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New Product Development at HPM[1]

Introduction

To compete in today's business environment, HPM Industries must deal with the most competitive and hostile marketplace that it has faced in the company's entire history. Improvements in technology and an increasingly globalised market mean that competitors are now causing severe pressure in markets where HPM has traditionally held dominance.

The company's strategy to overcome this threat is to use innovation and technology to differentiate itself in the marketplace. Over the last two decades HPM has concentrated on developing a strong innovation culture within the organisation, and this is now successfully demonstrated in many areas throughout the company. This, combined with the company's strong focus on using the latest technology in both its products and manufacturing processes, has positioned the company in an excellent position to be able to adapt to market changes.

This case therefore describes how HPM is positioning itself in the marketplace and details some of the ways that the company is utilising technology and innovation to differentiate itself. It also details an example of how the company conducted a comparison between the conventional engineering path from product design to marketing introduction, with two "rapid" development alternatives. One alternative demonstrated the advantages gained by introducing stereolithography models while the other identified the further gains made by utilising the models to produce "rapid tooling" through a cold metal spray process.

Company Background

HPM Industries is a privately owned company established in 1925. Its core business is in the design, manufacture, and distribution of electrical wiring accessories such as electrical power plugs, power outlets, and light switches. HPM has traditionally marketed and sold its products through the electrical wholesale market, and although this area still forms the backbone of the company's success, more recently the company has also been successful in developing and marketing many products for the retail market sector.

For electrical products HPM has been the dominant player in the Australian domestic market for many years, and internationally the company has also managed to break into a number of special niches. Although the company is widely recognised as a leading electrical accessory manufacturer in Australia, the company could not be considered a "household" name. This is despite the fact that almost every home in Australia would contain one or more product lines that HPM manufactures.

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[1]This case was developed for use in classroom discussion and is not intended to necessarily illustrate appropriate or inappropriate management practices. Case information was gathered through interviews with Stuart Romm, managing director of HPM, visits to the HPM site, and reviews of various documents provided by HPM. The case author of the original case (1996) was Graeme Sheather, University of Technology, Sydney. Scott Cameron was the research associate on the project in the Graduate School of Management at Macquarie University and updated the case in 2000. We wish to thank Stuart Romm and his HPM associates for their contributions. The funding for this case production was provided by the Australian federal government's Department of Industry, Science and Resources.

The company had its origins in button production, when Ruth Simons's parents (Ruth is the wife of the current chief executive officer, Peter Simons) started HPM in the button-moulding business. In 1948 they bought a tool at auction to make plug-tops and started turning out about 20 products.

Today the business employs more than 1,100 employees working in its various factory sites, warehouses, and sales offices around the country, from which it supplies over 3,500 product lines. In Sydney alone, there are approximately 800 employees engaged in manufacturing, with over 200 staff in sales, administration, finance, and distribution around the country.

The Darlinghurst site in Sydney contains the operations of design, engineering, manufacture, and also distribution, while the 500 employees at the newer Waterloo factory are mainly involved in assembly and distribution. There are nine factories in Sydney which supply every part of HPM's manufactured product range. The seven sites average around 200 employees, with each managed by a single engineer plant manager qualified in moulding, materials, processing, and the latest technology.

As an Australian company, HPM has a strong philanthropic ethic and sense of corporate responsibility and each year contributes in various ways to the Australian community. As well as sponsoring the annual HPM Award for Excellence in Design, the company supports a number of Australian community organisations such as the National Trust, the Australian Chamber Orchestra, Kidsafe, and the Lord Mayor's Bush Fire Appeal. In 1994, HPM also committed to fund a three-year scientific research project through the Australian Koala Foundation and James Cook University.

Competing in a Changing Environment

HPM has enjoyed a strong position in the Australian electrical market for almost half a century, and through its attention to quality and strong product development the company still continues to enjoy steady growth. In the pursuit of this growth, however, the company now faces many different challenges to those which existed when the company first began.

One of the most notable changes that has taken place in the market over the last two decades is in the length of product life cycles. In the 1970s and 1980s HPM's products generally had a life cycle of around 8–10 years. However, in today's market the company now must contend with product life cycles of two years and less.

Impact of Technology. The company's Managing Director Stuart Romm attributes much of the reason for this reduction to the impact of new technology on the market. This is not only because competitors are able to develop alternative products on a much more frequent basis, but also because competitors are now able to reengineer exact duplicates of HPM's products and saturate the market with cheap copies.

In the past, the quality of the cheaper, generally imported, products was very poor, thereby providing HPM with a competitive advantage on quality. However, recent improvements in technology mean that the quality of the imported product coming into Australia is now very good. Competitors can optically scan a product, reverse engineer it, and then produce a product with all the same characteristics as the HPM product.

These products are on the market today, and although they have not been very successful in gaining market share up to now, they are causing severe price pressure in the marketplace. Technology, in this sense, is therefore creating a lot of extra competition in HPM's traditional market areas.

Impact of Cheap Imports. In contrast to the recent trend for companies to outsource and/or move offshore for their manufacturing requirements, HPM has for many years held a unique "in-house" manufacturing philosophy and sourcing structure. The company has been fully committed to manufacturing in Australia, and this "Australian Made" philosophy has contributed greatly to the company's marketing success. As CEO Peter Simon remarks, "We made a conscious decision a few years ago to continue to manufacture our components locally."

The logic behind this domestic manufacturing strategy was that the company would be able to overcome the cheap labour and the lower setup costs of overseas competitors by investing in more automated manufacturing technology, and by utilising the superior engineering skills that exist within the company.

Today, however, the market pressure facing the company, particularly on standard products, is fast becoming overwhelming. Stuart Romm recognises this and attributes much of the pressure to low-cost Chinese sourcing. He comments that low-cost overseas sourcing has now reached the point where HPM can source a packaged finished product out of China for less than the cost of the raw material in Australia.

This kind of market pressure is no longer forcing HPM to increase its automation; it is forcing the company to totally reposition its manufacturing strategy. Management has come to the realisation that the domestic manufacture of standard, low-technology products has now become uncompetitive against low-cost imports coming from Southeast Asia. In recognition of this, from the year 2000 onward, the company's manufacturing strategy will change dramatically, and the manufacture of high volume, and particularly low-technology, products will probably be forced offshore.

Still concious of its commitment to Australian manufacturing, however, HPM is expanding its manufacturing capability in Australia in higher technology areas, and the company's acquisition of a large electronics factory in Sydney is a good example of this. This factory is larger than currently needed by the company; however, the acquisition forms part of the company's longer term strategy for developing its electronics capabilities.

Strategic Direction: Using Technology and Innovation to Differentiate

To achieve its goals, the company's main strategy is to differentiate itself from low-cost competitors through innovation. Management's aim is to build on the company's strong tradition of product development and to position the company such that the marketplace is constantly looking toward HPM for refreshing new products all the time.

Innovation at HPM. Similar to the way in which 3M operates, HPM has for many years tried to instill a culture of innovation within the company. This approach is still as strong as ever in the way that the company operates, and it continues to bear fruit.

Developing a Culture of Innovation

Organisational. HPM's culture for innovation has historically been embedded in its free-thinking process. The company structure involves very few rules and regulations, with a deliberate exclusion of set policies, and no job or position descriptions. "We don't like anything formal," comments the managing director, working instead with clear directional indicators and understood limits. There is no formal vision, mission, goals, or strategic objectives set down. They exist in broad terms, but are kept as fuzzy as possible to ensure that necessary changes and resources can be drafted as needed. The only documentation is in the form of a pictorial diagram of the business objectives. This is represented as a roof with five supporting product line pillars. To have a formalised corporate planning process would be too bureaucratic, totally alien to the company, and would destroy its family culture.

Remuneration is highly graded, with executives highly paid and tradespeople drawing 30 to 40 percent over the MTIA award. Design and engineering staff are given the necessary resources, freedom of action, full responsibility, and opportunity to exhibit initiative and creativity—there are no rules to inhibit performance.

The enterprise agreement that HPM has been able to develop with its factory employees over the last five to six years also provides the company with the flexibility it requires and reinforces the company's desire for flexibility, employee contribution, and new ideas. Features of the agreements that have been struck are as follows:

- Workplace flexibility; related to flexible starting and stopping times for specified periods, staggering start and finish times for auxiliary staff, continuity of operation, and coverage of additional machines due to absences.
- Quality assurance for continuous improvement, with future progress motivated by employees taking responsibility for quality within their workstations and diversifying the responsibility of quality to each employee rather than to inspectors only.
- Responsibility for control and work planning taken by operational staff for their own stock at their workstation, rather than relying upon auxiliary or indirect labour.
- A consultative committee to continuously monitor and review training for new technology, multiskilling and job sharing, shop-floor training for new/transferred staff, English in the workplace programs, and shop-floor training for QA procedures and requirements.

To emphasise the importance of innovation and new ideas, the company has also set up a separate research and development organisation that is constantly looking for new product ideas and better ways to progress from concept to marketplace. R & D is given so much credibility in the organisation because it is seen as the key to the future success of the company.

External Influences. Some of the ways in which HPM encourages innovation through its external relationships are as follows:

1. HPM has made a significant commitment to the federal government's Intelligent Manufacturing Systems (IMS) consortium agreement for R & D projects. This program gives the company an insight into tertiary-level research and development and provides it with a network of contacts around the world. Through this program the company has been able to develop strong relationships with other facilitating companies, including Daimler-Benz (Europe), Pratt and Whitney (Canada), and United Technologies in the United States. Participating institutions also include the Fraunhoffer Institute in Germany and MIT in the United States.

   Wherever there is research going on within this international consortium, HPM is in an excellent position to tap into that knowledge and intellectual property. It is the company's strategy to utilise the latest in processing technology, and by maintaining strong links with other leading companies and tertiary institutions the company can be confident that it will have the inside information on any new developments in processing technology.
2. The company is also heavily involved with a number of Australian universities; for example, the company provides the funds for an annual engineering co-op scholarship with the University of NSW, and they are also governors of the Warren Centre, which is Sydney University's commercial arm.

New Product Innovation. The company's approach to product development is very much marketing-led, as Stuart Romm remarks: "The strategy to start with has to be to find the problems in the marketplace, and create the solutions. That's innovation."

At HPM innovation inputs come from four different directions.

1. Management think tank. Every morning there is an executive think tank for 45 minutes to one hour. Executives who know the industry get together to play around with ideas and discuss the progress of different issues. There is also a formal meeting with the R & D executives once per week for about two hours.
2. Inventors. The company encourages these, and there are probably around two to three per week who "knock on the door" with some idea that they are looking to develop. These people are embraced and encouraged.
3. Salespeople. All of the salespeople are strategically aligned with the end user, which is the electrical contractor, rather than the commercial customer, who is the electrical wholesaler. Salespeople are encouraged to spend 70–80 percent of their time with the end installer, the electrician, who actually makes the purchasing decision.

   The issue here is that the user knows the problems with the HPM or competitive products, and he/she knows the problems on installation. This feedback generally provides simple and practical ideas which are then fed back through the salespeople to the designers and engineers.

   This is the area responsible for the majority of the company's new innovation ideas.
4. International study tours. The innovation process is also supported by attendance at a number of the international conferences that are held around the world each year. The idea here is not to copy the products shown at the fairs but to stimulate thought and generate ideas.

Technology in New Products. HPM's strategy is to concentrate on highly innovative products, particularly focusing on those that hold the following characteristics:

1. Where there is added value.
2. Where the company has some intellectual property in the product.
3. Where the product can't be copied or will take a long time to copy.

In satisfying these criteria the company is increasingly moving toward new electronics technology in an effort to:

1. Increase the product life cycle of their products.
2. Differentiate the HPM product in the marketplace.

Placing electronics into products is allowing the company to do things that could never be done before. A typical example of this is the way in which HPM now offers dimmers and time switches in a lot of its products. This patented technology works off a single wire (there is no neutral required), giving the company an advantage that competitors have as yet been unable to match.

The technology means that an electrical contractor can now take out a light switch (which just has a wire in and a wire out), and without having to bring a neutral wire into it, he/she can replace it with an HPM digital time switch. This allows the user to set the time for whenever he/she wants it to go on or off.

The company is not only using electronics in existing products but is also moving into the area of providing complete electronic systems. The company's "smart house" product, OSCAR, is an example of this. This product is designed for the normal domestic residence, and provides home automation to the consumer for security, light control, power control, and home entertainment.

Management's vision is that tomorrow's consumer will want increased functionality within the home. Consumers will want to be able to plug their computer into any room in the house, to be able to turn on the video downstairs and watch it on the television upstairs. They will also want the ability for remote operation of these facilities, the ability to log in to the network and have total control of the system from anywhere in the world. In a similar style, HPM's continuing focus will be on providing total electronic systems for commercial and industrial applications.

It can clearly be seen that although technology is in one sense causing the company increased competition, on the flip side it is also allowing the company to differentiate itself from the competition and move into other areas.

Increased Market Servicing. Coinciding with the development of higher technology products, HPM is also looking to increase the number of support services that they offer in the field. In the future the company will offer services such as systems installation, commissioning, and upgrades to support their products.

The premise for this is that the electrical contracting industry tends to be quite conservative, and HPM believes that without this support they will not move at the rate that the company wants to move. The concern therefore is that the momentum of the penetration of electronic systems (like OSCAR) into the marketplace will be limited by a conservative installation industry.

Developing New Distribution Channels. The existing OSCAR system is sold through traditional distribution channels (i.e., the same as powerpoints, etc.). It goes on the shelf of the electrical wholesaler, and is then sold to the electrical contractor.

Future systems will not be sold via this channel, however, as they will need to be programmed on-site by someone with the appropriate programming skills. It is not envisaged that the normal electrical contractor will have these skills and hence new distribution channels and a new style of contractor will be required.

Technology in New Processes. HPM's main manufacturing strategy in the 1960s, 1970s, and 1980s was vertical integration, and this is clearly shown in the way the company operates today. It makes its own mouldings, screws, pressed metal parts, production tools and equipment, and robots.

The flexibility of designing and making their own equipment gives the company an advantage in creating a fit between the technology it introduces and the goals of the technology introduction. The focus is on the unique requirements of the situation, rather than what is available, and will this work.

New technology flows through the company to all areas, and the direction of the company is for complete computer control. The following describes how technology currently impacts the production of the company's core products, such as powerpoints and light switches.

1. Design is done on CAD [computer aided design] electronically. The tools are made via a direct download from the CAD workstations to either wire-cutting or spark erosion equipment.
2. Component warehousing is computerised with radio frequency control.
3. The components are then all fully automatically made, whether it be metal or plastic, which are all computer controlled.
4. The material handling between these processes is all manual.
5. Assembly and subassembly of products to the lowest common denominator is then done on PLC-controlled robots.
6. Final assembly of these products is then manual or semiautomatic to configure the product to the customer's requirements (e.g., colour).

7. Fully automatic testing.
8. Automatically packaged.
9. Finished goods warehousing is not computerised yet, but will be in the near future.

Adopting New Process Technology

When a new technology is developed or introduced into the marketplace HPM prides itself on being an "early adopter." Introducing new technology when it is early in its life cycle can bring many benefits, as it may let the early adopter get the jump on its competition. However, because decisions must be made without proven evidence of the benefits that the technology can bring, the implementing company must be very thorough in its decision-making process.

Investment decisions at HPM are carefully evaluated, and any major capital purchases must comply with two primary criteria:

- Strategic fit: Investments must be aligned within the company's overall business strategy, which is to satisfy the needs of consumers in terms of their electrical requirements.
- Financial payback: Previously HPM used a two-year payback period as a guide for deciding whether an investment decision was financially viable. This has now changed, however, and financial decisions are made on a more ad-hoc basis. For example, for investment decisions involving a product that has an "electronic" type long-term focus, the company may approve a purchase with a five-plus year payback. However, if it is a copyable product, and especially if it is low-tech, then the company would be looking for well less than one year.

Rapid Product Development

HPM recognises the importance of getting new products to market quickly and therefore pays particular attention to new developments in the area of rapid prototyping technology.

The case that follows is typical of the type of investment decision that the company often finds itself in. It describes how the company was able to evaluate the benefits and costs of using:

1. The stereolithography rapid prototyping technique.
2. A technique to produce rapid tooling for "first off" production samples.

Stereolithography

Stereolithography is a process that has the potential for dramatically reducing product development lead times and their associated costs. Stereolithography was discovered in the early 1980s and patented in 1986.

Traditional prototyping and hard tooling processes rely on the removal of material for the formation of prototype parts and the subsequent manufacture of their tooling for production. Stereolithography and other rapid prototyping techniques are the complete opposite. Using layer-building processes, they deposit only the required material for each particular layer, gradually building an exact replica of the part, regardless of its complexity.

Development of a New Light Switch Product

During mid-1993 HPM perceived a strategic threat to one of its light switch products in the marketplace. It was anticipated that the product could suffer serious damage from inferior but inexpensive import competition by early 1994. The key strategic objective, therefore, was to "fast track" a product development that would produce a new model that was considerably cost reduced and yet maintained the traditional product's superior performance and market appeal.

In developing the new product, HPM also wished to test and quantify the benefits of the rapid product development approach. The decision was therefore made to carry out the product development using three concurrent but different methods, and to monitor the progress of each method. These three product development paths were:

Case 1: Employing conventional engineering.

Case 2: Employing a rapid prototype model.

Case 3: Employing a rapid prototype model plus rapid tooling.

The critical component of the new model light switch to be developed was the switch cover, a highly accurate polycarbonate moulding that would house and locate all the metal components of the product and would be used as an assembly jig during the manufacturing process. The development of this component therefore forms the basis of this case.

Project Management. For each new product, a project management plan is constructed for the design, tooling, and production stages. Milestones are set to resolve problems and these are continually reviewed in relation to manufacturing processes, functions, and testing requirements.

The company uses the Microsoft Project software to keep track of the various projects that are occurring concurrently at any one time. The main projects and some of the smaller ones are monitored on a weekly basis, against theoretical timescales. Product comparisons and cost estimates are also made at every stage of the project to ensure that the project remains within its boundaries.

At one time there are typically around 40 projects in the pipeline around the company. Of these, around 10 are given priority as they are believed to be the main ones.

Comparative Analysis of RPD Options. In order to make an accurate comparison between the various methods for developing the new switch cover product, the projects were all measured from a point where the overall product design had been completed and confirmed.

Case 1: In the case of the conventional engineering path, the injection mould tool design was then commenced.

Cases 2 and 3: For both the cases utilising the rapid prototype development technique, the injection moulded component data was processed using INPROTO faceting. These data files, in STL format, were then passed to the Queensland Manufacturing Institute (QMI) for the production of stereolithography models on their SLA 250 machine. For additional security, four complete sets of stereolithography models were produced.

The stereolithography models were produced within a couple of days by QMI and, once received, the components were then assembled to evaluate form and fit. One error and two tolerance problems were discovered when the components were assembled and these changes were incorporated into the design of the production tooling.

The stereolithography models were then measured in all major dimensions and these results are shown in Figure 1.

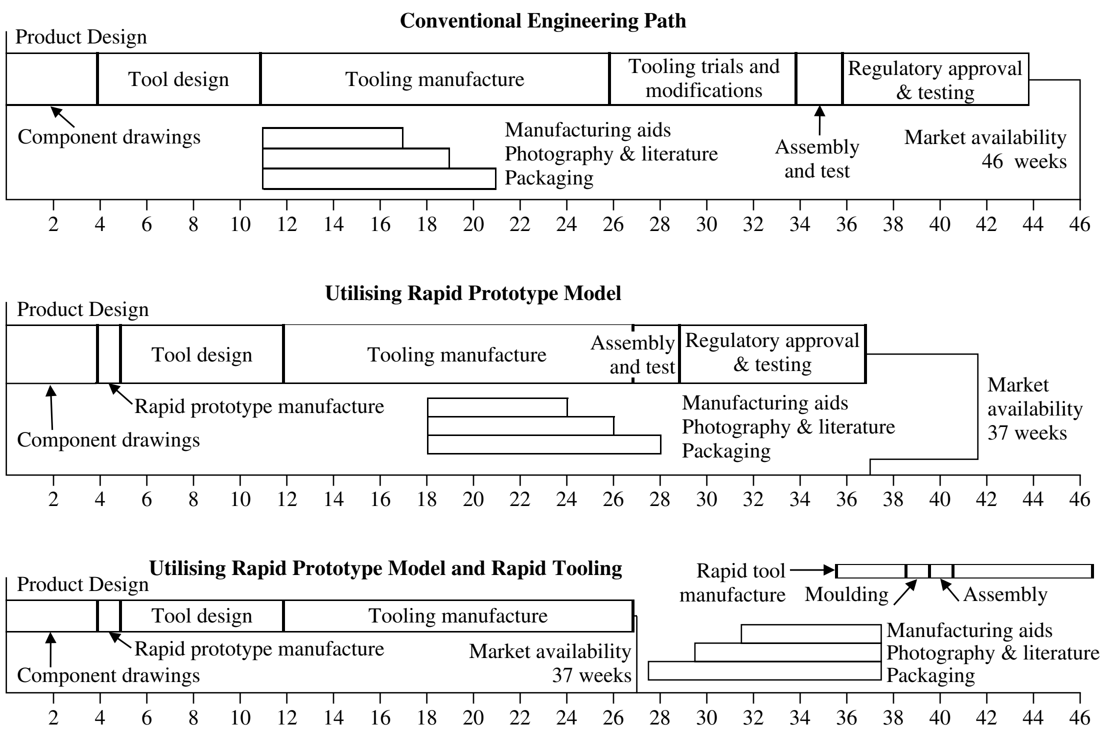
Once the production of the models was shown to have been successful, no further work was carried out to monitor the conventional engineering path. However, Figure 2 has been extrapolated from results recorded over the last six years to obtain a reasonably accurate comparison with the other two methods.

Cases 2 and 3: For both these cases, the tooling design was completed on the Intergraph CAD/CAM System, and the tool design data transferred to a Sodick A 3CR spark erosion machine for production of the injection mould tool.

FIGURE 1

DIM Number	*CAD Dimension*	*Stereolithography*	*Cold Metal Spray Tool*	*Polycarbonate Moulding*
1	39.78	39.86	39.89	39.77
2	29.15	29.16	29.01	28.88
3	45.66	46.06	46.09	45.78
4	45.12	45.23	45.26	44.73
5	31.65	31.72	31.50	31.24

FIGURE 2



Case 3: For the case utilising rapid tooling, at the same time as the production tooling was being designed and manufactured, one of the four stereolithography models was passed to QMI. The rapid tooling was created using a cold metal spray process known as the HEK process. This process combines the use of zinc alloy wires which are melted under a plasma arc and "blown" by an air blast onto the model. By the time the molten metal reaches the stereolithography model, the metal is almost at room temperature and thus causes no distortion to the photopolymer model. The thickness of the cold metal spray is then built up gradually layer by layer, until a thickness of approximately 4 mm is achieved.

Once this was completed, the stereolithography model was then physically removed from the metal backing. This is a difficult process, as the model must be carefully broken into small parts and removed piece by piece.

The cold metal spray mould was then "backed" in epoxy resin, and with a hand-made metal core, the tool was then inserted into an Engel 150 ton injection moulding machine. The injection moulding was carried out by the Plastics & Rubber Technical Education Centre (PARTEC) in Queensland. Initially, the mould trials were carried out by injecting polypropylene material at the lowest possible clamp pressure, deliberately "flashing" the mould. The clamp pressure was then gradually increased until the flashing was eliminated and the minimum clamp pressure noted. After this trial, the polypropylene was replaced with polycarbonate, this being the engineering plastic required in the final product and essential as part of the Regulatory Approval testing procedures.

For comparison purposes, the cold metal spray tool and the final polycarbonate moulding were both measured and the results are shown in Figure 1. Both were well within the tolerances limits required for prototype performance.

Comparative Improvements. Figure 2 displays the steps and time taken by each of the different development methods to bring the product to the point where it is ready for release into the marketplace.

Conventional Engineering Model. With the conventional engineering approach, it can be seen that the market availability (elapsed time) was 46 weeks from the time of confirming the product design until the product was available for mass production and distribution.

The photography and production of literature and brochures is normally conditional on the availability of the finished product, or highly accurate models, and it is therefore shown that, using the conventional development method, this process cannot commence until the product is physically available. It is also conventional practice not to complete manufacture of production jigs and fixtures until the final product or models are available. Packaging design, particularly any blister packaging and drop testing, are also not normally finalised until the product or models are available.

Rapid Prototype Model. In the second case, where a stereolithography model was used, it can be seen that the minimum time from product design to market availability was reduced to 37 weeks, compared to the 46 weeks for conventional methodology. This reduction of 9 weeks represents a 19.5 percent reduction in development lead time.

The availability of the stereolithography model at week five meant that the production of manufacturing aids and jigs, photography, and product literature, as well as packaging, could commence at week five, although not critically required until week 37. However, even though the stereolithography model was available at week five, the product could not be submitted for the Regulatory Approval tests until week 29, when the product was available in its specified material form. Stereolithography polymers are not suitable for Approval Testing since they are not representative of the final product's electrical insulation, physical strength, and fire retardant properties.

By using RPD processes, a physical appreciation of any redesign to improve functionality or manufacture related to tooling, moulding, or testing can be given early attention.

Rapid Prototype and Rapid Tooling Method. As can be seen from Figure 2, the major advantage that this approach had on the development project was that it enabled HPM to obtain Government Regulatory Approval for the product prior to the completion of the production moulding tool.

The Approval Testing delay was regarded as one of the obvious strategic areas for improvement, but one that industry generally has little or no control over. The process typically takes eight weeks to meet the requirements for Government Regulatory Approval testing of electrical products in Australia.

Because Regulatory Approval could be carried out in parallel with the manufacture of production tooling, the minimum development lead time was reduced down to 27 weeks. When compared to the conventional engineering path, this methodology saves 19 weeks (or 41.3 percent) compared to the orthodox process.

Cost-Benefit Evaluation. The development savings from this comparative analysis were clearly identifiable and relatively easy to quantify. Compared to the conventional engineering path, the path employing both the rapid prototype model plus rapid tooling produced an estimated saving of 19 weeks in development time.

An historical analysis conducted by the company's accountants and engineers of the costs incurred in typical tool trials with tooling modifications and rework indicated a saving of approximately A$20,000.

In addition to the operational efficiencies calculated above, the more significant financial gains were achieved through the early introduction of the product into the marketplace. The financial and commercial gains cited below represent the gross profit generated in the first 19 weeks of the product's release onto the market. (N.B.—These figures exclude any commercial overheads associated with the marketing of the product.)

Week	*Gross Profit (A$)*
1–4	$28,550
5–8	71,375
9–12	99,925
13–16	142,750
17–19	71,275
Total: 19 weeks	$413,975

The direct development costs of the series of experimental trials, excluding management time overviewing and recording the trial, were calculated as:

4 stereolithography models	A$2,000
Cold metal spray cavity and die production	A$2,200
Low pressure injection moulding of 20 components	A$ 500

The relationship between cost savings in development and the cost of the RPD models was found to be typical of case studies reported in the rapid product development literature, that is, savings are approximately 10 times the cost of the models.

It is recognised that there are a number of costs that have not been quantified in this analysis, such as the increased project management costs resulting from the new development method. However, there are also significant additional benefits that have not been specifically valued in this costing. These concern the strategic benefits of bringing a new and unique product into the marketplace, which strengthens both the product range and the company's commercial market presence.

These benefits are of paramount importance to HPM, particularly in HPM's retail market sector, where major retail stores are constantly seeking to reduce the number of suppliers in order to reduce their own administrative costs. Ability to fill orders with new products ahead of competitors is the company's key competitive advantage.

Changes in Operational Processes

The introduction of change initiatives into any organisation is never easy and there are always some difficulties that must be overcome. Listed below are a number of the experiences and insights that HPM was able to gain through the assessment of the new product development process.

Quality Assurance. The need for a separate and unique quality assurance process for rapid prototype development was evident from the delays caused by the formalities required by the company's adherence to ISO 9002. While every effort was made to gather all the required approvals and signatures as the product design progressed from research and development through to production engineering, the procedure was far too bureaucratic for "fast tracking" a new product development, and the company lost its agility as it introduced ISO 9002.

Compliance with procedures imposed restrictions, particularly when introducing new technology in days and not as part of a six-month project. "If we find something we do it tomorrow, we don't plan it, we get it in, let's try it," says the GM. Following ISO documentation meant the company couldn't short-circuit the design, the R & D, the production engineering, and manufacture of the product, if they were to gain compliance. A form of short-circuit documentation was trialed to avoid these restrictions, finally resulting in a ". . . controlled short-circuit, quick control mechanism that works within ISO 9002" and is mutually acceptable.

Politics of Change. The need for the company's senior executives and management to support the cultural change necessary to successfully implement rapid product development was certainly one of the key issues. Changing the way of thinking of traditional engineers and designers was a difficult but rewarding process. It was necessary to convince the company engineers and tool designers that an entirely new set of rules and standards for simple rapid tool design was required, where tool longevity and short moulding cycles are no longer acceptable. Prototype tooling design only has a requirement for 1,000–2,000 shots, and if components have to be removed by hand for expediency, then this is perfectly acceptable.

Project Management Resources. The experiment confirmed current experience of a heavy demand on management resources when introducing rapid product development projects. In this particular case study, involving extensive use of subcontractors, the amount of project management resources virtually had to be doubled for the short period of implementation. Without any doubt, one of the most crucial factors in the implementation of successful rapid product development is the allocation of dedicated project management resources.

Skills Acquisition. Before RPD was introduced, the CAD skills of the design group were used to incorporate tool-making skills into the drawing office as tool quality was believed to be the way to ensure a quality product. The company now employs highly skilled industrial design engineers with design and tool-making skills, supported by electronic technology and quality engineers. A wide range of new skills have been added to support RPD, where those long-time middle managers who could not accept the changes or reorient themselves to the new process responsibilities were relocated or retrenched.

Current Use of Rapid Prototyping

The success of this and other projects has reinforced the company's commitment to using rapid prototype techniques in order to improve product development. The company today uses the latest technology in this area, working in 3-D CAD with direct connection to computerised spark erosion and wire-cutting equipment.

The company now almost always produces rapid prototypes for a wide variety of products:

- For metal products, these are created directly from the CAD screen, downloaded, and produced by the wire cutter.
- For plastic products, prototypes are generally produced using the stereolithography process with QMI. Numerous other alternatives are also available depending on the requirements of the prototype.
- Once the product is designed, the company uses the latest technology to produce rapid tooling. In conjunction with IMS (intelligent manufacturing systems), HPM shares technology on an international basis (mainly in R & D) and hence it has access to leading edge developments in this area.

APPENDIX 1
THE PROCESS OF STEREOLITHOGRAPHY

The first stage in the stereolithography process is to convert the CAD data into a format that is readable by the stereolithography machine. The most common method is to transfer the CAD data into a stereolithographic (STL) file that breaks down the CAD model into a series of triangles that can be interpreted by the SL machine.

The information is then downloaded to another computer that controls an ultraviolet laser. The STL file is now sliced into layers as fine as 0.012 mm, so the 3-D image of the model is now represented by thousands of 2-D slices. If the component requires the aid of any supports during the forming process, they are added to the file and will be built along with the part to be removed at a later stage.

The first of these 2-D images is then traced onto a vat of liquid photopolymer resin by an ultraviolet laser. Exposure to the UV light causes the liquid resin to solidify, leaving an image of that particular cross-section of the original CAD model. After solidification, the work area, which is on a table within the vat of resin, lowers slightly, allowing new resin to flow in over the hardened surface. The table then rises to a height that remains one-layer thickness below the surface where a blade wipes across the part to break the surface tension and assure a level surface and even coating. This process is repeated many times until the part is fully built.

When finished, the table raises the part to the surface where it stands allowing any excess resin to drain from the part. Any support structures or excess material are then removed and the part is placed in an oven for a final cure. This is required because the SL process does not cure the part 100 percent, and it also ensures no liquid material remains in the component. The SLA-250 units (from 3-D systems) have a work envelope of 250mm $\times$ 250mm $\times$ 250mm. The larger SLA-500 unit has a work envelope of 500mm $\times$ 500mm $\times$ 600mm (Vasilash, 1995).