ELECTRONIC DESIGN FOR THE 90s

M.H. Allardice
Chief Engineer Philips New Zealand Ltd

Bio:
Murray Allardice was born in Wellington and following a secondary education at St. Patrick's College joined Philips Lamps Ltd serving an apprenticeship in Electrical Engineering.
After completing his apprenticeship he was appointed Head of the Radio and Medical X-Ray Service Department. He then spent several years engaged in design and development both here in New Zealand and in Holland. Since 1960 he has been Head of Electronic Design for Philips Electrical Industries Ltd, Technical Manager of Claud Neon Lights Ltd and in 1976 was appointed Chief Engineer with responsibility for Electronic Development and establishing a Professional Telecommunications Development Laboratory in Lower Hutt. Currently Murray Allardice is Chief Engineer - Philips New Zealand Ltd and Consultant to the Sir John Marshall Development Laboratory having reached the official retiring age of the company.
Other activities undertaken have been; since 1960 are working on Standardization in the Electronics Industry for the Electronic Manufacturing Federation, Chairman for seven years of the Divisional Committee on Electrical and Electronic Manufacturing of the Metric Advisory Board and presently Chairman of the Electronic Sector Committee and member of the Executive of the N.Z. Electrotechnical Committee of SANZ.

I am deeply honoured to be invited to deliver the 1985 Ralph Slade Memorial Lecture and I welcome the opportunity to pay tribute to the memory of a man for whom I had the highest respect as an engineer, associate and friend.

I am mindful of the impressive list of distinguished gentlemen who have honoured Ralph Slade with memorial lectures, and trust that what 1 have to say will be of interest to you and in keeping with the high standard of previous speakers.

My association with Ralph over a period of 25 years goes back to an interview with him when I applied for a job with Philips. Ralph at that time was Technical Director and Manufacturing Manager, and I was impressed with his leadership qualities and enthusiasm for a local electronics industry.

Ralph was a man born ahead of his time. He clearly saw the way electronic development was heading and wanted to be in the thick of it. His enthusiasm and optimism was passed on to all who came in contact with him.

After a prolonged illness, Ralph passed away in 1965, somewhat disappointed that his dream had not reached the heights of his aspirations. But he was a man to remember, and all who came to be associated with him are richer for that association. He was indeed a notable pioneer of the electronic industry in New Zealand.

However Ralph's dream is not forgotten, and the lessons I have learnt from him in those early days have helped me in establishing the development group of Philips "Sir John Marshall Laboratory" at Naenae in Lower Hutt over the past 10 years. As I come to the end of my career in electronic design and hand over the reins to the next generation it is interesting to reflect on the changes that have taken place particularly in the last 10 years, and the trends away from consumer product development toward professional product development.

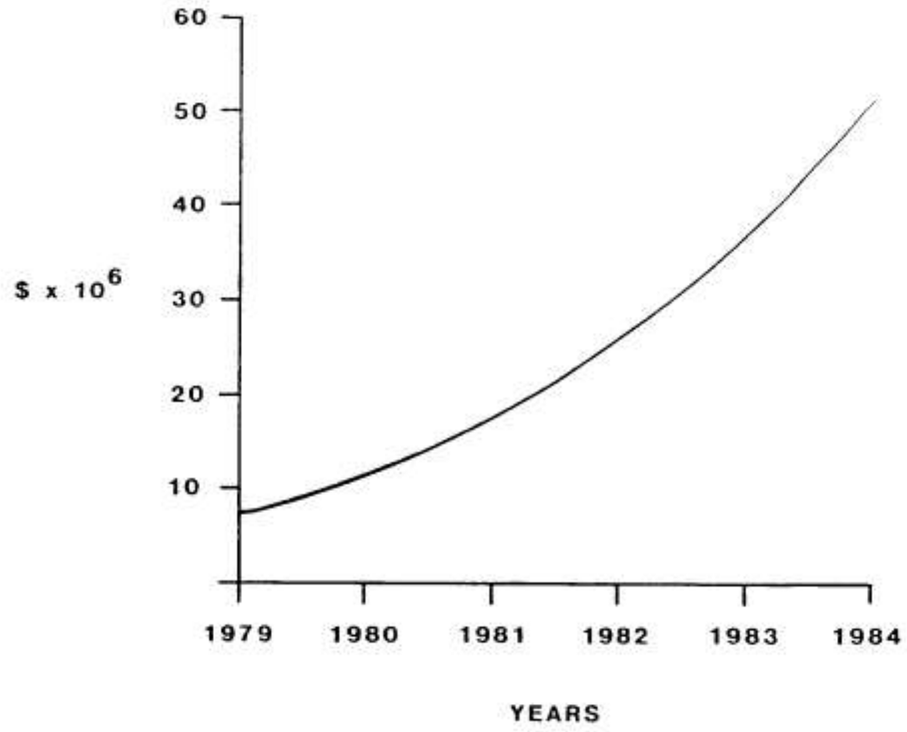
Since the commencement of local electronic development in the early 30's, New Zealand designers have served the local consumer well with a range of products suitable to the New Zealand environment and special local requirements. The export market, with its emphasis towards professional products required a different approach and presents a whole range of additional problems.

Customers have special requirements, and communication with them is often more difficult. Environmental requirements differ from country to country. Approbation and Safety requirements must be recognised, while subtle trade barriers still exist in many countries.

The trend that started in the mid sixties towards professional applications of electronic design has gathered momentum since the mid seventies and now dominates the activity and will continue to do so in future years.

Export of electronic equipment over the past 10 years has increased dramatically.

N.Z. ELECTRONIC PRODUCT EXPORTS



Precise figures for electronic equipment are not available for the period 1975 to 1978 as they were included in other electrical equipment exports but in 1979 exports were 7.5 million dollars, nearly doubling in 1980 and for 1984 were 52 million dollars. A figure of 64 million dollars is estimated for 1985 which is somewhat down on the projections of the industry study, but nevertheless a worthwhile contribution to overseas funds earning.

If we are to maintain a place in the world scene of electronic development in the 90's it is essential that we take a professional approach to design, with emphasis on quality, efficiency, and an understanding of what the customer wants.
The increasing acceleration in electronic development which I have come to accept during nearly 40 years of involvement in electronic design will continue, and the increasing complexity will require a streamlining of the development process if the product is not to be outdated before it gets into production. The axiom: The right product, at the right time, at the right price, with the right quality will become even more the requirement for success.

Speed of development, from product concept to manufactured article will be the essence of a successful design. Except for very simple products, the day of the individual designer working in isolation in his `back room' laboratory has long gone, and a motivated project team, totally committed to the product, time bound and fully aware of costs and cost price, is the modern formula for success.

I have come to the conclusion that we must aim to at least halve the present development and production preparation time, and with our limited manpower resources, the project team approach with the right development equipment, is the way most likely to succeed in the future.

A project team will need to encompass skilled inputs from

1. Market research	Commercial /Technical
2.Circuit design	Electronic hardware
3. Mechanical design	Hardware
4. Industrial design	Hardware
5. System design	Software
6. Test design	Hardware Software
7. Production engineering	Manufacturing
8. Quality engineering	Reliability, Safety
9. Service design	Service Information Ease of service
10. Cost Calculation	Estimation of production costs and development cost
11.Project administration	Planning Budget control, Documentation

Ideally one person would be responsible for each aspect but this is not always possible. However it should be recognised that all these functions have to be taken into consideration in the product design process.

Everyone involved in development in New Zealand will agree that finding development people with training and experience and the right attitude to design is extremely difficult. We are not going to be able to organise or afford large development teams so we must look at alternatives.

The small dedicated project team well trained, with modern time saving development equipment backed by a production unit and material supply organisation that is geared to fast reaction is the alternative most likely to succeed. Production preparation and material supply are subjects in their own right requiring separate treatment, so I must confine my remarks to the development sphere.

Now let us look briefly at each of these aspects of the project and consider the requirements for a successful product in the future.

1. MARKET RESEARCH

A successful product must first of all satisfy a need in the market place and secondly it must be profitable to those who manufacture and market it. For the most part such products require a careful survey of needs, the size of the market, and what the market will pay for the product. Imagination and forward thinking are essential ingredients in finding the right product.

There is no point in looking at today's market for tomorrow's product. We must expand our imagination to find the exciting possibilities for tomorrow. This is basically market research and usually requires the expertise of an astute commercial man in close association with a technical man who is right up with the latest technology and knows what is possible within the price range.

Some pre-development will probably be necessary, but this should be carried out quickly and done to verify the feasibility of an idea and the product cost. The next phase is to come up with a detailed product brief and specification, and to determine the makeup of the project team.

Very often a team brainstorming session, in which the team retire to some retreat where there are no interruptions and just let their thoughts flow and express them openly, can shorten considerably the development process. All ideas must be recorded for follow up and assessment of their feasibility.

Having carefully considered all the requirements of the product a specification must be finalised and written as a basic document.

A rough cut bill of materials should be costed, and a development budget drawn up to which each member of the team has to estimate his/her requirement for the project both in time and money. Any special development equipment requirement and its cost of either purchase or hire must be included in the development initial cost.

A development programme must then be drawn up indicating possible critical paths and times.

Now comes the first important assessment. Will it meet the price and time criteria? Only when the team is convinced that they can meet these predictions should the project proceed, and move out of the feasibility stage into the development stage. The project specification must be frozen and the development programme finalised. The group involved must now start to function as a formal team, with formal documented communications.

2. CIRCUIT DESIGN

The product design will usually be centred around the electronic circuit design, and the circuit designer will need to be aware of the latest technology and components. He will need to have available skilled technician backup to build up prototypes and equipment for circuit analysis and performance evaluation, and from this activity a product `concept model' should evolve.

This concept model should be used to verify customer reaction and from it a detailed engineering specification, agreed upon by the project team and the customer, must be drawn up.

3. MECHANICAL DESIGN

The mechanical designer who should also be involved in the concept model must now finalise the mechanical aspects of the design. He will need to be well versed on modern materials and their applications, tooling, plastic mould design, and manufacturing techniques.

It is in the field of mechanical design and tooling where some of the greatest improvements in speed of development will be possible. Every technical aid available will be essential to the success of a high-speed development. Computer Aided Design (CAD) leading to Computer Aided Manufacture (CAM) has been a promise for the future for some time. Like the introduction of computers themselves in the 60's CAD is a bright star on the horizon, but in spite of what the salesman may say the promises are not always fulfilled at the outset. Many systems at present available are not very user friendly and require specialist operators.

CAD technology is evolving quickly and the price is rapidly reducing, but there are still snags in getting the system that will do the comprehensive job expected and at an acceptable price. Choose carefully the system and be sure that is suits the immediate needs and can be expanded to cope with future technology. There is no doubt however that CAD will be one of the essential tools for rapid development of all aspects of mechanical design from PCB layouts, and metalware piece parts, to tooling and plastic mould design.

There will not be time for detailed and time consuming drawings, and the trained mechanical designer with a CAD work station must be able to package the electronic design without putting pen to paper and produce computer data that will enable tooling to be completed directly from it.

4. INDUSTRIAL DESIGN

Industrial design at the concept stage is essential and the product must be ergonomically right, functional, and aesthetically pleasing. New Zealand industrial design has made great advances over the past ten years and our young designers have come up with some excellent innovative ideas. We will come to have a considerable dependence on them in the future if we are to have our products accepted on world markets. This is one area where consultancy is likely to be beneficial in product design, as it is unlikely that many N.Z. electronic design laboratories will be able to employ the full time services of such a designer. In addition industrial designers require the stimulus of involvement in a number of different products to avoid stagnation.

5. SYSTEM DESIGN

Software will continue to play a major role in system design and processor control within the product.

Software development is presently one of the most time consuming operations in the design process. The need for software standards as an aid to speeding up software design is apparent.

Up to date microprocessor development equipment is essential. Again, choosing a development system requires careful consideration. Universal systems may be versatile and cheap, but they are invariably later in their ability to accept new devices, and this could be crucial to the timing of the project.

6. TEST DESIGN

Test design both in equipment and procedures has tended to be considered only after the product has reached the engineering model stage. The testing of a complex electronic product requires high speed sophisticated equipment, and the level of test and degree of confidence in the product must be considered at the time the engineering specification is written. Test equipment design must run almost parallel with the product design to ensure that the equipment is ready for the commencement of the trial series of the product, so that there is still time to sort out any problems before full scale production commences.

The test philosophy will depend on the production methods to be used. With modern component placement equipment with verifiers, and use of components with assessed quality, where in the future, near zero defects can be expected, test designs should aim for dynamic performance testing and a final comprehensive customer test.

Board test equipment is highly desirable but at present is difficult to justify unless the production series is reasonably large. The investment cost and the cost of software is still very high.

7. PRODUCTION ENGINEERING

The involvement of the production engineer in the team right at the concept stage will play an important part in getting the product into manufacture quickly, and with the minimum of assembly problems.

Flexible systems for jigs and manufacturing aids will improve preparation times, but the continual improvements to be expected in manufacturing techniques means that the production engineer must be guiding the design team to design with the production techniques in mind that will be available when the product is manufactured.

8. QUALITY ENGINEERING

The growing awareness that quality is not only built into a product but is also designed in has resulted in the emergence of the quality engineer.

Again early involvement in the design process is essential if delays are to be avoided due to shortcomings of components when production commences.

Reliability calculations, piece part tolerance, the choice of quality assessed electronic components, the negotiations with material and parts suppliers, all require the involvement of a quality engineer.

Product safety and procedures to ensure 100 percent confidence that the product complies with all safety requirements is the responsibility of the quality engineer.

9. SERVICE DESIGN

The engineer responsible for field service will have an important input at the design stage and has responsibility to ensure that technical service documentation is completed before the product is released for series production. Product reliability will continue to increase and service personnel will not only need greater diagnostic skills but will require comprehensive information to effect repairs efficiently.

Mean time between failure figures running up to decades will mean that field service personnel will no longer be confronted with familiar faults that are easily diagnosed and repaired.

Self-diagnostic programmes will need to be considered in complex systems with ease of accessibility and board replacement part, of the mechanical design brief.

Each component should be considered on its reliability merit and provision made for spare parts to be readily available when the product is delivered to the customer. The results of the trial series and field failure information should be available to the service engineer and failures should be analysed by the relevant members of the project team.

10. COST CALCULATION

The whole project team must be continually mindful of the product and development costs. The service of an experienced cost estimator is highly desirable at the outset, but as the design progresses it is essential that the cost is updated so that when changes are made, the cost consequences are fully realised by the designers. Ignorance of cost consequences of design changes can mean that at the end of the design phase the product is too expensive for the market, and should have been stopped at a much earlier stage. The cost of development of a product is mainly in person hours, and these must be regarded as a resource that must be applied profitably. By continually monitoring the cost the project team can be aware of the situation and must take steps to keep the project viable, or stop the project at an early stage if costs are becoming excessive, and apply the resource to a more viable project.

The cost of development will continue to increase and with development resources in N.Z. limited, few companies can afford failure of a fully developed product.

It should be realised that money spent on development must be considered not only as an investment on which a reasonable return should be expected, but on which interest is being paid. On today's interest rates this can have a bearing on the project viability.

I cannot over-emphasise the need to plan the project on a realistic time span with accurate budgeting.

This requires skill, and experience gained from analysing carefully the successes and mistakes of previous projects.

Every member of the team must make a commitment and remain committed throughout the project. The responsibility of the team leader must be to motivate all members to achieve the goal, within the time and cost targets.

In electronic product design, the leadership of the project will in most cases be in the hands of the electronic designer, but this is not essential. Leadership is the important quality and accurate reporting on progress by project administration at regular short intervals is essential. Apart from keeping accurate time records designers time should be applied essentially to designing. Technicians should be used where possible to carry out support tasks, and administrative tasks, by clerical staff, preferably with some technical background.

11. PROJECT ADMINISTRATION

The use of a computer to speed up the processing of costs, development hours, project planning and performance against budget will ensure that the required disciplines are adhered to and fast factual reporting is available.

All product documentation should be on a word-processor with a full range of graphic text available, so that rapid update is possible.

In addition it should be a basic requirement that every designer maintain a laboratory design note-book where the results of all measurements and experiments are carefully recorded at the time of the action. This note-book must remain the property of the Company and should not be removed from the design laboratory under any circumstances. The loss of a designer for what-ever reason can be a serious setback to any project, but more so when the project team is relatively small and speed of development is critical.

The introduction of a replacement team member can be considerably expedited if adequate records are available, and when problems are encountered it can often assist the rapid solution to refer back to the result of early development work.

This leads me on to the importance of accurate documentation of all aspects of the development project with formal written procedures laid down for each document, and for introducing changes.

The documentation package should include: Commercial product specification
Engineering specification
Technical description Software programme Test specification Service documentation and circuit diagrams Product release report

The product release report must also include a safety release report. Every product which operates from potentially dangerous voltages - either mains or internal - should be subjected to stringent safety examination by either an independent TELARC registered laboratory or a competent group not involved directly with the development project. The product should be checked clause by clause for compliance with the relevant safety requirements, and any deficiencies corrected before a release for production is given. The repercussions of neglect of safety assurance in countries where "absolute liability" is law can be devastating.

During the development the security of documentation and the laboratory must be treated seriously. The possibility of industrial espionage should not be overlooked. The development area should not be accessible to unauthorised personnel both within and without the organisation, and all discarded or outdated paperwork should be reliably destroyed. The use of a paper shredder is highly recommended. Electronic development in New Zealand has made rapid progress over the past 10 years which is evident by the expansion of exports of manufactured electronic products. The emphasis has shifted from consumer electronics to professional electronics, and there have been some excellently designed products marketed. As an export item for N.Z., professional electronic products have a high unit value, low transport volume, and reasonably high local added content. However, the rate of technology change means that to exploit the market, fast reaction is essential. New Zealand designers are well educated, versatile and innovative and the cost of development is not expensive by world standards.

To capitalise on these advantages we are going to need well equipped laboratories, and production facilities that are continually updated to keep pace with technology advances.

Laboratory equipment is becoming more complex and sophisticated, and therefore more expensive, but its effective life is shorter. This must be recognised by

Government and real encouragement given to development, by faster write-off of equipment both development and production, reduced or zero taxes on imported development equipment, and other tax incentives on development costs.

The Japanese have achieved fast product development by large design teams, developing products for the mass market at incredible speed, and with obvious success. They have considerable assistance from a sympathetic Government that recognises the export asset. New Zealand does not have this large resource of development people so we must find the way to match this speed of development by choosing the right product and niche in the market place, and with our unique attributes, find ways of improving development efficiency.

Government should also be continually reminded of the encouragement given to electronic development in countries in close proximity to New Zealand where the success, due mainly to Government policy, has been spectacular.

We must look carefully at the training programmes for design and development engineers remembering that they are the critical resource for the continuance of the electronic industry in New Zealand.

Although the realisation of success by the designer will be to see the product of their work selling profitably in the market, they must be adequately rewarded for their performance.

Good development staff today must have a keen desire to design products, and the ability to communicate and work within a team. Almost independent of their education background it takes about two years for new design staff to become fully productive. During that period further training in Company procedures and training courses are necessary, while lower level design tasks are undertaken under the supervision of an experienced designer. During the training period performance must be continually evaluated and the scope of design work and responsibility increased. A knowledge of manufacturing techniques and basic electronic skills must be acquired and in my experience, technicians who complete NZCE training and then go on to university and complete an engineering degree are inclined to develop designs skills faster and with greater depth than graduates direct from University with little practical knowledge or skills.

It will become more imperative that industry keeps in close contact with learning institutions to ensure that they not only keep up to date with state of the art subjects but that they do not drop subjects out of their curricula too quickly. A case in point is the present emphasis being placed on digital technology to the detriment of analog technology - which at present is being seriously neglected in our higher learning institutions.

Remember, training development staff is a heavy investment commitment over a long period. Continuity of employment is essential and the development team must have confidence in the Company and its Management. Conditions of work must be conducive to productive thinking and discipline should not be too strict. The good designer does not "switch off" his thinking process as he leaves the laboratory. The problems of design are continually in his thoughts, and often the solution to a problem comes to him when he is away from the work place.

The active life of a good designer is in the order of about 20 years. During that time on todays dollars, an investment of something in the order of one million dollars is made, so, to get the most out of such investment it is important that he has the necessary facilities and equipment at his disposal to ensure a good return on the investment.

Equipment and facilities are not cheap but neither are development man-hours. Apart from the normal laboratory basic design equipment such as scopes, multimeters, various signal generators, specialised equipment will be required, and the lead time on such equipment has to be considered in the overall plan.

All equipment must be reliable and accurate, and regular calibration, with traceable accuracy will be necessary for some items of measuring equipment. A programme of equipment replacement is essential if the design facility is to be kept up to date and efficient.

Information from a comprehensive library of component data books, and technical literature is essential. Subscriptions to relevant technical magazines should be maintained, and the number regulated so that design staff are not overburdened with reading matter.

The library should include a full range of international and local standards documents continually updated. The acceptance of International Standards must be encouraged to avoid the need to develop special versions of a product for each market.

Any company involved in the manufacture of electronic equipment with a desire of continuity, must be prepared to face up to the cost of development. After the initial cost of establishing the laboratory, the company must be prepared to invest somewhere between 5 to 10 percent of turnover in design and development. On present day dollar values, the development budget will have to provide about $75,000 for each design person employed.

To summarise - the New Zealand electronic industry has made a promising start in its transition from consumer orientated to professional orientated product design but there is no room for complacency, and greater efforts must be made to keep up the momentum.

The real proof of our efforts will be our success in exports, and up to now many of these have been in spite of - not because of our performance.

The world market place is becoming more competitive and it is essential to find the right product for a place in the market that suits our development and production facilities, and allows us to maintain a lead in that particular technology. Don't try to take on the big manufacturer in the mass market. At least some experience on the local market is highly desirable to prove the product before export, where failure problems are extremely expensive.

There are always opportunities to be found in the professional sphere, and it is up to the combined skill of the commercial and development team to search them out and make the most of those opportunities.

Government departments are important potential customers and in my experience the co-operation to date has been excellent. The NZPO purchases locally something in the order of 100 million dollars of communication equipment per year, and this is increasing at a significant rate, but other departments should not be overlooked.

Much of this equipment has export potential but don't treat your local customer complacently, he is an important partner in the export drive. Realise that there is also pressure on Government departments to be up to date with technology. Speed of development is just as important for them if they are to give you the opportunities.

The 1990's has exciting possibilities for the New Zealand electronics industry if we can anticipate, and react to market requirements.

Our experience to date has indicated that the small, well equipped and motivated design team, can develop products competitive on the world market.

We have started the ball rolling, I trust that my comments will help to keep it at your feet and running in the right direction.