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CHAPTER NINE

The Final Convergence

Intellectual property (IP) was a noble experiment, and it may have been the cause of some of the growth and development we have enjoyed in the last century or two. But its days are now numbered. The end of IP is written into the structure of an ongoing technical and scientific revolution. Nanowares will be the final merger of numerous seemingly disparate technologies into a single, overarching technological infrastructure. This revolution, when fully realized, will alter our fundamental relations among each other, to the products of our creativity, and to the ‘natural’ world. No longer will many of the forces that have driven prices in markets function as they have. Scarcity, in the best version of the nanoware future, will cease. This future is being prepared for by many who are trying to develop it.

I have been trying to make a case, ever since I first examined the nature of cyberspatial goods, that IP regimes do not reflect reality well, and that they can and should be altered (or abolished) to serve our needs, and to better embody both logic and pragmatic ends. The *technology* is revealing that our preconceptions about the nature of our technical artifacts, as applied through existing IP regimes, are fundamentally flawed. The case is being made for us by both the inadequacy of current legal norms to deal with emerging technologies and the recognition of innovators, who now consciously skirt those regimes, and are instituting and embracing new means to promote and to protect innovation. If we are to pave the way for the full, beneficial, and equitable realization of nanowares, then we must finally declare IP as we know it to be dead, and move on. Let’s review what our examination has revealed, and explain why the death of IP means opening a new door for the future of technological and scientific progress and economic prosperity if properly navigated.

Nanowares: What Are They, Really?

I have attempted to use a single word to connect several different paths of current technological approaches to the same goal. The sciences have been pushing technology inevitably toward a convergence, as the fundamental goals of science – better understanding, prediction, and

control of nature – have been leading to the development of the technologies that underlie nanowares. The emergence of essentially programmable physical goods will complete the development of two major tracks of technological development. On the one hand, computerization and information and communication technologies (ICT) have involved ever-increasing abilities to manipulate information, and on the other hand, better, more precise, and miniaturized manipulation of the physical world (necessitated in many ways by the underlying technologies of ICT) has involved ever-increasing control over our manufactures or artifacts. The convergence of information technologies and manufacturing means fundamentally rethinking our connection to our artifacts, as discussed in the chapters above.

One exciting feature of these converging technologies is *how* they are finally converging. I have specifically included in the analysis of nanowares technologies that are clearly not nanotechnology. There are two reasons for including in discussions about nanotech and innovation the grassroots development of localized or microfabrication technologies. The first is that those who are behind the emergence of these technologies have their theoretical roots in nanotech. The second is that the tools and infrastructures that they are developing capture many of the same issues as those that will be presented by the full realization of molecular nanotechnology (MNT). The goals of enabling the complete accessibility of all potential means of production, and of liberating fully human creativity from the traditional demands of capital, are implicit in the Fab Lab, RepRap (and other) micro-manufacturing efforts, and will be the ultimate inevitable result of true MNT. Because I (and others) see both streams of development as meeting at some future point, and motivated by the same ultimate goals, a single term ‘nanowares’ has been used throughout this argument.

We should treat all of these emerging and converging technologies as a kind, and look for ways we can precipitate their smooth arrival and realize their full potential. Ultimately, I do not think there is any real danger that governments or others who foolishly seek to keep alive current IP paradigms, and extend them to nanowares, can succeed. In fact, it is encouraging that while some of us try to justify the theoretical underpinnings of a movement, the movement itself marches inexorably onward, propelled by the general acceptance of its tenets. IP has been breaking down for some time as a result of half of the two-track movement toward true MNT. Even as the patent profession (really, the patent industry, in which patent lawyers, courts,

and other related professionals are assured of profits by the mere filing and litigation of patents) seeks to bolster their floundering field against the tide of radical change brought about by ICT, those who are innovating in software have learned how to work around the legal impediments to innovation, and work out among themselves a more just spectrum of rights and expectations. This is happening as well in nanowares. It is part of the nature of the technology that openness and free markets will drive innovation in the field, and it moves those working in it at least away from excessive upstream patenting, and at most, toward open source paradigms.

In both the grassroots nanowares approaches to microfabrication (including desktop fabrication) and in the realm of synthetic biology, where bio-bricks approaches ensure free and open access to the foundational research and components, researchers and innovators alike are taking matters into their own hands and preventing patents from impeding these emerging sciences. The same trend motivated both industry and individuals to disclose rather than enclose genes in the race to decode the human genome and thereafter. Nanowares are thus part of a spectrum, and the continuation of a trend. The patent industry will grow louder, and look to governments to secure their domains, even as those who are doing much of the work in both the science and innovation work steadily to keep this expanding domain open.

In many ways, this book is not a call for action, but rather an attempt to theoretically explain trends that will occur anyway. It is descriptive rather than normative. Nanowares will be open, eventually, and IP will continue to break down, with or without philosophers making the case that it should. But some remain unconvinced, and innovators and scientists are still at the mercy of states, as well as market forces, that sometimes work at cross-purposes, and that are often impelled by habit rather than reason to continue to support dying methods and ideologies. Even while I am certain that the seeds of revolutionary change in our thinking about the natures of artifacts are embedded in the technology itself, we should be mindful of the pernicious ability of those whose domains are threatened, even by the inevitable, to attempt to secure their monopolies.

I have argued throughout my informal IP trilogy that where institutions or norms conflict with grounded principles of justice, we must seek justice. This is an ethical argument, and suggests that the forces I describe, and which are moving technology and science, are *good*, and that attempts to

impede that development are the opposite. You may well accept the trends I have described, their economic efficiency, their inevitability, and their benefits for innovation without accepting the ontological and ethical arguments that pervade this text, but I have tried to point out the shortcomings of mere utility as a foundation for action. Let's look briefly at why ethics and justice ought to finally motivate us to embrace nanoware without IP, and why ethical foundations ought to be part of our thinking in science and technology in general. There are sound historical reasons to believe that some things are better than others, not just instrumentally, but also *fundamentally*.

Ethics and Innovation

If science and technology never had any impact on rights or duties, and if IP law did not impede some of those rights and duties, then philosophers could avoid confronting the ethical issues raised by new technologies like nanowares. But each new technology presents us with a range of new considerations regarding the rights of scientists, innovators, and the public, and the proper role of states in ensuring justice. It is a modern trend to incorporate earlier in the development of new technologies ethical considerations that are anticipated to pose impediments or lead to harms. As discussed above, most of the discussion regarding nanowares has focused upon potential harms posed in the realm of safety, security, public risks, and environmental impacts. All of this inquiry is warranted, given the experiences of harmful technologies in the past, and we have delved into them briefly above. But the argument I have been making in this text focuses primarily on IP, and how the current IP regime threatens the development of the technology itself. While I am mindful of, and concerned about, potential physical harms arising from nanowares, and indeed support inquiry into the general ethical duties of researchers and innovators in avoiding those sorts of harms, I am most concerned with the implications for justice arising from the application of current IP norms to this and other technologies.

We are not, as individuals, entitled to the fruits of innovation. I do not think there is a duty, either, for anyone to innovate. Nor do I think that justice requires the free dissemination of physical goods that result from innovation to either the needy or the wealthy. But I do think that states ought not to impede either individual human creativity or markets for the fruits of that creativity. There may well be individual, moral duties to contribute to society, and to not harm others consistent with Mill's oft-spoken about

(and incorporated herein) ‘harm principle.’ I would certainly encourage innovators to innovate, to share the fruits of their innovation openly, and to enable others to improve upon their own innovations. Doing so would certainly be what ethicists consider to be supererogatory goods, or praiseworthy (morally speaking). But this is not an argument for achieving some moral utopia through adopting socialist principles such as the famous maxim: ‘to each according to their needs, from each according to their ability.’ Instead, it is a call to let markets sort out prices, free from state interference, and to allow human creativity to thrive without creating artificial barriers in the form of state-sanctioned monopolies.

I do not mean to imply that an utterly free market in innovation will result universally in ‘the good,’ ethically speaking. Rather, it is clear from history that people will do bad things, intentionally or unintentionally, and that states have sometimes tried to step in to rectify harms in some cases, and succeeded sometimes. The law and the state have played roles in marshaling public resources to great good in the past, and have in fact helped us to achieve our current level of innovation and wealth through various means, including through the allocation of resources to both science and industry. It is not *per se* unethical that we should make such democratic choices about allocation, control, regulation, or preference where those choices are truly democratic, and where harms might be avoided with certainty. Neither is it *per se* necessary that states do any of these. Looking at past examples, as we have a bit throughout the above argument, there are clear instances of state failures, in both allowing for and in some cases precipitating harms. Moreover, there is an even clearer history of state error in its actions regarding markets. There is as yet no good evidence that attempts to influence markets, especially in the development and dissemination of new technologies, are necessarily successful. Such attempts are also arguably bad, in a moral sense, when they involve impediments of natural rights (to life, liberty, or property, for instance). I believe that nanotechnology presents us with an important choice, and that many who are involved in this nascent field have already made that choice. The choice is: Do we wish to adopt failed IP policies in nanowares, or pursue new paths to liberate both the science and its development through technology?

We have other choices to make as well. For instance, should we pursue informal policies, or create institutions that help us to track dangerous materials, precursors, or final products that enter the stream of commerce? Are there some sorts of technologies that need to incorporate limitations,

for instance on the potential negative consequences of unhindered self-replication? Should scientists and innovators choose to abide by certain ethical principles in general? All of these choices have ethical implications. The common thread of everything I have tried to demonstrate, and the overarching thesis of this book, is that it is the nature of each of the above as *choices* that is most important.

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Choosing to Do Better

With the move away from classical scholasticism, and the modern embrace of Enlightenment liberalism, we have abandoned largely the notion that the good is that which must be done because of some commandment handed down by an authority. Rather, the turn of ethical theory, and of institutions, has imbued in individuals a greater role in choosing the good, directing their intentions, and in accepting personal responsibility for their actions. No other system could suffice for a complicated world with ever-expanding realms for decision-making, and without historical guidance for directing our intentions and actions to new, unanticipated situations. There is no clearer argument against a scholastic approach, and in favor of liberalism, than the trajectory of science and technology since the Enlightenment began. By liberalism, we mean an approach to questions that embraces empirical evidence, and that is open to reform. Moreover, liberalism centers power not in the state, or in some higher authority (like a sovereign or deity), but rather in the individual, from whose consent the just power of a sovereign must constantly derive. Political liberalism recognizes the contingent nature of the state's authority, and the ultimate authority of citizens over the state. It also recognizes that the methods of the sciences, by which truths are

forever amenable to falsification, are applicable too to the mechanisms of state power. But classical liberalism of the variety we have inherited from Locke and others also recognizes certain immutable principles of right that must guide and limit the state, including inviolable rights of individuals to maintain their liberty, property, and lives. These are like axioms in mathematics and the sciences, and while they are open to falsification, the burden of proof necessary to overturn an axiom is greater than other contingent truths.

Out of liberalism, and the methodology of the sciences, came two great historical attempts to devise a universal ethics. These two schools contend today. Kant's deontology and Bentham's utilitarianism stand as two distinctly different approaches to ethical problems. While I clearly favor one, our agreeing that deontology is best is not necessary nor sufficient for us to reach the same conclusion about the role of the state in innovation, or about the ethics of IP in general. Utilitarian arguments might very well be made that suggest that IP laws impede general utility. But that is neither here nor there. What is critical is that both of these major, post-enlightenment theories of ethics present us with the capacity and responsibility as individuals to make choices, reasoning out the ethical consequences or categorical duties directing those choices, rather than blindly accepting the wisdom of past generations, sacred books, or other authorities.

The currently accepted wisdom about IP should not be blindly accepted. It must be challenged. If it is supported by empirical evidence, then so be it. If IP does not accomplish the aims it was intended to, then based solely upon a utilitarian calculus, its harms measured against its benefits must impel new choices. Or, if there are categorical duties, natural rights, or further considerations outside of a utilitarian calculus that suggest that IP schemes lead to injustice, then we have more bases for choice. In any event, the fact that we actually have choices, and that we need not accept as immovable the current status of institutions regarding innovation and IP, is what sets us apart as members of liberal democracies. In the case of IP, we need not even change the law. We can choose to develop wholly new institutions and adopt them, even without the intervention or support of states. This is truly liberating.

The above has been an argument that the choices currently being made by whole categories of researchers and innovators are soundly based not just upon pragmatism, but upon justice. Informal and formal institutions

exist that *already* enable those who wish to innovate outside of standard IP norms to do so, and to further thwart attempts by those who would lock up information, potentially impede scientific and technical progress, and steadfastly hold to outdated dogmas. It is not just fortunate that many of those spearheading the science, and building these technologies, are choosing to do so in the open, and without IP. It is just.

As I wrote earlier, this is not so much a work of normative ethics as it is one of descriptive metaphysics and ethics. I am documenting trends that I suggest are naturally impelling those who pursue nanowares to adopt open innovation and to reject standard IP. Moreover, they are doing so based upon sound, and ethically justified choices. Many of those connected with what I have called the ‘patent industry’ argue that such choices are foolish, that they will slow innovation, and that they deny rights to innovators. We should critically examine and question the motives behind such opinions and advice, and then choose, based upon reason, not fear, how to pursue nanoware science and innovation. I believe I have made a case throughout this book that choosing open innovation, and rejecting IP, is wise, ethical, and pro-innovative. The evidence, and the analysis I have offered, suggests that the end of IP is coming anyway. It has been slowly breaking down, its weak foundations revealed by emerging technologies since the advent of ICT, and completed with nanowares. What we are faced with now is a choice, and therein stands the ethical challenge. Will we choose to retreat to the safety of accepted dogma, or brave the future with new models, new approaches, and a greater respect for justice and right, and their necessary relations to science and technology?

The Logical Necessity of Open Innovation

As we have briefly discussed, and as numerous other scholars have noted in much greater depth, science has proceeded apace in the past, and innovations have thrived, even absent explicit state-sponsored monopolies. The past seventy years are an aberration of sorts. Spurred by the emergence of cold-war paradigms of ‘big science,’ academic institutions, researchers, corporations, and the public have grown used to a mode of operating that seemed for a time to propel us into a brave new age, and even got us to the moon and back, but which no longer seems either workable or necessary. Many have argued, and I agree, that the trend toward the commodification of ‘upstream’ science contradicts the scientific ‘ethos.’ As early as 1942, Robert Merton argued

that science is an inherently democratic institution, and embodies, when properly pursued, the following values: universalism, communalism (which he unfortunately called ‘communism’), disinterestedness, and organized skepticism. There have been many lengthy debates about the adequacy and accuracy of Merton’s appeal to a scientific ethos, but the sentiment captured by this list echoes some good, pragmatic values that are certainly a *part* of most scientific inquiry, and that are arguably necessary for scientific progress.¹

Science progresses through transparency, and tends to become pathological when it is obscure. Scientific progress can only be tested by universal acceptance of its methods and axioms, and communally organized research groups sharing their findings and laying them bare to falsification. Scientists must be detached from the truth (or profitability) of their findings, because self-interest tends to promote lies or delusions. Scientists must remain always skeptical of their findings, understanding that they are always contingent, and that tomorrow’s experiments may prove everything they assumed previously to be suddenly incorrect. Merton’s ethos demands, in short, open pursuit of scientific knowledge. Technology does not demand any of these. But because of the nexus between science and technology, pushed ever closer by various commercial and political forces, science is in danger of setting aside these important values. Technology, on the other hand, may very well have no ethos.

It is difficult to reasonably extend the ethos of science to technology, or for that matter, to conceive of anything like Merton’s values in the pursuit of technology. People may well work in secret, applying the fruits of science to productive ends, they may well choose to work in groups, to obscure their labors, to devise means to defeat reverse-engineering. They certainly may be interested, in fame, profit, and world domination. I believe the ethics of any of these choices are independent of any technological ethos. But as a matter of pure self-interest, trying to extend any of these motivations or attitudes upstream toward the basic science will only hinder the ability of innovators to have access to new means to develop new technologies. As science and technology *merge*, which is arguably what is occurring with many converging technologies, attempts to hide, obscure, or protect the basic knowledge are not only unnecessarily expensive, but also self-defeating. Whatever IP future we choose, there will always be opportunities for fame and fortune of some kind from entering a marketplace with a killer app before others do. Shrewd

inventors keep abreast of breaking science, and have the market sense to predict demands before even potential customers know they exist. The *application* of scientific discovery to something new and needed, or *wanted*, or creating a need or want, has made fortunes before, and always will, even absent IP. But taking advantage of the virtuous cycle between science and technology demands that the scientific ethos remain untainted by the perfectly ethical (but orthogonal) ‘ethos’ of the market (or lack thereof).

So why do converging technologies suggest that open innovation is preferable to traditional modes of innovation? Although the domains of science and technology do not fully overlap, the area of overlap is increasing. Moreover, we are discovering that openness in innovation is often a market advantage rather than a liability. Open innovation does not require one to divulge trade secrets, or to throw open wide one’s entire stock of innovative creativity. But it does require rejecting IP. Market advantages can be gained more cheaply, and more creatively, than through the use of artificial monopolies. As automobile manufacturers discovered when they early on created ‘patent pools’ to prevent costly litigation, to standardize modes and parts, and to accelerate innovation in their industry, so too are innovators today learning that there is profit in sharing, and that competition is better than rent-seeking, or squatting on ideas that remain underdeveloped due to patents. Ethics does not demand open innovation in technologies, but it is becoming clear that without it the basic science is hampered, and with it, everyone benefits.

Converging technologies are shortening the distance between science and innovation, and decreasing the temporal gap between discovery and invention. The basic, foundational science is becoming more accessible, as with synthetic biology which can be practiced literally in garage-labs. The direction of home-built microfabrication as it is being pursued by serious hobbyists, using scientific techniques, should suggest that true MNT might actually be accomplished outside of formal labs as well. If the techniques and science behind self-replicating replicators is perfected in someone’s garage, and not in a lab, this will be the final convergence not only of technologies, but also of science and technology. The missing bit, and the part that may well never be completed, is the holy grail of artificial intelligence (AI). This seems unlikely (so far) to converge as predicted with the technologies we have been discussing in this book. Its perfection, and its merger with nanowares, will pose a whole new set of ethical and practical issues. I have scrupulously

avoided these issues in this book simply because AI seems to forever be just around the corner, but remains instead still so far away on a distant horizon. And this is, so far, fortunate.

How would we deal with AIs that innovate? When artifacts create artifacts, who could possibly ‘own’ the IP? When the *final* convergence occurs, we’ll be thankful we have left IP far behind, or the robots will beat us all out of the marketplace. Terminators hell-bent on destroying humanity scare me much less than robots with patents. I’d rather be dead at the hands of runaway technology than have our own machines use our legal institutions to deprive us of our uniquely human gift of creativity.

A New Theory of IP and Its Role in Innovation

I have promised to develop a new theory of IP. In fact, it may not be new at all. Innovators in the ‘useful’ and ‘aesthetic’ arts worked for thousands of years outside the current IP paradigm, creating new things, profiting through their creativity, and enriching the sum of human achievement. The notion that ideas could be tied up, monopolized, and contained by laws is what is new. The theory of IP that I propose is one that has previously existed, and that began to be *revealed* through ICT, and will be completed with converging technology. It is simply this: all new man-made objects, intentionally produced, are *expressions* along a spectrum. That spectrum exists between primarily utilitarian and primarily ‘aesthetic’ uses. The ideas represented by these expressions belong to a ‘commons by necessity,’ which means that attempts to contain them are attempts to enclose an unencloseable space. These attempts are also attempts to curtail free expression and freedom of conscience, which ought to allow anyone to express any idea within the limits of the ‘harm principle.’

The past 200 years of IP have been an interesting but doomed experiment. Borne out of liberalism, the seeds of its destruction are also inherent in liberalism. Anathema to free markets, contrary to freedom of expression, autonomy, and freedom of conscience, and also contrary to the scientific ethos, IP could only die eventually. But what replaces it? What was IP law *attempting* to accomplish? It was hardly an evil plot, but rather a misguided attempt to carry out the modern agenda of progress, human betterment, and freedom. But the objects of the law were mistaken. IP attempted to place limits on expressions in order to secure monopoly rights for innovators, to encourage their creativity, and to ultimately benefit the public. These ends

could well have been achieved by focusing not on the objects, but rather the *actors*. Can we learn lessons about the functioning of rewards and incentives, and market-based commercial rights that can help ensure those incentives, by looking at other successful economic sectors?

The ethical considerations I have argued for above, regarding the duties of scientists and innovators, as well as freedoms of expression and conscience, apply equally to the consuming public. In any market exchange, there must be trust and reciprocity. Each party must perceive some benefit in the exchange, or the exchange is not likely to happen, unless it occurs under duress. Many markets thrive, as we have discussed above, without pre-existing monopolies granted by states. These markets prosper, secured only by the trust and expectation of benefit by all parties to market transactions. When you buy a loaf of bread, when you purchase a piece of clothing, when someone washes your car or watches your children, each party receives value, and that value is compensated on the one hand by the provision of not just a product, but a service. Someone else made that bread for you. Someone else baked that bread. You might have been able to do either of these, but the convenience of someone else performing these services was worth your payment. You could have washed your car, and you could well have watched your children, but other necessities made it worthwhile for you to *choose* to pay someone to do each of these for you, and to pay them (after the provision of the service) only because you likely felt they *ought* to be compensated for their service.

Creativity, as we have said before, will always be scarce. Not everyone will innovate, even as the tools that make innovation more accessible, in the form of nanowares, become ubiquitous and cheap. Creativity is a service. When someone introduces some new, man-made, intentionally produced object into the market, they are enriching our culture, increasing the store of human artifacts, and bettering lives (hopefully). Most people feel strongly that those who provide such a service ought to be compensated, just as bakers, farmers, grocers, babysitters, and car washers ought to be compensated. While many argue that the recent spate of peer-to-peer (P2P) technologies and the ‘piracy’ that they allow show that people cannot be trusted, and that states must create exclusive rights as well as enforce legal sanctions against ‘thefts’ of IP, I believe that the evidence shows that people will actually pay for value they receive, even if they know they do not need to.

Even while record companies bemoan the death of the music industry, the *independent* music industry is arguably thriving. As we saw above, there is a

growing spate of examples of independent musicians adopting new means, utilizing the internet in various ways, to get attention for their work, and also to be compensated. P2P networks continue to thrive, and pretty much all content comes to be copied and shared on them. But the movies industry, television programs, and music have not collapsed. Perhaps P2P networks offer models by which these industries need to evolve. Given the ability to reach audiences, to distribute works, and to access the tools of production in media, the huge media companies of the past may be outmoded. Artists, filmmakers, and others, whose creativity was once hampered by the inaccessibility of the tools of production and distribution, can now be liberated by these forces. Musicians need have little more than a computer now to reach the world with their works. The future is wide open for those who wish to create, and there is no evidence that fears of IP ‘theft’ are keeping artists from creating. Nor does it appear that artists are suddenly starving because of the ability of the public to quickly share content through P2P networks. It is likely that profit margins would shrink if we suddenly ignored IP, and that business models would radically change. But the success of new markets, created in the wake of the success of underground P2P file sharing, suggests that creativity could in fact bloom.

One prominent example of how new markets can thrive is the iTunes store, and now the App Store, both introduced by Apple. Apple, which has historically been a strong IP proponent, and jealously guards its IP, has embraced, in my estimation, the vision of what the future of content really is. They are making money by bypassing the middlemen, the large record producers and content providers, and instead making new *markets* in which anyone could offer their content, take a larger cut of the costs as profits for themselves, and cut dependencies on old models of production and distribution. Even while Apple’s IP policies are outmoded, what is critical is these new markets, and the freedom that creators have in accessing them, and in providing their content with or without traditional IP. Another promising element, particularly of the App Store, is that Apple has opened up its standards for app development so that anyone can make an app, and market it through the App Store. This has made a number of creative app developers wealthy overnight, and provided an expansive new venue for creativity and distribution. Because of the relative simplicity of app production, and new tools that streamline it, even those without particular expertise in coding have been able to access this new market.

Apple also produces tools that make music and film production (relatively) cheap and simple. These tools have revolutionized the ability to make professional film (film-quality video, really) and music at home, without large production studios, and with relatively little capital. Creativity is almost all the capital one needs to enter the market now with professional film and music. Over time, the prices of these tools continue to fall, and the learning curves for using these tools grow less steep. But above and beyond these tools, the genius of Apple is in creating the markets for the distribution of the products of creativity, and reducing barriers to entry for thousands of people who had good ideas, but previously could not, or would not, profit from them. Apple's failures to be totally open have provoked encouraging market reactions as well. Now that a US court has held them to be legal, markets for Apple-rejected apps are available through sites like Cydia, and these markets include paid apps as well. Let 10,000 app stores bloom.

These new markets seem to be thriving, even as the ability of consumers to 'pirate' new wares continues. One simple explanation for this is that people seem willing to pay US\$.99 for a song, US\$.99 for an app, or US\$9 for an album, because of the convenience of the iTunes and app stores, because these seem like more reasonable prices than the markups on traditional CDs, or maybe even because consumers think these prices are fair. It is worth compensating content creators for their services. Some people will not pay, and they might never have paid, but most people still seem willing to compensate those who make new things even where the threat of sanctions for not doing so is minimal, and the ability to take without paying is well within reach. Apple's IP policies are antiquated, and there should be more openness and transparency in its marketplaces, but their genius is in redesigning their business strategy to fit the future of content. They have embraced a vision of a future of content as a service, and not as products, and recognize the role of access to markets in facilitating creativity, both through providing new tools and in new marketplaces like iTunes and the App Store.

The Creativity Economy

This is the new theory of IP in a nutshell, and it is working. Creative production is a service, and while we cannot legitimately enclose ideas, we still *ought* to compensate people for providing services that we find valuable. The market should dictate the cost of those services, rather than allowing

state-sanctioned monopolies to skew prices. When faced with new creative content that is valued, consumers will pay for that value, not out of duress, but based upon trust, as other market transactions for services have long worked by trust.

Other examples of the emergence of new market models abound, and as with Apple, their IP policies are not always consistent, but they demonstrate the fact that given new markets, people will devise new and creative ways to profit from their creativity, with or without IP. Google's platforms for services are open, for the most part, as are Facebook's. Even while each obscures a fair amount of their operations, they have each created new marketplaces that open up content provision to those who might never have been able to realize their creativity before. Facebook apps are created by large conglomerates and basement programmers, and available to all Facebook users alike. As with the App Store, Facebook's app platform standards are available to everyone who wants to try to develop an app. Although Google keeps its most valuable asset (its algorithms for its search engine) as a trade secret, the open standards it employs for its service platforms allow the development of new apps by anyone, and the provision of profitable services on top of those platforms by new market players.

Each of these imperfect examples illustrates the model that nanowares will likely follow, and a mechanism by which openness of standards and the foundational science can help to facilitate profits by a new creative class. Physical goods, produced using the methods of nanowares, will be the apps of the future. Those who are embracing openness in the foundational science and technology are providing the open platform upon which artifactual 'apps' will be designed and distributed in the nanoware future. As with the App Store, iTunes, or any of the examples discussed above, people will pay for these artifactual 'apps' because they value the service of those who design them, the costs will likely be reasonable and fair, and people will be willing to compensate (as they are now, despite P2P networks) for the convenience of downloading something they want or need. Nanoware will be the ultimate killer app, enabling people to fully realize their creativity, to enter marketplaces without friction, and to quickly access any tool they need or desire at little cost. Even as the costs of nanowares may fall toward zero, the margin of profit will be comparatively high as the tools of production become cheap and ubiquitous, and the expenses associated with market entry and distribution disappear.

Creativity will be the new capital, and those who have it will continue to innovate and profit, and consumers will be able to profit from the products of creativity. Nanowares, as we have envisioned them here, and as those currently working to see their development envision them, will involve the final unleashing of the possibilities of human creativity, the emergence of expansive new markets for the fruits of that creativity, and the possibility of market entry for anyone with nothing more than an idea. Trust will be the basis of these new markets, even as it is the basis of markets for bread and other goods, provided as services, since the beginning of commerce.

Nanowares and Converging Philosophical Inquiries

I have addressed only superficially a number of issues consuming philosophers with the introduction of nanowares, primarily in the areas of ethics of risk, safety, and security. In so doing, I have argued that nanowares do not present wholly unique concerns, although they are certainly serious. Converging technologies require us to extend our current philosophical foci on risks, and on the natures of technical artifacts, but they may not require us to rethink anything fundamentally. Risks, duties, and even utilitarian calculi can be adopted to deal with challenges posed by converging technologies, and these will remain fruitful realms of inquiry. But perhaps the balkanization of applied ethics can be resolved through nanowares, even as the technologies themselves converge. The emergence of medical ethics, bioethics, and other sub-categories of applied ethics may ultimately also converge again with nanowares. Synthetic biology is, after all, an engineering paradigm, applied to traditionally 'biological' substrates. Does the substrate make all the difference, or are the duties and rights involved the same regardless of the applied field? I have argued above that the duties owed by scientists and engineers are in fact the same, regardless of the medium. Nanowares are an opportunity for us to reconsider the canard that 'the medium is the message,' and instead to say: the medium doesn't matter at all.

Do we need a philosophy of technology, or of aesthetics, or an applied ethics in medicine, and another in nanotechnology, or do the underlying objects and principles, as they converge through nanowares, reveal that these subfields are all intimately related. I would argue that philosophers of technology and philosophers of art unfairly distinguish among the objects of their field, just as the law of IP has illogically distinguished between utilitarian and

aesthetic objects. All artifacts have uses, so why do we feel it necessary to treat aesthetic uses and other uses ('utilitarian uses' would be redundant) as distinct? Perhaps there are interesting cultural or psychological reasons why we make these distinctions, and we ought to examine the reasons we make them (particularly if we discover that other cultures or certain people do not make such distinctions), but perhaps nanowares suggest that various fields of philosophical study ought to converge as well, or at least critically examine the reasons for their divergence.

Physics, chemistry, biology, engineering, design, and a host of other disciplines are implicated in nanowares. This offers an exciting realm for reconsidering the nature of our sciences, technologies, and artifacts, and the relationships among cultures, individuals, and their products. I have only touched on one small area of particular concern to me, namely IP, and some ethical considerations. But there is certainly a great deal of interesting analysis that remains to be done even as nanowares continue to develop. Each new technical field offers philosophers new opportunities for inquiry. This is one reason I have focused my work on the philosophy of science and technology. We should be open and interested in what is new. But even while the objects of our study may be new, we should be wary of multiplying principles, or finding uniqueness where there is none.

When ICT emerged as an area of philosophical inquiry, a number of people suggested that cyberspace was somehow fundamentally different from other 'spaces.' One typical response to the problem of software's dual status as both patentable and copyrightable was that it was somehow a new 'hybrid' object of a type that had never before existed. I did not think so when that was proposed, and I have grown more certain that it is not in any way unique. It is an expression of the same kind as *Ulysses* or as a steam engine, and the distinctions we previously drew among novels and engines were never firmly grounded. We could well have treated all of the objects of IP as I suggested, with something like copyright, only with shorter terms. But something else happened that I did not anticipate. The market found solutions, and producers began to skirt existing IP norms consciously, choosing open source solutions, rooted in private contract. Private contract is itself founded upon ancient principles. It has proven to be the working foundation of most market phenomena, and as long as it remains backed up by institutions by which disagreements can be resolved, it should be preferred over artificial monopolies. The emergence and success of open source, copyleft, creative

commons, and other private means of promoting and profiting by innovation without IP serve as models for the nanoware future. It is not surprising that so many who are already engaged in building that future have adopted these models, or models like them. Looking back at their emergence, it is clear that my philosophical concerns were well founded, but my suggestions for resolving them unnecessarily conservative. The market figured it out, and better models emerged. I am confident now that the trends that are already extending these models to nanowares will succeed, and that like it or not, nanowares embody the end of IP. It's about time.

Case Study

The Final Convergence: From Idea to Market

Nanowares are here, and they are evolving. In each of their various permutations, we will have choices about how we choose to move ideas into markets. Throughout this text, we have considered the practical, philosophical, and even ethical implications of choosing to treat our artifacts in particular ways. Now let's examine how various forms of nanowares might be placed into the stream of commerce under several different scenarios.

The Nano-now: A RepRap Designed Object

Using off the shelf CAD/CAM design software, one can design and prototype objects using the RepRap Mendel. Suppose you design a salt-and-pepper shaker set, which could be easily constructed on a Mendel, using the extruded plastics, and a CAD/CAM designed form. Let's assume that it is unique, incorporating design elements that distinguish your salt-and-pepper shakers from all others on the market, either functionally, or aesthetically, or both. Under current patent law, only truly new, non-obvious, and useful elements of your shakers could be patented, but let's assume also that you have developed such elements. Arguably, if you choose to patent your shakers, you will be forced into capitalizing the creation of a robust production and distribution plan, or license the idea to others. Using the current patent system, you could not patent the design

Case Study: *The Final Convergence: From Idea to Market* (continued)

specifications themselves, though you could copyright them. If you want to distribute your shakers via a nanowares infrastructure, as designs that RepRap owners could use to reproduce the shakers themselves, you would need to copyright your designs, patent the final object, and sell the designs with a license of some sort that entitles purchasers to reproduce the patented shakers for their own use. This would enable you to enter the market with your product and only pay for the patent process, utilizing the nanowares infrastructure, eliminating yourself from the burden of raising capital for production and distribution, and helping to protect your idea from ‘pirating.’ Could such a process work?

There is no reason to think that consumers won’t pay monopoly rents for items they value, and end user license agreements are used now for the distribution of software, parts of which may be both copyrighted and patented. While clunky, this option exists as a means of preserving strong IP protection, using the new and valuable processes involved with won’t emerging nanowares, and allowing those who create new things to enter the market perhaps a bit more easily than in the past. The drawbacks to this approach are the same as in software, in that end users often agree to the terms in order to secure the goods, and then violate the terms as they please. Pirated versions of software proliferate on P2P networks, none of which would be available except for some user’s violation of an end user licensing agreement (EULA). You could ensure that some people abide by the license, you would get some of the proceeds of the sales of your product, but there is no way of stopping those who decide to distribute your works despite the EULA. Once they do decide to violate the EULA, and your designs end up being distributed without your awareness, anyone with a RepRap will be able to duplicate your shakers. If all they want is a ‘free’ salt-and-pepper shaker set, then you will have virtually no way of stopping this, nor of seeking out those who possess illicit copies,

short of some sort of technological means that would provide a means to track them down.

These are pragmatic obstacles. We have not discussed at all other reasons to avoid the strong IP route. Supporters of IP may well choose this route, and they may be able to succeed with new and inventive objects that are sufficiently desired, as long as their products are priced within a range that the market will tolerate. After all, as we have discussed above, IP is working for new markets like iTunes, the App Store, and even the Cydia store. People will pay (reduced or reasonable) monopoly prices either out of some sense of duty, desert, or merely due to convenience. One advantage of the emerging nanowares infrastructure, even for those who choose to abide by a strong IP regime, is that the costs of capitalizing new products are significantly reduced. In fact, in this scenario, besides the labor and creativity involved in dreaming up a great new salt-and-pepper shaker, the major costs would be involved in securing a patent. This option uses existing institutions and models, and among the only reasons to not pursue it would be the pragmatic inability to police distribution of your design, some sense that strong IP will not be fair, efficient, or worthwhile, etc. Perhaps you even feel that you could profit, and innovation in general would benefit, from some other institutional approach.

Another reasonable option might be to copyright the entire object, and avoid the costs associated with patenting. This approach makes metaphysical sense, as described at length throughout this text. The design and the final product would each be considered copyrighted expressions, and each would be susceptible to the same protections and monopoly benefits afforded unique expressions. While this option makes metaphysical sense, it is not yet supported by any institutional framework. Current laws do not consider *non-utilitarian* expressions to be on par with utilitarian ones. We might well hope that some day the law catches up to the facts of the matter, but if one were to try this now, it would have to be done with the knowledge and fortitude to pursue legal reform through a test case.

Case Study: *The Final Convergence: From Idea to Market* (continued)

Finally, you might choose to distribute your salt-and-pepper shakers under some sort of ‘copyleft,’ creative commons, or similar license, or no license at all. As with the previous option, the costs for market entry are essentially nothing (excluding the costs of labor and creativity). So how would you get paid? What reward would you receive for your creativity? The rewards might certainly be monetarily lower than you *might* receive under strong IP, assuming there were sufficient market demand for your product (no product is guaranteed to be desired) and sufficient consumers willing to abide by a EULA. But this does not mean you might not do even *better*. It is conceivable that consumers will so desire your product that, as with innovative means of rewarding artists through donations, or payment for services, you might well be paid by consumers of your product according to their valuing of your creativity. A ‘donate’ button by the file might help to urge those who appreciate your creation to reward you for your efforts. If you wanted to help encourage this, you might well offer the design as a form of ‘shareware,’ which although it could be used without payment, might prod users to pay you according to their valuation of your services as a creator.

This option requires no institutional adjustment, and offers some benefits as well as apparent drawbacks over strong IP or a unified copyright regime. This approach operates merely on *trust*. It assumes that people will pay for services they find valuable. It also requires accepting that some people do not pay for valuable services, even when they benefit. This is true for most other sectors of the economy, so why should we not accept it for creative sectors? Creators too may benefit under such a scheme, as their creations will be prone to improvement, and the ever-increasing stock of innovative and improving goods will grow, presumably. But this final, perhaps, utopian approach also justifies itself based upon the expectation that the need for capitalizing the development, production, and distribution of new products falls to essentially

zero. As a creator, only your time, intellectual effort, and creativity involved in developing the revolutionary salt-and-pepper shaker are an expense. In the past, you would need to invest in prototyping, mass producing, and distributing new products, and no IP could ever guarantee market success as no inventor or author can ever truly predict the desires of consumers. This is why most new products fail, and how fortunes have sometimes been lost in the process even of bringing revolutionary products to the market. In this scenario, though, what has been lost is the time, and perhaps the 'labor' of creation. Success, we hope, will still be rewarded, and the marketplace will grow as new efforts at creation can potentially earn market share based solely on the desires of consumers, without the costly burdens of failed products.

Each of these scenarios fits just as well with the far nano-future in which MNT allows something like Stephenson's 'matter compliers' to replicate any product, anywhere. What applies to RepRap-produced salt-and-pepper shakers applies to any nano-based object of an MNT future. These are all choices, and those who are paving the way for the nano-future can pursue them as they see fit. I have tried to make the case that the latter path is most virtuous, provides the best future for innovation itself, and is justified by the economics of nanowares. Now let's see where the technology takes us.