be predicted, but rather to study and isolate the points of bifurcation.

For Prigogine, the utopian dreams of humans are thus an input in our future, not an incidental element. Millions of scientific research dollars and hours are spent on attempts to model and predict the future, rather than imagining preferred future options together.

At the very far edges of human knowledge, creativity is at work designing nature's rules, and we have only just begun to explore them. Yet, uncertainty paralyzes reason's steps toward the future. Chained by certitudes, one forfeits the degrees of freedom necessary to envision a sustainable, desirable future on this planet. Without this vision, the only certainty that exists is that this reality will not come about. Time and complexity are concepts that present intrinsic mutual relations, thereby tying ourselves to each other, and to a future—one in which we all actively participate.

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