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The Green Growth Knowledge Economy: Implications for Technology and Design Teachers

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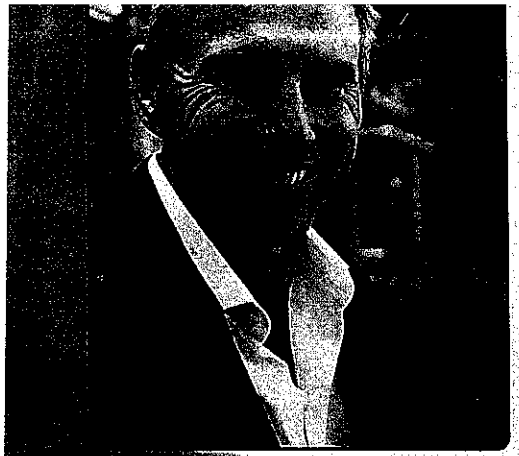

Rick van der Zwan is a psychologist and neuroscientist with an international reputation for his work in vision science. He works also to promote understanding of mental health issues in the media and broad community.

The effects of technologies on the societies in which they are developed define cultures. With that in mind, this book is the first in a series that incorporates essays focused on current issues in technology, in society, and especially at the points of intersection between both.

While broad in scope, this book provides the reader with research-focused snap-shots of the hottest topics emerging from the interface between Technology and Society. Readers can approach the book as an overall review of the various topics covered or use selected chapters as the starting point for their own literature review or new research enterprise.
For either approach, this is a valuable, contemporary resource.

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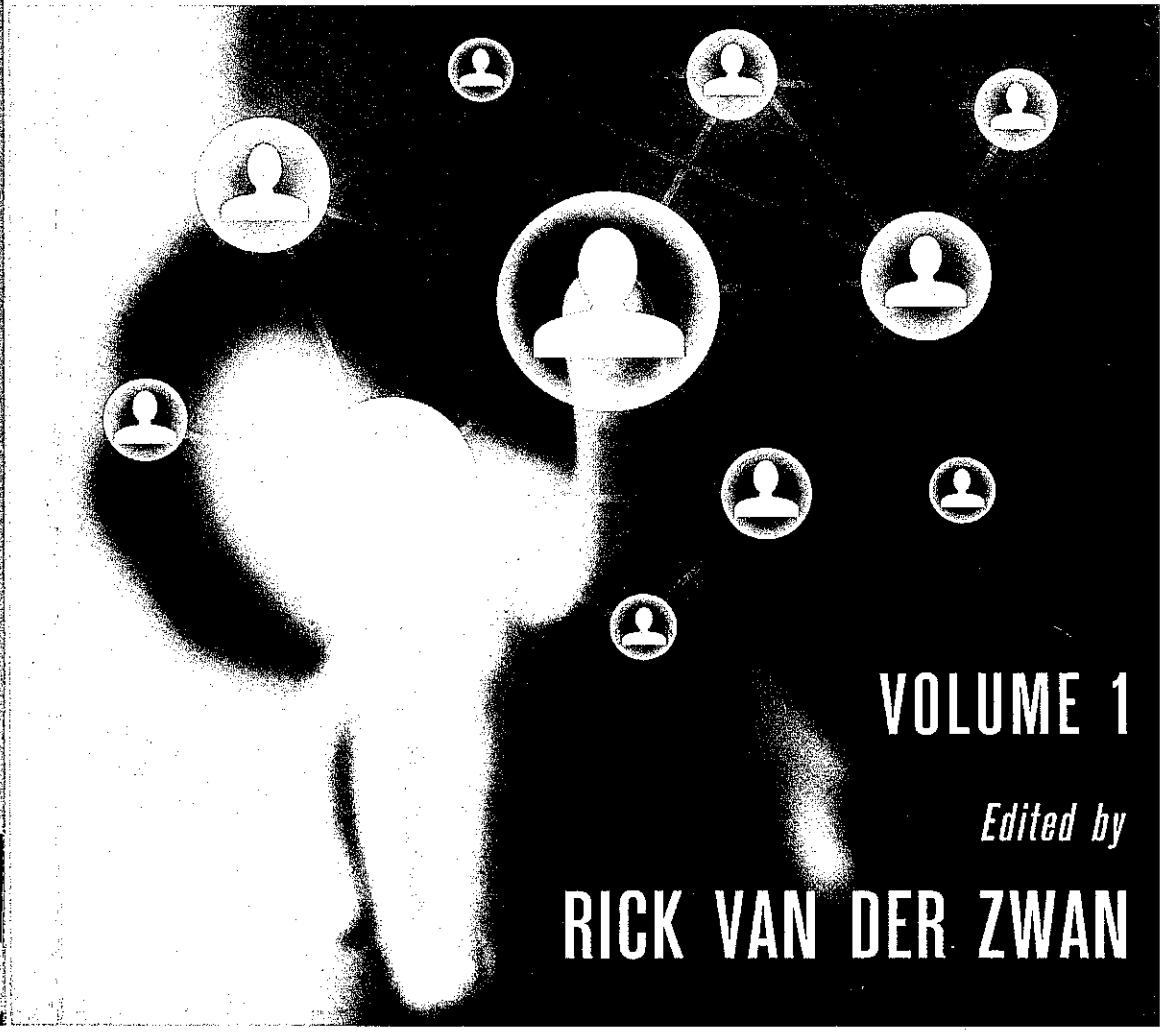

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Edited by

RICK VAN DER ZWAN

Current Trends in Technology and Society

Volume 1

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The knowledge base and text in this book has been sourced significantly from Lynch (2004). Some works or sections within may be attributable to the individual author's previously published works. The author acknowledges the contributions of Professor Richard Smith to the body of knowledge and sections of text contained within the book and through a recent collaboration in the form of Rethinking Teacher Education- Smith and Lynch (2010).

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Chapter 4: The Green Growth Knowledge Economy: Implications for Technology and Design Teachers.

Dr Kurt Seemann and Mr. Jason Newcombe and Ms. Angela Turner

How societies learn, design and develop a green growth focus in knowledge innovations are the keys to sustainable economic and social development. The unique characteristics of knowledge and the dynamics of the knowledge economy mean that, whether we like it or not, a cultural change is required from thinking in terms of production to thinking in terms of innovation. Inevitably, the teaching and learning of green knowledge innovations is a key factor for determining how well societies will sustain a quality of life in the emerging resource constraints that populations face. This chapter outlines key ideas underpinning the nature of a knowledge economy as it applies to Technology and Design teachers, and offers insights for how such areas of knowledge drive our quality of life.

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The Foundations of the Knowledge Economy

Growth by Producing 'Stuff'

Two hundred years ago an agricultural economy existed where land and labour were the key elements of production. Since then, five waves of technological development, starting with early mechanization in the late 18th century, have changed the way we work and live. During the industrial revolution *capital*[2] became a major competitive advantage. In a simplified model, productivity and growth were seen as functions of combinations of land, labour, and capital.

At this time production was the key to economic growth. Output was measured in 'stuff' produced: the more a nation produced, the more the economy grew. Scarcity of natural resources and inputs was inevitable and was a major economic concern. Even at this early stage technological development was recognised as impacting on growth and productivity, but it was seen as a largely unexplained external factor that occurred by chance. There was no attempt to identify the source of technological development and the distinctive ways it was used.

[2] *Capital* refers to the plant, equipment, buildings and goods used to produce other goods and services.

The indifference toward technology was partially explained by the view that growth generated by technological development was temporary. It was believed that technology advances led to population growth which would negate any production benefits. In addition, technological development at the time was focused on plant and equipment, which resulted in diminishing returns on production and reached a point where the costs of the additional capital would outweigh the return.

The Role of Innovation

It was not until the 1930s, through the work of an Austrian economist named Joseph Schumpeter, that innovation was identified as a key contributor to economic growth. He saw the entrepreneur as an innovator who could increase growth by, among other things, efficiently combining resources and adopting new technical improvements.

Schumpeter showed that internally generated innovation could increase productivity and therefore profit for the entrepreneur. However, this internal innovation also had its drawbacks. The knowledge production required in order to innovate was fraught with uncertainty and experimentation, and consumed large amounts of resources. Moreover, the resulting innovation introduced imitation from competitors which ate away at profits. This would lead to diminishing returns on innovation investment and what Schumpeter called 'creative destruction' – the creation of new profit opportunities and the destruction of currently profitable businesses. Whilst highly influential, Schumpeter's model could never explain why countries and firms that invested in innovation seemed to continue growing faster than their competitors.

A Virtuous Cycle of Growth

Stanford University Professor, Paul Romer, was the first to identify technology, along with the knowledge on which it is based, as an intrinsic part of the economic system and a key to long-term growth. Romer's new growth theory has transformed perceptions of economic growth. Some of the key points are:

- Technology is a central part of the economic system, along with labour and capital, because it allows us to find value by combining inputs in new ways. Rather than producing additional 'stuff', we have learnt to combine and rearrange a fixed quantity of inputs in ways that add value. For example, a computer chip is of much greater value than the silicon, metals and impurities that go into making it. We add value by innovating combinations of inputs, rather than by increasing the amount of matter used, making the recipe more valuable than the ingredients.
- Ideas are the instructions that let us combine limited physical resources in arrangements that are ever more valuable. The combinations of inputs are limited only by our ability to innovate.
- While new technological developments like the computer chip provide a one-off benefit, they also create technical platforms that act as springboards to further innovation. Ideas build on each other and lead to increasing rather than diminishing returns on technological investment. For example, investment in the knowledge of genes has opened profitable opportunities in areas like biotechnology.

- Investment can make technology more valuable and technology, through these technical platforms, increases the value of investment. This creates a virtuous cycle that raises a country's economic growth rate permanently. The growth rate depends on people's ability to innovate and the rate of return on innovation.

In short, ideas - not objects - stimulate growth. New growth theory emphasises the possible capacity for people to innovate faster than any diminishing returns. The potential for discoveries and continual improvements are endless, and innovation - almost regardless of the condition of the larger environment - powers long-term growth.

The Implications of New Growth Theory

Knowledge as a Competitive Advantage

Knowledge has become the primary resource of production, while land, labour and capital are easily obtained secondary resources. In the past, poor countries lacked resources and capital, while countries like Australia developed wealth by successfully exploiting their natural resources. However, poor countries of the future will be those that lack ideas and the motivation to create ideas. As futurist Peter Drucker notes, there may be no poor countries, only ignorant ones.

> *"Knowledge and information is being reproduced today like cars and steel were produced a hundred years ago. Those like Bill Gates who know how to produce knowledge and information better than others, reap the rewards, just as those who knew how to produce cars and steel a hundred years ago became magnates of that era."*
>
> - **Joseph Stiglitz,** - Senior Vice President and Chief Economist, The World Bank Group

Comparative advantage now comes from the process of innovation more than any other factor. Firms and countries will solve a never-ending stream of societal, environmental, and competitive problems by combining technological know-how with the creative talents of their people. The leading organisations and countries of the future will be those that are best able to derive value from information. We live in an information society and in a knowledge economy.

Why Knowledge is Special

The Characteristics of Knowledge

The unique characteristics of knowledge provide clues to help us better understand the challenges and opportunities that citizens, organisations, and nations will face in the information society.

- Knowledge, ideas, and concepts are nonsubtractive and independent of space. Their use by one person does not exclude their use by another. Unlike a pair of Nike shoes

or a seat at a restaurant, my obtaining and using knowledge does not diminish your ability to do so.

- Knowledge is unlimited and renewable. Whereas scarcity of natural resources and capital were fears of the old economy, the potential exists to create new knowledge every day. Scarcity comes only through the inability to use or renew the knowledge base.

- The cost of knowledge is unaffected by how many people eventually use it, and production technology can replicate knowledge easily and quickly. The expense of preparing this document is the same whether 1 or 1 million people read it. As Microsoft has shown, profitable discoveries easily reproduced provide enormous economic benefits.
- Similarly, there is little correlation between knowledge inputs and outputs. The value of knowledge is unrelated to the cost of creating it. Profits can result from creative discoveries with negligible cost.
- Knowledge is time dependent and ever changing. While physical assets depreciate reasonably slowly over time, the value of financial advice may lose all value in minutes. Knowledge makes itself obsolete quickly, and competitive advantage based on knowledge will always be challenged.
- Globalisation and the lowering of technical barriers to accessing information move knowledge across borders more quickly than ever before. Imitation is becoming faster and better, and competition fiercer. For developing countries, enormous gains can be made simply by purchasing the ideas or 'recipes' of others. This, in part, explains the growth achieved by many East Asian nations in the 1980s and 1990s. However, developed countries have less opportunity to stay ahead simply by adopting ideas. These countries must continually innovate, rather than imitate. In short, knowledge is increasingly becoming the key to local and global competition. Countries that foster societies where innovation can flourish will lead economic and social development in the next century.

Knowledge Economy Inputs

Romer uses a computing metaphor to re-categorise how we view economic inputs. Traditional categories of inputs like capital, raw materials, production and non-production workers are replaced by:

- Hardware - physical equipment, structures, raw materials and infrastructure.
- Software - codified and transmittable knowledge like manuals and instructions, computer codes, books, scientific principles, and routines. Software is the know-how of performing a particular task that, once created, can be stored, easily reproduced and used simultaneously by a large number of people.
- Wetware – the tacit knowledge, creativity, and cognition stored in the 'wet' computer of a person's human brain. The wetware provides the innovation capacity that enables us to create and exploit software.

Production makes hardware, education makes wetware, and innovation makes software. According to Romer, software is the currency of the knowledge economy, and educators are now charged with developing in their students the wetware that will foster software innovation.

The Life Skills of the Future

Success in an information society requires a change in the way people think and a shift in the cultural emphasis from one of producing objects to one of fostering and managing knowledge. The 'quarry mentality' that still exists in Australia will need to be replaced with one of continuous and vigilant innovation. Long-term growth depends on how efficiently knowledge is used and how well new knowledge is continually produced, codified and disseminated. More important than the actual stock of knowledge is the ability for countries to renew this stock.

Peter Drucker is one of those who believe that education will become the centre of the knowledge economy. The acquisition and distribution of knowledge in the information society, he says, will become as central as the acquisition and distribution of property and income were in the capitalist society.

Successful nations will create a society of skilled, flexible and creative people. They will support their citizens to develop their innovation potential. Some of the identified skills that contribute to this will include:

- Interpreting situations, needs, possibilities, and procedures;
- Generating alternatives, innovations, or solutions;
- Collaborating with others;
- Reflecting on situations, procedures, needs, and opportunities;
- Representing ideas or suggestions;
- Evaluating merits and disadvantages.

A lot of knowledge work will require advanced manual skills; architects and surgeons are two examples. However, these skills will supplement specialist knowledge. Manual skills alone will never be sufficient, regardless of how advanced. Knowledge workers will be increasingly expected to:

- Work with intangibles, rather than physical products.
- Possess high degrees of specialisation, and work and communicate effectively with people who do not share their knowledge base.
- Learn how to assimilate specialised knowledges from other areas and other disciplines into their own work.
- Select and screen relevant information, and discard obsolete knowledge.
- Develop willingness to change and experiment.
- Establish capabilities in problem solving, innovating, and conceptual technological literacy, rather than the operational know-how.
- Develop higher order cognitive skills.
- Undertake formal, on-going education for much of their working life.

The Increasingly Important Role of Technology Education

The emerging society and economy based on ideas, not objects, will require different educational forms and priorities. Educators must employ strategies to effectively build the 'wetware' that their students will use to engage in a knowledge economy, or risk being obsolete.

If the vision statement articulated by educators in the Technology Education Action Plan (2002-2006) is realised, technology educators are poised to play a crucial role in determining Australia's future. Through the technological processes, systems, and cognitive

skills they imbue, students will develop the knowledges, capabilities, and dispositions to actively participate in the information society. Technology educators will be asked to arm the workers of the future with the critical capabilities they need to survive in the knowledge economy. However, for technology education to remain relevant it must reflect the changing needs of the information society. This introduces challenges for teachers, school leaders, communities, and education jurisdictions alike.

The industrial revolution lasted well over 100 years and affected every aspect of our family, social, and working life. There is no reason why the knowledge revolution will not have the same impact. This places great responsibility on, and creates exciting opportunities for, all technology educators.

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