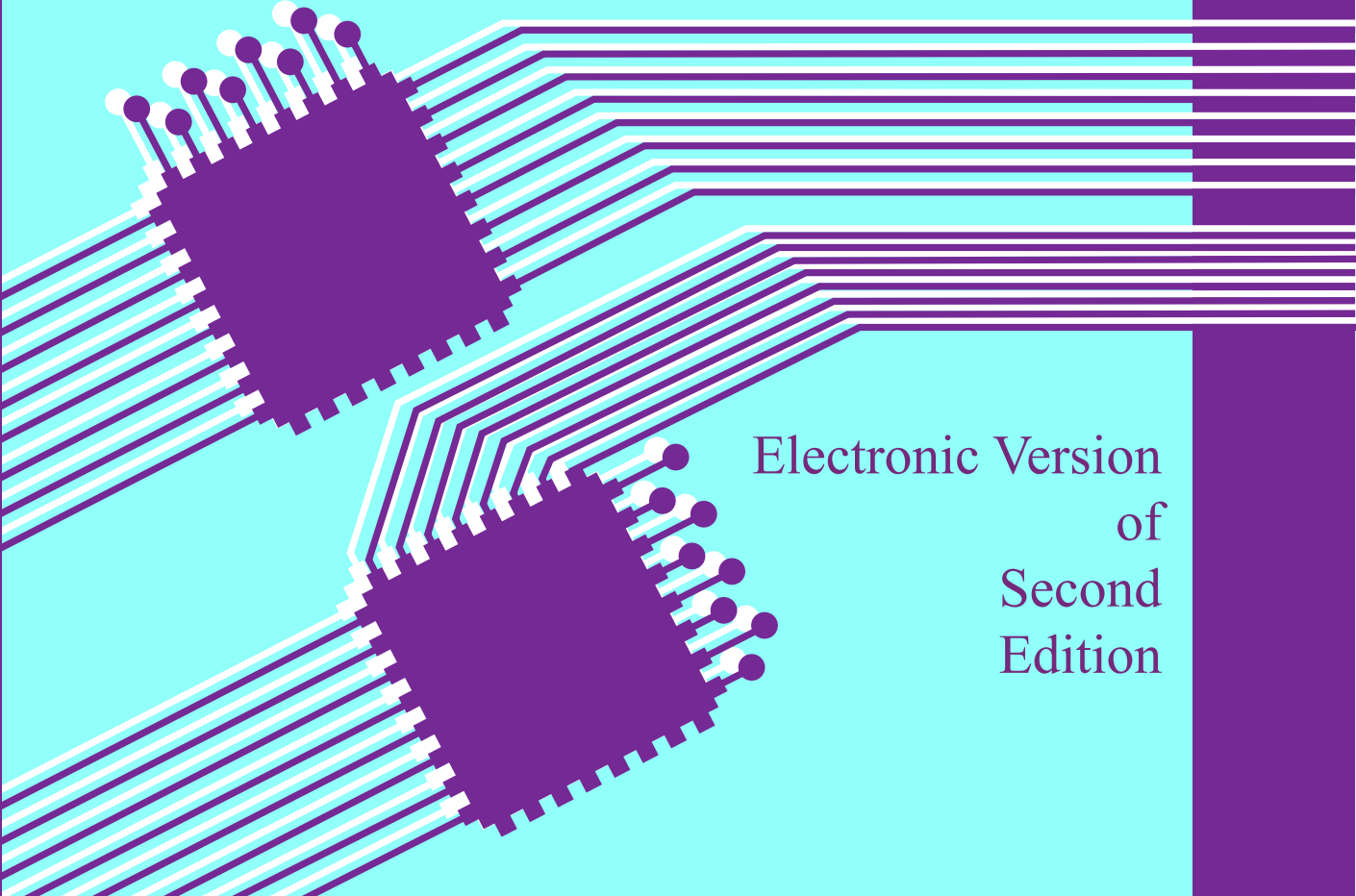


*Sample pages from...*

# The Economics of Automatic Testing

*Front matter  
Contents and prefaces*

**Brendan Davis**



Electronic Version  
of  
Second  
Edition

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## **“The Economics of Automatic Testing”**

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## About the Author

**Brendan Davis** has been actively involved in automatic testing since 1969, when the General Radio Company introduced the first commercially available computer-based board test system. During the next twenty-six years he held a number of sales and marketing positions within the same company, the name of which was changed to GenRad in the mid 1970s. He now runs a consultancy, BD Consulting, on testing, concentrating on the economic analysis of test strategies.

From the dust jacket of the second printed edition

## Update for this electronic edition

**Brendan Davis** now lives in Ireland with his wife and his two youngest daughters. Technically 'retired' he keeps busy with some consulting and a passion for photography.

## From the Back Cover of the Printed Edition

The speed of bringing cost-effective, high technology and high quality products to market is of key importance in today's competitive environment. The use of automatic test equipment that can minimize costs, maximize productivity and maintain or improve quality, has an important role to play in gaining the necessary advantage. However, it has to be used effectively.

The second edition of **The Economics of Automatic Testing** is much broader in scope than the first, covering all major business issues affecting the competitiveness of a company, as well as the detailed issues surrounding testing decisions. The book is based upon the concept that the optimum strategy for the testing of electronics can only be established after a detailed economic analysis of the alternatives. Thus, all the issues that have to be considered, and the various analytical approaches that can be used to make a test decision, are discussed in detail in the first two thirds of the book. Particular emphasis is placed on the key roles of quality and time-to-market and their effect on the decision process. The following chapters deal with the activities that follow the decision, including the evaluation of commercial testers, the financial justification and the presentation of the proposals to senior management.

### Special features

- ◆ Advice on the use of economic analysis techniques to compare alternative test strategies.
- ◆ Comprehensive guidance on presenting the financial case to senior management
- ◆ Practical help in the form of numerous worked examples, reference tables and charts

*Brendan Davis, the author of the very first text on test economics—**The Economics of Automatic Testing**—has produced an expanded and updated second edition. It has been written in Brendan's customary highly readable style, reducing to an understandable level the complex issues that are brought to play in this field of analysis. The book is a must for postgraduate courses and, more importantly, for industry professionals. prepared as it is by someone with a wealth of experience in industry ATE requirements.*

### Professor Tony Ambler

Brunel University, UK

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# Preface: to the electronic edition

It was first suggested to me in 2010 that there was still a potential need for this book. The second edition of the book (1994) had been out of print for some years but people I knew and trusted were telling me that they were still using the book or being asked if it was still available. There was also a steady flow of sales of used copies—some of which were at highly inflated prices!

Whenever the opportunity arose I asked others their opinion and found general agreement that the core elements of the book were just as valid as ever—but the numbers in many of the examples, and the references to testing technology and defect rates, were well out of date.

However, the book was never really about test technology, labour rates and defect rates. It is about managing the potentially conflicting issues of cost, quality, time-to-market and technology adoption by using engineering economics and life-cycle-cost analysis, to enable optimal decisions to be made about complex technological issues in design, manufacturing, test and the field.

These core elements could be applied, and have been, to engineering decisions that have nothing to do with electronics or electronics testing. The out-of-date numbers used in the examples are also irrelevant—since the methodology used is what matters.

So, without too much arm-twisting, I set about the task of converting the book to e-book form in 2011. As I was nearing completion of the project I came across a reference that really confirmed what I had been told. A new book on the reliability of electronic systems\* had been published in April 2011. Written by Norman Pascoe the book is based on course notes for a class he taught at MIT. In the introductory chapter he says...

*“An excellent account of the technology, economics and associated advantages of using ATE is provided by Brendan Davis. Although Davis wrote this comprehensive work on the economics of automatic testing over a quarter of a century ago, the value of its contents has not in any way diminished with time.”*

The reference to a quarter of a century indicates that Mr. Pascoe is referring to the original (1982) edition. There is general agreement amongst users that the second edition (1994) was a much more comprehensive work than the original.

Brendan Davis, 2012

\*Pascoe, Norman (2011) *Reliability Technology: Principles and Practice of Failure Prevention in Electronic Systems*. Published by John Wiley, April 2011.



# Preface: to the second printed edition

The first edition of this book was prepared in 1980 and 1981 and published in 1982. Since then there have been many changes in the electronics industry and in its testing arena. Some of these changes have a significant impact on the way that we should view the economics of test. Because of this, and because of the encouragement of some of my colleagues, I finally decided to put pen to paper, or fingers to keyboard, and prepare this second edition. However, not everything has changed. Many of the key issues and concepts of the early eighties are the same today. The following paragraph is reproduced verbatim from the preface to the first edition.

This is all still valid today (2012)—only the numbers have changed—and, as in 1982 and in 1994, the improvements in the quality of components and the manufacturing process have been accompanied by increased complexity, the demand for lower prices and faster time-to-market.

*Electronics technology is growing rapidly in terms of its use and its complexity. It is no longer easy to define the 'electronics industry' since the technology is penetrating into just about every industry you can think of. The applications for 'semiconductor-based' products continue to multiply—think of your car, your television set, your watch, and your children's toys. But while semiconductor technology has substantially lowered the cost of microprocessors, memories, and supporting chips in the last decade, the complexity of electronic equipment has increased substantially. In 1970, a typical complex semiconductor chip contained the equivalent of 1,000 transistors; by 1980 chips containing the equivalent circuitry of 100,000 transistors were fairly common. At the same time, this accelerating technology has reduced product lifetimes drastically, with three years being fairly typical. Customers buying these high-technology products are also demanding greater reliability. Electronic equipment manufacturers are therefore caught in a squeeze—business success depends on getting more complex, but more reliable, products to market faster than ever before. To make matters even worse there is a shortage of skilled and experienced electronics engineers.*

The situation and the trends outlined here are still valid. They are simply bigger and more important than they were twelve years ago. Component and board complexity continues to rise, customers continue to demand higher quality and the competition forces the need to bring new products to market faster than ever. Sadly the only comment in the paragraph reproduced above that is not so valid today is the last comment about the shortage of skilled and experienced engineers. The downturn in the electronics industry that took place in 1985 resulted in cutbacks and streamlining of operations. Recovery was slow and in many cases did not return to the levels of early 1985 before the next recession hit. The second half of 1989 saw the start of the 'outbreak of world peace'. This was a major benefit to mankind but the reduced military spending that followed added to the problems of the electronics industry. The commercial benefits, however, may come from the opening up of markets in Eastern Europe and what was formerly the Soviet Union as they slowly rebuild their economies. In the longer term, these countries will simply add to the numbers of competitors fighting for a share of the world electronics market, and their lower labour costs will give them an advantage for a while.

The recession in the electronics industry led to a deeper recession in the automatic test

equipment (ATE) industry. Not only was there little need to increase testing capacity but a lot of surplus testers also became available on the second user market. Under such conditions there are only two reasons to buy new test systems. The first of these is when the new equipment can result in cost savings and the second is when the existing equipment cannot cope with the test requirements of new technologies. The effect of operating in times of recession leads quite naturally to an increase in the importance of good economic analysis. Indeed, in the twenty-two years that I have been involved with ATE the interest in test economics has varied in a direct relationship with economies. When the economy of the country is buoyant nobody is interested, but when money starts to tighten up it becomes most important. Naturally I believe that it is important at all times. There is no need to waste good money even if the economy is good.

Apart from the recessions there has been another important reason for the relatively lower sales of ATE. The eighties saw a change in the awareness and the understanding of the importance of quality that has been more revolutionary than evolutionary. The degree of improvement in component defect rates and the yield of defect-free boards has been quite dramatic, especially when you factor in the increase in complexity that has also taken place. The higher component quality has led to less use of incoming inspection and the higher board yields has led to the need for fewer board testers. Fewer failing boards means fewer re-tests after repair and therefore increased tester capacity. This quality revolution has arguably been the most important change since the first edition of this book was published. As a result I have included a completely new chapter to cover the impact this has on how we should think about test economics.

Other major changes that have taken place include the increased degree of integration between the design and test function, the increased use of custom devices, the changes in manufacturing to the use of surface mount technology and JIT (Just In Time) processes, the introduction of new types of testers, the adoption of testability disciplines such as SCAN and Boundary Scan and the adoption of new test strategies. The impact of these and other trends are covered in this new edition. The net effect of all of the changes that have occurred since the first edition was published is that the cost of test, as a percentage of the total product cost, has risen dramatically even though some of the changes are aimed at lowering test costs. This means that even in the absence of any recessionary problems, the economics of test are more important today than they have ever been. In the past, test economics has been used mainly to compare alternative test strategies, alternative testers or to justify the purchase of equipment. Today the more enlightened companies are using test economics in the planning stages of a new product to determine the life cycle cost of the product. Various alternative design approaches and test strategies can be compared to find the optimum approach to meeting the main objectives. These objectives will have been driven by the four main market forces of cost, quality, time and technology.

Survival in a competitive market is heavily dependent on introducing new products that cost less, that have better quality, that are brought to market on time and that incorporate the latest component and manufacturing technologies.

My main personal hopes for this book are that it should broaden the use of economic analysis techniques as applied to testing decisions and that it should help to reduce the amount of time needed to perform the analysis. To this end the book has been structured to be both tutorial and a reference work. Most of the chapters contain numerous examples as well as reference tables and charts. The more useful reference material is

also contained in appendices for more convenient access.

Many people have aided and abetted in the preparation of this second edition. Some have provided ideas and information, some have reviewed and critiqued the manuscript and some have helped in other ways. They are too numerous to mention individually but they know who they are and they know that I am grateful to them all.

Brendan Davis, 1994.