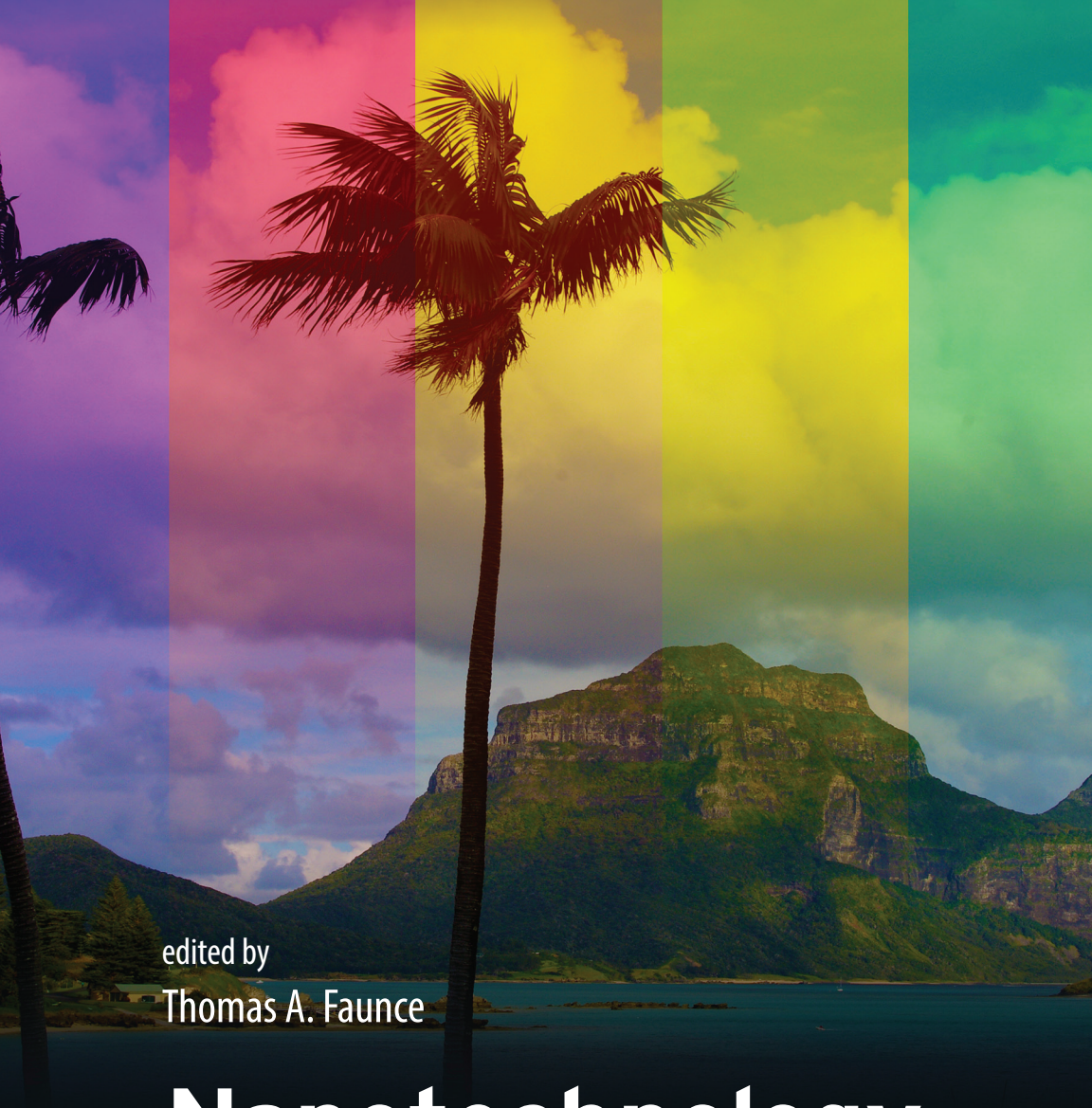

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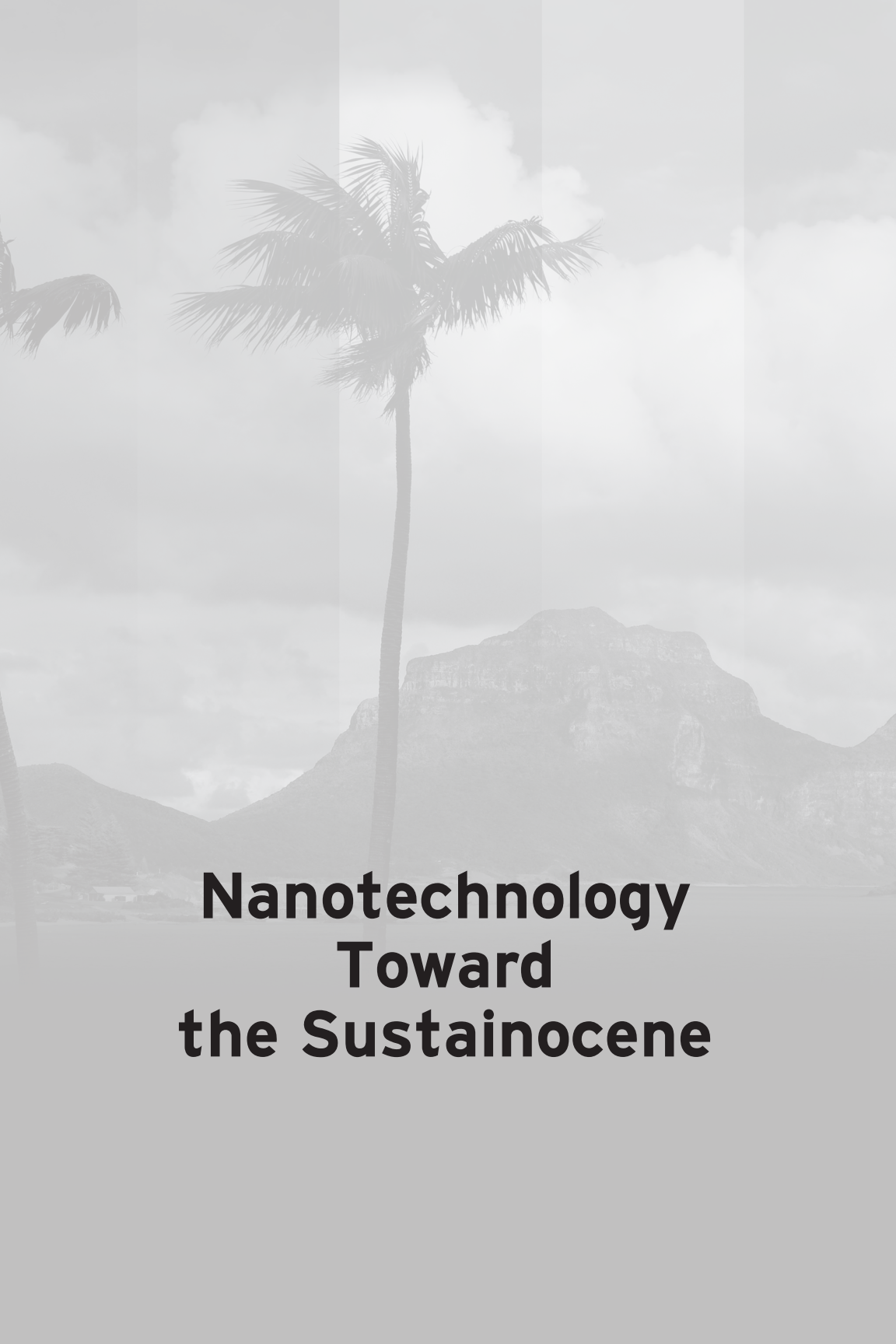
Nanotechnology Toward the Sustainocene



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This book is dedicated to Dr. Bryan Furnass, Canberra ecophysician and developer of the concept of the Sustainocene and to ANU photosynthesis researcher Warwick Hillier who attended the 2011 Lord Howe Island 'Towards Global Artificial Photosynthesis' conference, but tragically departed this life in 2014.

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Foreword

Analogical Precedents: Informatics, Biotechnology, and Energy

The Hon. Michael Kirby AC CMG

Former Justice of the High Court of Australia (1996–2009). One-time chairman of the Expert Group of the OECD on Transborder Data Flows and the Protection of Privacy. Formerly a Member of the World Health Organisation Global Commission on AIDS and of the UNESCO International Bioethics Committee. Commissioner of the UNDP Global Commission on HIV and the Law (2010–2011).

Introduction

The "Towards Global Artificial Photosynthesis: Energy, Nanochemistry and Governance" conference I attended at Lord Howe Island in August 2011 was concerned with radical changes in energy services that will be necessary as the finite sources of energy from fossil fuels are depleted (Faunce, 2012). Whichever way our species turns, there will be challenges. Some of these will be technological and scientific. Some will be economic, environmental, and social. But others will be governmental and legal, necessarily, at least so far as artificial photosynthesis' global deployment.

In medieval times, a revolution occurred in the communication of ideas following two technological changes, perfection of spectacle glasses and invention of the printing press. The former allowed the monks, who spent their years inscribing religious texts, to extend their working lives beyond presbyopia. The printing press then released words (and hence the ideas represented by words) from the calligraphy of the monks.

For holy men, the words were written to be said or sung. But after Caxton, printed words took on a life of their own. Their meaning could be delivered without mouthing the sounds they conjured up. In a forerunner to the urgencies of the present-day email, text messages, and social networks, ideas could be communicated four times faster than they could be said. A revolution in communication had begun. It continues to expand.

In addressing energy, science, and technology this conference opened a new dimension for me. My past encounters with my chosen issue had been with information technology and biotechnology. These are major features of the contemporary world. From the viewpoint of law, they present a common difficulty—that no sooner is a relevant law or agreed guideline developed to address some of their features and to regulate those deemed necessary for regulation by reference to community standards and the technology itself has raced ahead. The law in the books is then in great danger of becoming irrelevant, in whole or part. Because of fast-moving science and technology, laws, and institutions conceived at one time may have little or no relevance to events that happen very soon thereafter.

My encounters with information technology and biotechnology suggest possible directions in which laws and institutions may emerge to respond to the remarkable developments that are occurring in the fields of energy technology. Everyone knows that fossil fuels as a source of energy now have a limited life. Most experts also believe that fossil fuels have serious environmental disadvantages, despite their enormous efficiency for use, transmission, and storage. It is these features of fossil fuels that have led to urgent endeavors to find viable alternatives. At first, it was believed that nuclear technology would be the cheap, safe, and plentiful energy source for the future. However, experiences in Chernobyl and more recently in Japan have demonstrated the vulnerability of this source to accidental and natural disasters.

As well, the risks of nuclear terrorism have combined with accidental events to turn attention urgently to other energy sources and the technologies that will deliver them efficiently and economically for worldwide human use. It is here that solar energy and wind energy (often in symbiotic combination) present themselves to complement hydro sources as safe and powerful energy sources for the future. These and the developments of global artificial photosynthesis (if it can be perfected) are presented as the energy alternatives to replace fossil fuels that have dominated the past century (Faunce et al., 2013).

Whether by default, or by design, many issues presented to the law by contemporary technology are neglected or ignored because one suspects that, in many instances, it is too complicated or seen as too sensitive. I now will identify a number of paradoxes, or at least curiosities, that emerge about regulating technology generally

but that are likely to provide valuable precedents for governing the technologies that eventually make our world sustainable.

Five Paradoxes

Doing the Best without Experts

The first of the curiosities is a reflection not only on my own limited competence but also on the limited competence of every lawyer and every would-be regulator.

There are no real experts on the generic subject of regulating technologies. They do not exist in the United Kingdom, the United States, Australia, or elsewhere. It is much easier to find an expert on the intellectual property implications of biotechnology and information technology than it is to find someone skilled in considering what new law or institutional arrangement, if any, should be created to deal with a particular issue presented by technology and how it should be devised. It is easier by far to find an expert on income tax or unjust enrichment or international human rights law than to find governmental officials, judges, or even legislative drafters who can claim to be experts on subject matters such as those of safely globalizing artificial photosynthesis, as presented at the Lord Howe Island conference.

Each new area of technology will have its own features, relevant to the regulators and institutions appointed to the task of responding to its national and international challenges. Take, for example, the provision of intellectual property protection for computer programs—a comparatively new technology. Lawrence Lessig was the founder of Stanford School's Center for Internet and Society. His book *Code and Other Laws of Cyberspace* (now updated by *Code V2*) blazed a distinctive trail. He is something of a guru on the interface of cyberspace and the law. He challenges lawyers and technologists to think freshly. His thesis is that "Code," or the architecture of technological systems, will sometimes incorporate regulatory imperatives into the information technology itself, thereby obviating or negating any real choice on the part of the user as to whether or not to conform to a particular law.

In the High Court of Australia, the judges came face to face with this reality in *Stevens v. Sony Computer Entertainment* ([2005] 224 CLR 193). The case was about a claim by Sony Corporation of a breach of a "technological protection measure" installed by

it in the program of its computer games. Sony asserted that the measure was protected under the Australian Copyright Act 1968. Sony argued that Stevens had unlawfully sought to circumvent the device-incorporated computer games that it produced and sold on CD-ROMs for use in its PlayStation consoles.

Applying a strict interpretation to the expression "technological protection measure," the court held that Sony's device did not fall within the statute. I agreed in this analysis (Stevens [2005] 224 CLR 193 at 246). The case was a vivid illustration of the way in which, for copyright, contractual, and other legal purposes, attempts are now often made to incorporate regulatory provisions in the relevant technological codes (Brennan, 2006). It is a new development, although I suppose one might see primitive attempts directed at the same purpose in the safety provisions incorporated in the engineering designs of houses, bridges, and airplanes. Computer PlayStations simply take this to a higher level of sophistication and technological capability. Professor Lessig identified this new development with particularity. Inevitably, his expertise did not include all of the current major technologies such as energy technology, still less the way in which law can regulate them all.

We may complain about the absence of law concerned with new cutting-edge technology. We may acknowledge our own imperfections for addressing the gap. We may recognize, with Professor Lessig, that regulation in the future may not necessarily come in the form of instruments made by or under the legislature and published in the *Government Gazette*. It may take new and different forms and sometimes be grafted onto the technological setup itself.

Nevertheless, the issue of regulating technology, including sustainable energy technology, is undoubtedly one having the greatest importance for the future of the rule of law in investigating governance for the globalisation of artificial photosynthesis in every society.

The conference at Lord Howe Island in 2011 surveyed what is substantially a blank page. Increasingly, the content of law, like the content of life, will be concerned with renewable energy technologies like artificial photosynthesis and with their many consequences for society. The importance of energy technology regulation therefore belies the comparatively little that is written, said, and thought about it. Paradoxically, those who first lay claim to expertise may thereby participate in a self-fulfilling prophecy.

Too Much/Too Little Law

The second paradox is that the failure to provide a framework for legal regulation to deal with the consequences of a particular technology, such as global artificial photosynthesis, is not socially neutral. Effectively, to do nothing often amounts to making a decision.

In so far as law expresses prohibitions supported by sanctions that uphold the command of a relevant governmental or intergovernmental power, silence may, for once, imply consent or at least nonprohibition. Nothing then exists to restrain the governmental or intergovernmental power except its own ethical principles, any institutional ethics requirements, the availability of funding, and the prospects of a market.

The recognition that inaction in the face of significant technologies may amount to making a decision coexists with our appreciation, as observers of the law, that premature, overreaching, or excessive lawmaking may, in some cases, be an option worse than doing nothing. It may place a needless impediment upon local scientists and technologists, obliging them to take their laboratories and experiments offshore.

In a big world with diverse cultures, religions, and moral beliefs, it is generally possible to find a place offering a regulation-free zone in exchange for investment dollars. Just as bad is the possibility that laws will be solemnly made and then ignored or found to be ineffective, as was temporarily the case with the "technological protection measure" considered in the Australian Sony litigation. Following the decision of the High Court of Australia in that case, and under pressure from the US government under the United States-Australia Free Trade Agreement, Australian law was changed. The amended law represented an attempt to overcome the High Court's decision, although in a somewhat different way (deZwart, 2007).

Most of participants at the "Towards Global Artificial Photosynthesis: Energy, Nanochemistry and Governance" conference at Lord Howe Island would recognize that, in their own fast-moving field of energy technology, premature, overreaching, and ill-targeted laws might diminish experimentation, burden innovation, and cause economic and other inefficiencies. It is this attribute that reacts with anxiety about the dangers of the so-called precautionary principle (Andorno, 2004), which initially emerged in an environmental context.

While the precautionary principle appears to be gaining increasingly widespread acceptance in the international community, particularly in respect of protection of the global environment, it carries risks of its own. If taken too far, it could instill a negative attitude toward science and technology and encourage excessive regulation in the attempt to avoid *any* risks. Life is risky. Most technological innovations carry at least some risk. An undue emphasis on precaution, for fear of *any* risks, would not be good for science or technology or for the global economy, energy sources, or innovation, in thought as well as action. On the other hand, energy technologies clearly involve risks, as the accidents in connection with nuclear power plants demonstrate and as the vulnerability of large-scale power grids and environmental dangers of wind, solar, and hydro technology may present.

The second paradox is thus more of a contradiction or tension, difficult to resolve. At the one time we must accept that doing nothing to regulate technologies involves making a societal decision. Yet we must also recognize that sometimes doing nothing will be a better option than making laws that unduly impede innovation and burden efficiency.

First Amendment and Copyright Law

The third paradox concerns the proposition that while the law generally recognizes that while "free" expression and access to a "free" media constitute important human rights, they are not unlimited. They have to be harmonized with other fundamental human rights. These include the right to individual honor and reputation and to protection of privacy and family relationships (International Covenant on Civil and Political Rights [1976], articles 17.1, 17.2, and 19.3). They also include protection of the legitimate rights of inventors (Universal Declaration of Human Rights [1948], article 27.1; International Covenant on Economic, Social and Cultural Rights [1976], articles 15.1[b] and [c]).

In the field of energy technology we are inevitably also influenced by US regulatory models and traditions, simply because of the very significant role of US scientists, technologists, and energy companies operating in this field. However, now there are other players, particularly China and India, with their insatiable demands for energy to sustain their fast-expanding economies. The influence of the regulatory traditions and economic needs of these other countries is likely to emerge as a major consideration in this

field. And in so far as international trade and investment treaties are needed and negotiated, they should necessarily reflect the interests of developing countries with their huge potential energy needs rather than those of multinational corporations.

Technology's Democratic Deficit

A fourth paradox derives from the way in which contemporary technology at once enhances and diminishes our facilities of democratic governance. When it comes to legal regulation few participants, at least at a conference on sustainable energy technologies, such as that on Lord Howe Island, will question the desirability of rendering laws and regulation generally available and accountable to the people from whom authority to govern society is ultimately derived. However, on balance, does technology enhance or reduce or encourage or discourage democratic accountability for the state of the resulting regulations?

There can be little doubt that information technology has improved communication that is essential to converting the requirements of electoral democracy into the realities of genuine accountability of the governors to the governed. Radio, television, worldwide satellite communications, the Internet, podcasts, blogs, and so forth have revolutionized the distribution of information about those persons and institutions whose decisions affect the regulation of our daily lives. In this sense, democratic governance has moved from small town-hall assemblies of earlier times into huge national and international forums, both public and private.

Paradoxically, however, the very quantity of technological information today has resulted in its manipulation and presentation in ways that are often antithetical to real democratic accountability. The technology stimulates a demand for the simplification and visualization of messages, personalization of issues, trivialization of conflict, confusion between fact and opinion, and centralization and "management" of news. The so-called spin and infotainment are characteristics of the present age. They tend to concentrate power in a way that even George Orwell could not have imagined. This energy technology conference was mercifully free of these deficiencies. However, another deficiency was certainly present in abundance. I refer to the complexity of the basic science and technological controversies addressed by the scientists and technologists. The participants could speak with each other. Even then, those whose training was in physics confessed to understanding only part of the

discourse of the energy chemists. In relation to such exchanges, the intelligent layperson was often left out in the cold.

Moreover, the effective incorporation of regulation in the technology itself, and the way it is rolled out, going beyond what is strictly required by local law, denies effective opportunities for those affected to challenge the regulation so imposed. Who can, or would, challenge the overinclusive software designed to bar access to Internet sites selected as "harmful to minors" but sometimes operating in an overinclusive way?

Once, when I was serving in the High Court of Australia, I found that the website of the archbishop of Canterbury was barred from use! My staff was unable to procure one of the archbishop's addresses. This was because an Internet filter, instituted to deny access to websites deemed undesirable, had erected a bar. Presumably, this was because, in the manner of these times, one or more of the archbishop's addresses dealt with issues of sex, specifically homosexuality. In fact, that was exactly why I wanted the nominated speech. I was surprised to find that at the same time the Vatican website was accessible without any restriction. This may say something either about the prudence of the Pope's choice of language, his discomfort with candid discussion of sex, the power of the Roman Catholic Church in such matters, or the religion of the filter programmer. I gave directions that led to the filter being overridden and duly secured a copy of the desired speech. Others might not have been so lucky.

Given the importance of technology generally to the current age, how do we render those who design, install, and enforce such programs accountable to the democratic values of our society? As information technology, such as "Code," enlarges and replaces the old style of legal regulation of technology, how do we render its architects answerable to the majority views of the people? How, if at all, are transnational corporations, like Sony or Esso or BP or Shell, for instance, rendered responsible to the democratic values of the nations in which their products are used? How do we render the inescapably complex discourse of energy scientist and technologists—and their large implications for peace, justice, economic advancement, and human rights—understandable to democratic legislations, the officials who advise them, the judges who supervise them, and, especially, the citizens who elect them?

These are legitimate questions because the fourth paradox involves the coincidence, at the one time of history, of technologies

that took notions of freedom over the Berlin Wall, and the energy technologies that may promise an end to poverty and inequality in our world. Yet both these fields of technological revolution also sometimes diminish genuine debate, enlarge unreviewable "technological" and corporate decisions, and expand the potential of a relatively few decision makers to "manage" news in a way inconsistent with real transparency and accountability of decision making to the people most affected.

Vital but Neglected Topics

I reach my fifth, and final, paradox. This is one of the most important issues for the future health of the rule of law in every country. Because of the elusiveness of much contemporary technology to effective regulation, large and increasing areas of activity in society find themselves beyond the traditional reach of law as we have hitherto known it. When regulation is attempted, as I have shown, it will often be quickly rendered ineffective because the target of the law has already shifted or because corporate lobby groups can use narrow international investment arbitration rules to attempt to shut down regulation perceived as undercutting their profits. Typically, in the past, the drawing up of laws has been a slow and painstaking process. Consulting governments and those primarily affected, not to say the people more generally, takes much time. In that time, the technology may itself change, as I have demonstrated from my experience in the design of human tissue transplantation and privacy laws. Now new forms of regulation are being developed in the form of what Professor Lessig calls "Code." Yet this form of regulation is not so readily susceptible, if susceptible at all, as conventional laws have been, to democratic values and to the participation (or even appreciation) of most of those affected in the moral choices that determine the point at which the regulation is pitched.

It sometimes falls to small groups, particularly in professions, to lead the way and to bring enlightenment to the many. This, then, is the fifth paradox—at least it is an oddity. Such an important topic as the regulation of burgeoning technologies such as globalised artificial photosynthesis with the capacity to shift modern society towards sustainability should engage the interest and attention of all who claim to be lawyers, sociologists, and philosophers and express an interest in the health of the rule of law. Yet, for the moment, and for most such observers, this is *terra incognita*. The contributions at the Lord Howe Island conference suggest that it will, and should, not be so for long.

Seven Lessons

Recognize a Basic Dilemma

Certain general lessons about how new technologies may help us achieve a sustainable world stand out from the presentations at the Lord Howe Island conference. Some of them have already been touched on.

The first is that the regulation of technology faces a fundamental dilemma, hitherto uncommon in the law. This is that, of its character, technology is normally global. Law, on the other hand, comprising the enforceable, consistent, and predictable commands of an organized community, on traditional "positivist" interpretations has been tied to the governmental and judicial apparatus of a particular geographical jurisdiction. In recent years the need for extraterritorial operation of municipal law has been recognized, and upheld (Martinez, 2003, *Re Aird; Ex parte Alpert* [2004] 220 CLR 308 at 344-350 [114]-[133]; [2004] HCA 44, referring to the case of the *SS "Lotus*" [1927] Permanent Court of International Justice, Series A, No 10, Judgment No 9, pp. 18–19). Nevertheless, the fact remains that the focus of most national law remains upon acts that occur within the territory of that nation. By way of contrast, the focus of regulating technology must be the technology itself wherever it is produced or utilized across the globe (Dow Jones [2002] 210 CLR 575 at 615-619 [78]-[92]). Sometimes, that feature of the technology will make effective regulation by national law difficult, or even impossible.

It is into this context that direct enforcement of certain laws by "Code," written into software programs or otherwise imposed, adds a new dimension to global technology. The values and objectives of transnational corporations may be even more unresponsive to national regulation than the rules of the municipal legal system are. Moreover, "Code" of this kind may opt for caution and overinclusion so as to avoid dangers to markets in the least right-respecting countries.

The contractual arrangements entered by the government of the People's Republic of China and the corporations selling access to Yahoo! and Google in China illustrated the willingness of the latter to succumb to the demands of the former so as to avoid endangering a lucrative economic market for their products. In this way the provider and also the users are subjected to forms of censorship that might not be tolerated in other societies. A smaller country, with a smaller market, is unlikely to exert the same clout. Considerations of

economics rather than of legal principle, ethical rules, or democratic values may come to predominate in such cases, and especially in respect of energy technology, with its distinctive transnational features and needs.

Recognize That Inaction Is a Decision

In the past, proponents of technological innovation have often favored containment of law and a generally "libertarian" approach to developments of technology. Yet most lawyers recognize that there are limits. Unless such limits are clearly expressed, and upheld in an effective way, the absence of regulation will mean, effectively, that the society in question has effectively made a decision to permit the technological advances to occur, without democratic and legal impediments.

Those who are hesitant about adopting any form of the precautionary principle may nonetheless recognize the need for some restraints. Thus, unlimited access to child pornography will probably promote crime and sustain the need for regulation of the Internet to prohibit, or restrict, access to such sites. However, that will still leave room for debate about the detailed content of the regulation: the age of the subjects depicted, any permissible (computer graphic rather than human) images, the means of enforcing the law, and the provision of effective sanctions (*Bounds v. The Queen*, 2006). Cases on these issues, and on any constitutional questions that they present, are now quite common (*The Queen v. Fellows and Arnold*, 1997; *The Queen v. Oliver*, 2003; *cf Lawrence v. Texas*, 2003).

Likewise biotechnology—views may differ over whether regulation is necessary, or even desirable, to prohibit therapeutic cloning, reproductive cloning, or the use of human embryonic stem cells. Yet nonbinding prohibitory resolutions and declarations have been adopted in the organs of the United Nations on this subject (Macintosh, 2005). Even those nations, like the United Kingdom, that have not favored prohibitions or moratoriums on experiments with human cloning for therapeutic purposes might well accept the need to prohibit, or restrict, some biotechnological experiments. Hybridization and xenotransplantation of tissue across species clearly require, at the very least, restrictions and safeguards so as to prevent cross-species transmission of endogenous viruses. To do nothing is therefore effectively to decide that nothing should be

done (Robertson, 2001). It does not necessarily amount to a decision to "wait and see."

Nuclear energy obviously requires strict regulation because of the risks inherent in the technology itself and its vulnerability to nature and man-made disasters, detrimental to human life and well-being. A hydroelectrical development may have significant associated environmental and cultural hazards. A huge oil spill, occasioned by the search for even more remote sources of fossil fuels, will necessitate national and international regulation.

This is why the regulation of a new globally distributed technology, such as artificial photosynthesis, is such an important topic in the context of creating a sustainable world. It is not a subject that can be ignored, simply because the subject matter, and the available regulatory techniques, is difficult, uncertain, and controversial.

Recognize the Limited Power to Regulate

A third lesson, derived from the first two, is that the normal organs of legal regulation often appear powerless in the face of the pace, complex content and significant social and environmental impacts of a new technology. This is clear in the case of attempts to regulate new information technology. So far as the Internet is concerned, the regulatory values of the United States inevitably exert the greatest influence on the way the Internet operates and what it may include. This means that both the First Amendment and copyright protection values, established by the law of the United States, profoundly influence the Internet's present design and operation. An attempt by another nation's laws (such as those of France) to prohibit transnational publication offensive to that country's values (such as advertising Nazi memorabilia) may face difficulties of acceptance and enforcement in the Internet (*League against Racism and Anti-Semitism [LICRA], French Union of Jewish Students, v. Yahoo! Inc. [USA], Yahoo France* [2–1], 2000).

The same is true of biotechnology. The Australian Parliament initially enacted the Prohibition of Human Cloning Act 2002 [Cth] and the Research Involving Human Embryos Act 2002 (Cth). These were part of a package of laws aimed at the consistent prohibition in Australia of human cloning and other practices deemed unacceptable at the time. Both acts were adopted on the basis of the promise of an independent review two years after the enactment. Such a review was duly established. It was chaired by a retired federal judge, the Honorable John Lockhart. The review presented its report on December 2005. It recommended an end to the strict prohibitions

of the 2002 legislation, the redefinition for legal purposes of the "human embryo," and the introduction of a system of licensing for the creation of embryos for use for therapeutic purposes (Australian Government Legislation Review: the Prohibition of Human Cloning Act 2002 and the Research Involving Human Embryos Act 2002, Report, Canberra, December 2005).

Initially, the Australian government rejected the recommendations of the Lockhart review. However, following political, scientific, and media reaction, a conscience vote on an amending act, introduced by a previous health minister, was allowed. In the outcome, the amendments were enacted. They passed the senate with only a tiny majority (Commonwealth Parliamentary Debates [House of Representatives], 6 December 2006, 127. Commonwealth Parliamentary Debates [Senate], 7 November 2006, 48).

The main arguments that promoted this regulatory response to a new technology were the recognition of the pluralistic nature of the society, the availability of widespread reports on the potential utility of the research and experimentation, and the expressed conviction that experimentation would proceed in overseas countries with results that, if they proved successful, would necessarily be adopted and utilized (Finkel and Cannold, 2006; Skene, 2006; Carr, 2006). Interestingly, both the then prime minister and the then leader of the federal opposition voted against the amending act (Commonwealth Parliamentary Debates [House of Representatives], 6 December 2006, 117 119).

The global debates on the regulation of experiments using embryonic stem cells have often been driven by countries that, to put it politely, are not at the cutting edge of the applicable technology (Macintosh, 2005). On the other hand, the United States has also often adopted a conservative position on these topics in UN forums. As happened in Australia, this may change in time as the potential benefits of the new technology become more widely understood.

Recognize Differentiating Technologies

So far as regulation of technologies is concerned, the 2011 Lord Howe Island conference established the need to differentiate emerging sustainability-focused technologies for the purpose of regulation. The consensus was that it could not be a case of one response fits all. Self-evidently, some forms of technology are highly risk sensitive and urgently in need of regulation. Thus, unless the proliferation of nuclear weapons is effectively regulated, the massive destructive

power that they present has the potential to render all other topics, including of regulation, hypothetical. Similarly, some aspects of the regulation of biotechnology are highly risk sensitive, including the use of embryonic stem cells and germ line modification. For some, the risk sensitivity derives from the technology's perceived threat to deep religious or other beliefs concerning the starting point of human existence. For others, it arises out of fears for humanity's health or moral worth if it sanctions irreversible experiments that go wrong.

Somewhat less risk sensitive is the regulation of information technology. Yet, this technology too presents questions about values concerning which people may have strong differences of opinion. To outsiders, Americans seem to imbibe First Amendment values with their mother's milk. US lawyers sometimes have to be reminded that their balance between free speech and other human rights is viewed in most of the world as extreme and disproportionate.

The regulation of energy technology at first sight may be less controversial in terms of such moral conflicts. However, as regulations are adopted, they will exert influence on national and regional tendencies to shift from one energy source to another. In such shifts, it cannot be expected that corporations selling current forms of energy will be altruistic over decisions that may profoundly affect national, corporate, local, and individual interests. Such debates are the stuff of politics and cannot be expected to follow a course of plain sailing.

Recognize Different Cultures

Most of the participants in the Lord Howe Island conference came from the developed world. They therefore reflected general attitudes of optimism and confidence about the outcome of rational dialogue, scientific research, technological inventiveness, and the capacity of human beings ultimately to arrive at reasonable responses to regulating technologies on the basis of calm debate. However, as present energy sources are depleted and change, it cannot be expected that experts, investors, and other citizens from developing countries will be quite so dispassionate.

Basing Regulation on Good Science

In the early days of the HIV pandemic, I served on the Global Commission on AIDS of the World Health Organization. One of the members, June Osborn, then a professor of public health at the University of Michigan, taught us all the importance of basing all

regulatory responses to the epidemic upon good science. The danger of responses based on assumptions, religious dogmas, intuitive beliefs, perceived national self-interest, or popular opinion was such that they would not address the target of regulation effectively.

The intervening decades have suggested that the countries that have been most successful in responding to HIV/AIDS have been those that have observed June Osborn's dictum (Plummer and Irwin, 2006). The same is true of the subjects of biotechnology, information technology, and energy technology examined at the Lord Howe Island conference. All too often, science and technology shatter earlier assumptions and intuitions.

For example, the long-held judicial assumption that jurors, and judges themselves, may safely rest conclusions concerning the truth of witness testimony on the basis of the appearance of witnesses and courtroom demeanor has gradually evaporated because scientific experiments shatter this illusion (*Fox v. Percy*, 2003). One day, by subjecting witnesses to brain scans, it may be possible to demonstrate objectively the truthfulness or falsity of their evidence. If, and when, the day arrives, other issues will doubtless be presented for regulators. We are not there yet. But any regulation must recognize the need to remain constantly abreast of scientific knowledge and technological advances.

Addressing the Democratic Deficit

This brings me to the last, and most pervasive, of the lessons of the Lord Howe Island conference on governance issues confronting the globalisation of artificial photosynthesis. Technology races ahead of our predilections and predictions. Its innovations quickly become out of date, both in terms of social usefulness and safety. Laws addressed to a particular technology are rapidly overtaken and rendered irrelevant or even obstructive. Nowadays scientific knowledge, technological inventions, and how they are perceived to mesh with community values change radically in a very short space of time.

In such an environment, there is an obvious danger for the rule of law. It is impossible to expect of legislatures, with their many responsibilities, that they will address all of the technological developments for regulatory purposes. The average legislator finds such issues complex and impenetrable. Such issues are rarely political vote winners. They struggle to find a place in the entertainment and personality politics of the present age as well as with the many other competing questions awaiting political decision

making. This leaves a gap in democratic involvement in this sphere of regulation. It is a gap that is being filled, in part, by "Code" that incorporates regulations designed by inventors of information systems themselves in the structure of such systems but without a democratic input or the necessity of individual moral judgment.

The democratic deficit presented by contemporary technology is thus the largest potential lesson for the global deployment of artificial photosynthesis from the 2011 Lord Howe Island conference. In an age when technology is so important to society, yet so complex and fast moving that it often defies lay understanding, how can we adapt our accountable lawmaking institutions to keep pace with such changes? One means is by the use of consultative mechanisms such as law reform commissions (Chalmers, 2005) or independent inquiries (Cooper, 2006; Stobbs, 2006; Karpin, 2006). In such cases, the very process of consultation and public debate promotes a broad community understanding of the issues, an appreciation of the competing viewpoints, and an acceptance of any regulations adopted, even when they may give effect to conclusions different from one's own.

Conclusion

Adapting the legislative timetable and machinery of regulating energy sources to the challenges of modern governance is a subject that has engaged law reform bodies and executive government for decades. Often they lie unattended for years, or indefinitely, not because of any real objections to the proposals but because of the legislative logjam (Mason, 1971; Kirby, 2006).

In the face of radically changing sustainability-focused technologies such as globalised artificial photosynthesis and the danger of a growing democratic deficit if their roll out is impeded by corporate interests in say the fossil fuel or global agribusiness industries, it will obviously be necessary to adapt and supplement the lawmaking processes we have hitherto followed in most countries. Different types of delegated legislation may need to be considered. So may the enactment of overarching laws, expressed in general terms, which will not be quickly reduced to irrelevancy by further technological change (*R v. Quintaralle [on behalf of Reproductive Ethics] v. Human Fertilisation and Embryology Authority*, 2005). So adopting international principles (such as the OECD Guidelines on Privacy) or preventing corporate fraud, evading tax or unduly influencing governments may prove so influential in helping

individual countries to act on the needs for regulation. And to do so in a way that is broadly consistent with a common approach chosen internationally.

Addressing the weaknesses in the democratic accountability of the large and complex modern government is an important challenge to legal and political theory. The 2011 Lord Howe Island conference demonstrated once again the particular ingredients and substantial urgency of the problem. It will take more conferences to provide the solutions appropriate to the differing systems of government operating in different countries. But the urgent need is for leadership through bodies such as the United Nations to bring together all those working in the complementary and competing sources of future energy so that a global approach to the challenges may be adopted for the whole world. That approach should seek to minimize the risks to the biosphere and to the human species. It should seek to harmonize the national and transnational economic interests at stake. And it should help maximize the contribution that future energy sources may make toward reducing the toll of poverty on humanity, increasing the sustainable pace of economic and social development, and protecting the universal human rights of all human beings for all time into the future.

References

Andorno, R. (2004). The precautionary principle: a new legal standard for a technological age. *J. Int. Biotechnol. Law*, **1**, 11–19.

Bounds v. The Queen, 228 ALR 190 at 197 [26], 211 [94]; (2006) HCA 39.

Brennan, D. J. (2006). What can it mean 'to prevent or inhibit the infringement of copyright'? A critique of Stevens v Sony. *Aust. Intellectual Property J.*, **17**, 186.

Chalmers, D. (2005). Science, medicine and health in the work of the Australian law reform commission. In *The Promise of Law Reform* (Weisbrot, D., and Opeskin, B., ed.). Sidney, Australia: The Federation Press, 374–387.

Cooper, D. (2006). The lockhart review: where now for Australia? *J. Law Med.*, **14**, 27.

deZwart, M. (2007). Technological enclosure of copyright: the end of fair dealing. *Aust. Intellectual Property J.*, **18**(1), 7–38.

Faunce, T. A. (2012). Towards global artificial photosynthesis (global solar fuels): energy, nanochemistry and governance, *Aust. J. Chem.*, 65(6), 557–563.

Faunce, T. A., Styring, S., Wasielewski, M. R., Brudvig, G. W., Rutherford, A. W., Messinger, J., Lee, A. F., Hill, C. L., deGroot, H., Fontecave, M., MacFarlane, D. R., Hankamer, B., Nocera, D. G., Tiede, D. M., Dau, H., Hillier, W., Wang, A. R. (2013). Artificial photosynthesis as a frontier technology for energy sustainability. *Energy Environ. Sci*., **6**, 1074–1076.

Finkel, B., and Cannold, L. (2006, August 7). Day for stem cells and the hope of finding cures. *Sydney Morning Herald*, 9.

Fox v. Percy, 214 CLR 118 at 129 [31]; (2003) HCA 22.

Karpin, I. (2006). The uncanny embryos: legal limits to human reproduction without women. *Sydney Law Rev.*, **28**, 599.

Kirby, M. (2006). Law reform and human rights: Scarman's great legacy. *Legal Stud*., **26**(4), 449–474.

Lawrence v. Texas, 539 US 558 at 590 (2003).

League against Racism and Anti-Semitism [LICRA], French Union of Jewish Students, v. Yahoo! Inc. [USA], Yahoo France [2–1] (2000). *Electronic Business Law Reports*, **1**(3) 110–120 (The County Court of Paris).

Macintosh, K. L. (2005). Human clones and international human rights university of technology. *Sydney Rev*., **7**, 135–136.

Martinez, J. (2003). Towards an international judicial system. *Stanford Law Rev*., **56**, 429.

Mason, A. F. (1971). Law reform in Australia. *Fed. Law Rev*., **4**, 197.

Plummer, D., and Irwin, L. (2006). Grassroots activities, national initiatives and HIV prevention: clues to explain Australia's dramatic early success in controlling the HIV epidemic. *Int. J. STD AIDS*, **17**, 1.

R v. Quintaralle [on behalf of Reproductive Ethics] v. Human Fertilisation and Embryology Authority, (2005) UKHL 28 at [25].

Robertson, J. A. (2001). Why human reproductive cloning should not in all cases be prohibited. *Legis. Public Policy*, **4**, 35.

Stevens v. Sony Computer Entertainment, 224 CLR 193 (2005).

Stobbs, N. (2006). Lockhart review into human cloning and research involving human embryo: closing the gap. *Queensland Lawyer*, **26**, 247–251.

The Queen v. Fellows and Arnold, 2 All ER 548 (1997).

The Queen v. Oliver, 1 Cr App R 28 at 466-467 (10) (2003).

Preface

Our world is now in a perilous situation; its sustainability is being endangered or destroyed by the misguided activities of artificial human entities (corporations) we've allowed to dominate the earth's governance. This is occurring just as real people begin to expand their moral sympathies sufficiently to prioritize protecting our world's interests. The immediate threats to sustainability of humanity and its surrounding biosphere include not only extreme weather events associated with climate change but also the extent and toxicity of pollution, loss of biodiversity, and the disrupted integrity of land use, oceans, and atmosphere.

At this crucial moment, our species has developed a new technology—nanotechnology. Yet, governance of nanotechnology is currently polarized as either a threat to human safety or a source of great profit in new industries. A theme linking the chapters in this book is that they envision nanotechnology as fulfilling a destiny to provide the solution to that most intriguing and important of riddles—how this generation can shape the conditions for our race's secure and sustainable future on the earth over a span of millions of years.

The contributions in this volume are drawn from researchers at the Australian National University in a variety of fields related to nanotechnology and to its implications for human security and environmental sustainability. One unifying theme of these papers is that nanotechnology (if properly used) has the capacity to usher in a many-million-year period of human flourishing and stewardship within the earth's ecosystems, a period that for public policy purposes has been termed the Sustainocene. The concept of the Sustainocene was developed by Canberra ecophysician Dr. Bryan Furnass.

The Sustainocene is a concept drawing directly upon utopian literature but also coherent with modern neuropsychology and brain plasticity studies. The latter emphasize that to enhance human performance, visualization of ideal performance can be critical. Such capacity seems, however, to be denied to the citizens of modern human civilization. Part of the reason is that they can be corralled into shopping malls and housing estates; mollified with mass media

television, videos, and videogames; and subjected to increasingly sophisticated surveillance with their freedom of choice eroded down to purchasing decisions. The mass centralized production and global distribution of energy and food facilitates such corporate control. A new decentralized energy and food technology such as artificial photosynthesis (capable of being employed in every building) cuts across this. It promotes a world where individual families and small communities address their basic energy and food needs locally with attendant local responsibility environmentally and socially. Thus are established the basic preconditions for that ecocentric transformation of human consciousness sustained by contemplative traditions as our collective destiny. Such is the vision at the core of the Sustainocene. This book explores some ways in which various applications of nanotechnology may contribute to this transition.

The foreword was written by the Honorable Michael Kirby, AC CMG, in the context of his attending the first international conference dedicated to the creation of a global artificial photosynthesis project at Lord Howe Island in August 2011 (http://150.203.86.5/coast/tgap/conf.htm). The conference was coordinated by the author under the auspices of the UNESCO Natural Sciences sector and was an official event of the UNESCO 2011 International Year of Chemistry. Many of the eminent nanotechnology researchers in this volume attended that meeting and/or have had their research focus altered by it. The papers were edited by the author in a special open source edition of the *Australian Journal of Chemistry* published in 2012, and he also coordinated a subsequent conference at Chicheley Hall, in the United Kingdom, focused on developing those initial ideas into a practical framework to establish a global artificial photosynthesis project with the assistance of the Royal Society in 2014.

The author has elsewhere promoted the idea that global artificial photosynthesis is nanotechnology's moral culmination (Faunce, Wilton Park, 2012; Faunce, BBC, 2012; Faunce, Energy Futures Lab, 2012; Faunce, ANU Public Lecture, 2012; Faunce, *Nanotechnology for a Sustainable World*, 2012). In many ways, the chapters in this book, by a range of nanotechnology experts at the Australian National University, are arranged and conceived as case studies or thought experiments to test that hypothesis.

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