National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Technology Level 2

This exemplar supports assessment against:

Achievement Standard 91361

Demonstrate understanding of sociocultural factors, and how competing priorities are managed, in technology

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade boundaries.

New Zealand Qualifications Authority

To support internal assessment

	Grade Boundary: Low Excellence
1.	For Excellence, the student needs to demonstrate comprehensive understanding of sociocultural factors, and how competing priorities are managed, in technology. This involves: • discussing the interactions between sociocultural factors and technological developments in a field of technology • discussing the decisions made to manage competing priorities within a development in a field of technology. The student established relevant socio cultural factors and emphasised the complexity of their interaction in the field of medical equipment technology (1). The socio cultural nature of the need in each case was explained (2). The interaction of social, environmental, economic and cultural factors were discussed for a IV flow controller (3) and baby incubator (4). Competing priorities were identified and explained, and the student discussed how these have been managed during key aspects of the process. Differing needs of the varying groups interacting with the M8 Intensive Care Bed were emphasised (5). Political factors were discussed (6). Differences between the M8 Intensive Care Bed and the other two innovations (the IV flow controller and the baby incubator) are emphasised, with the narrowing of the marketing focus influencing the detail of the decision making (7). The final summary discussed additional socio cultural influences on technological innovation in this field (8). For a more secure Excellence, the student could increase the scope of competing priorities identified as coming from interactions of socio cultural factors. This could make the discussion of the student's management of these priorities richer and more comprehensive.

[1] Medical equipment technology is a field in which 'real world' problems have to be addressed and as such developments are strongly influenced by socio cultural factors. The 'real' world encompasses both developed and developing countries - with massive social, political, environmental, economic and cultural differences between potential user groups.

In the process of technological development – wherever it occurs, and whatever the need or opportunity identified, socio cultural factors will be constantly interacting and the result will be a complexity of competing priorities which have to be addressed and somehow resolved as the development process progresses.

This complexity is illustrated in the consideration of three different examples of medical equipment development:

- The M8 Intensive Care bed
- The Acuset IV Flow Controller
- The 'car parts' incubator

In each case a need or opportunity has been identified, design innovation produced and prototype or end product implementation taken place.

[2] In the case of the IV flow controller and the 'car parts' incubator the innovation was to address pressing third world social issues:

- World wide over four million infants die every year within a month of birth
- In developing countries huge numbers of patients die unnecessarily due to inaccurate administering of medicine and drugs intravenously

The M8 Intensive care bed was designed to complement the changing intensive care environment in modern hospitals.

In all three social, cultural, economic and environmental considerations were critical drivers but the interaction of these factors during the development produced differing sets of competing priorities which had to be managed during the process.

[3] In the case of the IV flow controller economic considerations necessitated a cooperative development process. *Design That Matters* and Medicine *Mondiale*, two not-for-profit organisations with limited 'in-house' technical expertise, collaborated to develop a cheap, reliable device which could be easily used by non trained people to accurately administer life saving medicines and drugs in a non-hospital environment. In the design and development process technical expertise had to be identified and engaged within an environment in which costs had to be kept to a minimum. This was managed by initially working with design teams of professional volunteers and university students participating as part of their coursework. Plans for an initial prototype were developed and the challenge of producing a manufacturing prototype accepted without charge by a socially responsible and experienced industrial designer. He was faced by a range of competing priorities – the device would have to be able to deliver the fluid not only accurately but reliably over a period of time and be able to be used in non sterile conditions by people in communities where the was limited access to medical supplies and expertise. It would also have to be able to be cheaply and efficiently manufactured in bulk to be cost-competitive when matched against the cheap but inaccurate and unreliable roller clamp device extensively used in developing countries. The final product turned out to be a skilful combination of improved functionality and user friendly design. Plastic was selected as the construction material to enable production in bulk. However the type of plastic used not only had to be able to be machined accurately but also had to be strong enough to resist 'creep' – gradual movement away from its set delivery position. The device also had to be designed in a way that inexperienced users would be able to handle easily and operate intuitively and efficiently. With the absolute necessity for accuracy and reliability the manufacturing costs for the final prototype ended up to be greater than the roller clamp it was designed to replace. However as the device was more robust and able to be attached to the outside of the IV line it was re-useable and so this made the product more cost effective to the end users. In a climate of economic restraint the challenge of finding funding for the tooling required for commercial production and distribution to the target developing world market remained. This task was managed by developing further links with a like minded individual within the social entrepreneur network and the identification of additional marketing opportunities for the device. These included targeting rest homes and home swimming pool manufacturers in developed countries globally. The profits made from these sales could be used to subsidise the development of a sustainable distribution model to meet the differing needs of the developing world countries.

[4] The *Design That Matters* organisation has also been closely involved in the development of a range of low cost infant incubators. These are designed to be cheap enough to be able to be more readily available for regular use in remote geographical areas – particularly in developing countries - and in situations of urgent need in times of social and political unrest or where natural disasters have occurred and medical facilities are restricted. Currently about half of the worldwide total, or 1.8 million babies each year, die for lack of a consistent source of heat until they have the body fat and metabolic rate to stay warm. The recommended method of providing infant temperature regulation in resource-constrained settings is placing newborns directly onto the mother's chest. However If the mother either dies in childbirth , or is ill after delivery, or if she has other family obligations required in her economic and cultural setting she is often unable to provide this care. Other adults are not able to take the mothers place in some countries because skin-to-skin contact is considered a culturally inappropriate violation of privacy.

In the design phase the brief was to develop a device that would not only assist at-risk babies with temperature regulation and breathing but which would also allow for air filtration to reduce incidence of cross infection which can often occur in hospital environments. In doing this the design would also have to allow parents and caregivers to have easy access to the baby being treated. So where and how the incubator would be required to operate were critical considerations. It could be required to be used in rural situations where power may be problematic - with frequent variations being the norm in many places, causing damaging voltage spikes. In many places when malfunctions do occur there will be limited access to spare parts or repair expertise and even where this exists there will often be no budget for repairs. To be affordable for the agencies that would be using the incubators the cost was to be kept at around US$200 – about one tenth of the cost of the equivalent product used in hospitals in developed countries.

Because of budget restrictions the need for comprehensive initial research became critical. This would help avoid costly redesign situations occurring. The research carried out by the volunteer development teams proved that ongoing maintenance would the most critical factor – both in terms of spare part supply and availability of expertise to carry out repairs. It was established that even in the most isolated of environments car parts and technical support are usually close at hand. With there being in the order of 40,000 parts in a standard SUV, and with the global automotive industry having efficient distribution channels to deliver those parts to even the most remote communities it was decided to make use of many of these car parts in the incubator design in order to take advantage of economies of scale and have access to spares and skilled expertise.

The final incubator design featured a bassinette which would be detachable from the base and be light enough to allow two people to easily carry the newborn baby up and down stairs and over uneven ground — important features in the context of a rural hospital in a third world country where infants often need to be carried long distances between the delivery room and the newborn intensive care unit.

[5] In the case of the development of the M8 Intensive Care Bed the need focused on the intensive care department of a modern hospital and the particular needs of the critically ill patients and the team of specialist medical professionals responsible for their care. Here the focus was on designing a bed which would allow the wide range of medical procedures needed during critical care to be carried out without having to transfer the patient from the bed. By lowering the handling required by staff the discomfort felt by patients would be significantly reduced. The project reinforced the importance of extensive end user research, human factors and ergonomics in the field of medical equipment technology which have been emphasised in the first two developments.

In this hi-tech and emotionally intense environment seemingly innocuous social factors such as the increasing average age of nurses, and higher patient weights interact with regulatory issues such as more demanding occupational health and safety legislation and institutional priorities including the need to work towards greater workplace productivity. This is the complex environment that the in-house development team had to negotiate their way through as they worked to develop a solution that met the needs of the diverse range of stakeholders in a practical, innovative and intuitive manner.

[6] The development process was heavily shaped by the company's movement towards a design centred approach to product development. This was stimulated by taking part in the government – led *Better-by-Design* project with industrial design innovation complementing the existing strong mechanical engineering skill set in the company.

[7] The project built from a comprehensive initial research phase which successfully engaged the wide range of people that would interact with the bed in a critical care situation. The initial focus was on the needs of the patients – of differing ages, sizes and weights and from differing cultural backgrounds - and staff involved in the critical care process. Anthropomorphic and ergonomic data was gathered and analysed in relation to the specific requirements of each of the specialist tasks carried out. Data was also gathered from other groups such as maintenance staff, cleaners, hospital management and the families and friends of patients. This helped to broaden the understanding of differing needs and address issues of competing priorities. Functional modelling within a specialist facility allowed potential solutions to be tested and evaluated to find creative solutions to meet the user-needs. Safety was an important consideration in all aspects of the design. Features incorporated included additions such as a fifth wheel to allow not only flexible manoeuvring but also rapid breaking if required during movement of the patient. Sustainability of resources was also a major design consideration with material choices such as steel and leather being made to suit not only functionality within the operating environment but to meet changing public attitudes towards reuse and recycling of componentry. The developers had to work within the constraints of existing operating codes and regulatory standards relating to the manufacture and use of medical equipment. Differing global requirements would have to be factored into the decision making process in a way that maximised the export potential of the design without unduly extending the period or costs of development. The end result was the timely delivery of a product well suited for efficient use in critical care facilities in hospitals in a broad international market.

[8] The above three examples highlight in particular the complexity of interactions between economic, social and environmental factors in product development and the implications for innovation in medical equipment technology. In this field product development can be targeted at both narrow niche markets and broad global marketing opportunities. In all cases costs and returns will be carefully calculated before development begins with returns often being measured not only in economic terms but in terms of social, environmental and cultural gains achieved. The examples shown illustrate the influence that the targeted gains can have across all aspects of the technological practice undertaken by the developers.

Political influences in this field can also produce competing priorities. This can be evidenced in the evolving internationalisation of manufacturing standards and codes of practice in this field of development. Innovation is often driven by a need to simplify standard procedures undertaken to provide patient care and so benefit the medical professionals involved. Here a development focus on the needs of the user may produce competing priorities in terms of the protection of the rights of the patients. Legal protections and ethical codes of practice introduce the possibility of litigation and significant financial penalties for practice which is shown to be expedient rather than ethically and legally acceptable. This issue is illustrated by the focus on patient safety and quality of care in each of the above examples. Governments can also influence the direction of innovation in products such as the low cost incubator and the IV flow controller designed for use in developing world countries. Here the availability or non availability of subsidies, aid money and a reliable distribution infrastructure can have both positive and negative influences on decisions on whether a desired innovation is undertaken and how that development proceeds.

	Grade Boundary: High Merit
2.	For Merit, the student needs demonstrate in-depth understanding of sociocultural factors, and how competing priorities are managed, in technology. This involves: • explaining the interactions between sociocultural factors and technological developments in a field of technology • explaining the relationships between competing priorities and aspects of technological practice in a field of technology • explaining how competing priorities were managed within a development in a field of technology. The student explained interactions between socio cultural factors including economic, environmental, political, cultural factors and technological developments in the field of medical equipment technology (1). This includes explaining the effect of cost, codes of practice, equipment standards, import restrictions, low cost infant incubators, and comparing the use of the critical care bed and the Acuset IV flow controller. The relationship between some competing priorities and aspects of technological practice were explained (2). This included the identification of need, design process, operating environment and manufacturing considerations. How competing priorities were managed within the development of the IV infusion controller was explained (3). This included balancing the need for acquiring technical expertise within a limited budget and ethical responsibilities. To reach Excellence, the student could extend the breadth of the management of competing priorities across more than one innovation, so that a discussion is presented.

[1] Medical equipment technology is a field in which innovation is most often impacted on significantly by socio cultural factors. These include things like economic, social, environmental, political, cultural and even spiritual influences.

Economics is the driving force in many new developments. The cost of medical equipment is closely tied to the way it is used and often limits who can benefit from its use. Some equipment is prohibitively costly and so has a very small niche market. If production costs can be reduced, without affecting the performance of the equipment, prices can be reduced and the market potential for the product significantly increased. With some equipment, like heart rate monitors, use of new electronics technology has allowed costs to be reduced to a low enough point for the device to be able to be bought for individual everyday use.

Where the medical equipment is going to be used and who is going to operate the device is also critical in the way products are developed. Equipment like the critical care bed is only designed for hospital use by trained staff whereas the Acuset IV flow controller was designed to be used by non-trained people in any environment.

Political decisions can also influence the way equipment is developed. Codes of practice and equipment standards are introduced by governments as a protection for consumers. This can impose limitations which will put some companies off investing in new equipment research and development. Governments can also impose import restrictions and duties which penalise potential importers of equipment. This can make new product development less attractive and restrict improvements in technology.

Social issues will also impact significantly on developments in medical equipment technology. Low cost infant incubators are now more readily available in developing countries to try to lower the unacceptably high death rate of newly born babies.

In an international market place cultural differences will invariably impact on the way a medical product is viewed and used. If a product is to be effectively used in the way that is intended then cultural influences need to be clearly identified and addressed in the development process.

[2] In medical equipment technology as in all technological development there will be competing priorities which can come into play in all aspects of the development work.

This competition often surfaces at the point of fixing on the specific need or opportunity to be addressed. The driving force for the initial development may be a social one such as addressing the problem of over four million infant deaths annually within a month of birth, but if this is being addressed by a large commercial organisation then the interests of the shareholders will be a significant consideration with the project usually having to not only cover costs but end up making money for the company. This can stall some potential developments right at the beginning but even if they go ahead then competing priorities will force decisions to be made throughout the development process.

The drive for new development like the critical care bed may be the need to improve the performance of a particular device where the views of a range of stakeholders may have to be taken into consideration and the improvements required may be seen differently. In the case of a product to be used in a hospital situation the patients, doctors, nursing staff and relatives will all agree on the overall purpose of using the equipment – improved patient care in a way that makes things easier for everyone else, however their prioritising of desired attributes in the new product may well be different.

In the design process both form and function will be important - however their eventual weighting will have to be determined in the specifications developed. The equipment has to be able to do what it is intended to do but ideally this has to be able to be done in the most user friendly way. In the case of the infant incubator the equipment had to be able to effectively address the immediate needs of at risk babies and also to reduce the risk of cross infection but equally importantly be able to allow easy access to the babies by both staff and caregivers. The M8 Intensive care bed was developed to allow the wide range of medical procedures needed during critical care to be carried out without having to transfer the patient from the bed. By lowering the handling required by staff the discomfort felt by patients would be significantly reduced. In developing a solution that met the needs of the diverse range of stakeholders in a practical, innovative and intuitive manner, social factors such as the increasing average age of nurses, and higher patient weights interacted with regulatory issues such as more demanding occupational health and safety legislation and institutional priorities including the need to work towards greater workplace productivity.

The selection of resources to be used can also raise issues. Material choices will most often be made to match material properties and costs to the desired performance requirements of the equipment being developed. In the hospital environment this choice often hinges on sterility and durability issues. However when the equipment is designed to be used in more remote requirement the ability to be easily transported, assembled and serviced may be equally important. In this environment lifecycle issues may also be a strong consideration with the ability of parts or all of the equipment to be reused or recycled a desirable attribute.

How the product is ultimately manufactured may also be influenced by competing priorities. Some products such as artificial limbs may require significant individual customisation whereas devices such as the Acuset IV flow controller has the potential to be manufactured cheaply in bulk. Where bulk manufacturing is selected issues around selection of the manufacturing site, efficient use of resources, material sustainability and ensuring the health and safety of workers will require efficient management and inevitably involve resolving competing economic, social and environmental priorities.

[3] The need for the development of the Acuset Intravenous (IV) Flow Controller was established from observing that in developing countries medicines were still being administered intravenously (IV) using nineteenth century medical technology. Because present day drugs are delivered in a more concentrated form the need for accuracy is even more vital now. In a hospital situation in developed countries this medical procedure is most often carried out using microprocessor controlled syringe pumps by trained medical staff. In under developed counties this procedure often has to be carried out in the field by non-trained staff or by the patients themselves or close family members using roller clamp devices. Although these roller clamps are cheap to manufacture they can be inaccurate and difficult to control with the result that many patients end up not surviving when they should have.

The Acuset IV infusion controller is a device developed to administer medicines and rehydration fluids safely and accurately to patients in developing countries. Over two million IV drip sets are used every year in the developing world alone so the total cost of administering this procedure world-wide is significant. The not-for-profit organisation *Design that Matters* saw the need to develop a cheap, reliable device which could be easily used by non trained people and their initial design was picked up for further development by the not-for-profit *Medicine Mondiale* organisation

Ray Avery, principal of *Medicine Mondiale*, had the immediate problem of identifying and engaging the technical expertise which would be required to develop the initial design while keeping the costs within the limited budget available. In accordance with his organisational ethos he would also have to manage and finance the manufacturing and distribution processes both ethically and responsibly.

During development work industrial designer Murray Fenton had the task of matching the existing relatively inexpensive but inaccurate and difficult to operate in-line roller clamp system against the new design which would have to be more accurate and reliable but may ultimately turn out to be more expensive to produce.

In tackling this issue Murray focused on the duel demand of enhancing the functionality of the device while also addressing the need for a design that would be 'attractive' to an inexperienced user often working in an uncomfortable setting – fitting neatly into the hand and being intuitive to use. A design would also be required that would meet the need for the product to be manufactured cheaply and efficiently. These competing priorities were resolved through adapting the initial design to ensure that the final device would be not only accurate and reliable but could also be reusable. This multi-use capability would produce cost benefits that could be easily justified to potential funding partners and target user groups.

The prototype manufactured for field testing overseas had to be simple to use but robust enough to deliver the fluids accurately over the period it operates for. This was initially managed through careful selection of materials. Because of the need to manufacture in bulk the construction material had to be relatively inexpensive, so plastic was the obvious choice. However the plastic chosen would have to be able to be machined accurately and also be strong enough to resist any movement from the pre-set flow rate while in use. In selecting the material Murray made good use of his prior experience but admitted that in coming up with their final solution they 'stepped out on a limb'.

With a workable prototype now developed, additional funding had to be found to make the dies required for commercial manufacture, and for developing an economically sound distribution model for the final product. Ray was helped in the task of finding the required funding by his identification of both a like minded financial partner and an unforeseen alternative market for the device. Although originally designed as a life saving piece of equipment for use in developing countries it was recognised that it could also provide a relatively inexpensive but easy to use and accurate way of adding chemicals to home swimming pools in more developed countries. With this dual marketing strategy *Medicine Mondiale* would have an income stream from first world sales which would allow them to tailor a sustainable distribution model to meet the needs of the developing world countries.

	Grade Boundary: Low Merit
3.	For Merit, the student needs to demonstrate in-depth understanding of sociocultural factors, and how competing priorities are managed, in technology. This involves: • explaining the interactions between sociocultural factors and technological developments in a field of technology • explaining the relationships between competing priorities and aspects of technological practice in a field of technology • explaining how competing priorities were managed within a development in a field of technology. Interactions between economic, environmental, political, social and cultural factors influencing the design and use of school furniture were explained (1). This included explaining what was happening in education in the first part of the 20th Century, the social changes that occurred after the Second World War, and the socio-cultural changes of the later 1980's. Some relationships between competing priorities and aspects of technological practice in school furniture design and manufacture were described. This description included innovation, design, material selection and manufacturing requirements (2). Competing priorities within stakeholder groups for a furniture company were described (3). The student identified and explained how competing priorities were managed within the development of a range of classroom furniture (4). For a more secure Merit, the student would need to add more detail so that the explanations were strengthened.

[1] The field of school furniture in NZ has been traditionally characterised by stability and slow change in design and manufacturing methods.

Over the first half of the 20th century school roles increased steadily and the demand for furniture increased but the way schools operated and the learning environment itself changed little. The school desks and chairs in use in 1980s were still very similar in design to those used in the years leading up to World War II – uniformly sized, in-desk storage, cheap to make, durable and designed to be easily stacked . Function definitely ruled over form.

The steady increase in school roles meant Government investment in new schools but the designs of these schools were standardised and controlled by the Department of Education. Classrooms were of uniform size with a given amount of space allocated per pupil. Furniture was ordered centrally and the result was uniformity across the country. The classroom culture had a similar uniformity with a common curriculum and a common approach to learning – students sat at their own desks, movement was kept to a minimum and teachers taught from the front and moved around only as they saw the need.

Economic changes after the Second World War caused considerable social change, with population increases leading to a manufacturing boom. Many manufacturing industries were protected by import tariffs' and in the field of school furniture supply costs were kept down by efficiencies in material supply and improvements in manufacturing techniques.

By the late 1980's significant socio-cultural change was occurring in education. Immigration and a trend for movement to cities was changing the ethnic and social balance in schools. The Governments 'Tomorrow's Schools' initiative started to hand more control over to the individual schools and opportunities for differences in approaches to the structuring of the learning environment and how it was managed opened up.

[2] The traditional design of school furniture meant that it could usually be manufactured locally, often using locally sourced wood. The robust design ensured the durability of desks and chairs which had high usage and the need for regular replacement was not a common problem. With the increase in school roles demand for furniture increased and specialist manufacturers started to dominate the market. To be competitive costs had to be kept down so any design changes had to be balanced against the cost implications. Ongoing changes in curriculum had more influence on the design of furniture for specialist facilities such as science laboratories, art and textile rooms and workshops than on the general classroom environment.

Changes which did occur in general classrooms such as the introduction of tubular metal frames had to produce significant improvement – in this case the need to stack the desks and chairs was made considerably easier. The cost of investment in new cutting and bending machinery was offset by the use of new labour saving assembly techniques Material costs were controlled by carefully matching factors such as the gauge of the tubular metal to the strength required of the desks and chairs.

[3] The recent development of the Bodyfurn range of classroom furniture by the New Zealand company Furnware has been a significant influence in the school furniture market.

As an established school furniture manufacturer the company recognised that if they were to protect and hopefully increase their market share then the costs associated with innovation could potentially price them out of the market. They had recognised that existing school furniture did not cater well for the needs of a 21st century classroom but had to prove that the need for change existed and that the additional cost to schools of addressing this need was justified.

This process was managed by identifying the range of stakeholder groups involved and involving them in the innovation process.

Recent tertiary research had shown that existing furniture didn't properly meet the needs of different sized students. The Company then carried out a significant data gathering exercise to find out the size spread of students in schools across the country.

At the same time they worked with school based focus groups – Boards of Trustees, management, teachers, caretakers and students to find out what frustrated them about existing products and what they wanted from any new designs. Competing priorities within the groups quickly became clear: students wanted more movement but teachers wanted to keep their working positions in class fixed; students wanted lots of different sizes of desks and chairs to be available but caretakers wanted then to be easy to stack, clean and maintain; and school managers wanted to keep the costs low enough that they would be able to afford the new designs. Boards of Trustees wanted to be confident that the end result of the process would significantly benefit the learning of their students.

[4] The end result was a new range of desks and chairs - the Apha desk provided a larger working surface for the students and when used with the new Dynamic chair the amount of total space taken up by the desk chair combination was reduced and movement around the classroom improved. The desks were produced in a range of sizes to suit the different ages and ethnic groupings present in today's classrooms. Specific design features were introduced to meet the identified needs of the differing stakeholders. These included using screws which would be more student-proof, ensuring that the plastic surfaces could be easily cleaned and rounding the corners of desks to minimise the effect of contact with the desk while moving around.

To provide the capability for at-desk storage which some schools wanted a new side the Bodyfurn range was extended to incorporate a storage unit to complement the desk and chair system.

The end result was a system which was undoubtedly more functional and fit for purpose but which would come at a significantly greater cost to the user. To address this issue the company made changes in many aspects of production. This included stock control, use of robot welders and computer controlled assembly techniques, outsourcing of components and standardising componentry across different product ranges.

Another management strategy was to work towards environmental Choice registration which ensures the suitability of the equipment for use in 'green' building design. The certification not only provides a competitive advantage in the market place but ensures a healthy working environment for employees.

	Grade Boundary: High Achieved
4.	For Achieved, the student needs to demonstrate understanding of sociocultural factors, and how competing priorities are managed, in technology. This involves: • describing the interactions between sociocultural factors and technological developments in a field of technology • describing the relationships between competing priorities and aspects of technological practice in a field of technology • describing the competing priorities that were managed within a development in a field of technology. Competing priorities due to sociocultural interactions and their relationships to aspects of technological practice within the classroom furniture industry were identified and described (1). This included describing how a furniture company undertook research to make design decisions in consideration of cost, user comfort, maintenance and life expectancy. Competing priorities that were managed within the Bodyfurn development were described (2). A range of desks and chairs matched to student size and with the required strength, stability and maintenance features were developed. Storage problems were overcome. Changes were made to the manufacturing process to accommodate school budgets. To reach Merit, the student would need to explain interactions between socio-cultural factors, and the influence of competing priorities and how they were managed within the classroom furniture development process.

[1] In New Zealand, schools are the central focal point of many communities both in cities and in small rural towns. Although these schools have to address the needs of different communities in terms of the social and cultural mixes, until recently they have often been very similar in building design – and if you looked inside the classrooms the layout and the furniture used would be very similar as well. This is because at the time the schools were built the Government had the major say both in the design that would be used and the type of furniture which would go in the classrooms.

There has been a steady rise in the number of new schools being built due to the size of population growing through increases in birth rates and immigration. There has also been a movement of people from country towns into the cities. Although these changes have meant that the demand for school furniture has increased until fairly recently the design of the furniture has changed very little. This has been because the design was seen to meet the needs of the schools very well. The desks and chairs were easy and cheap to manufacture, lasted a long time and were easy to move around and able to be stacked up and stored when they needed to be.

Although the furniture met the needs of the school very well, it wasn't designed to meet the needs of the different sizes of students who had to sit on the same size of chair at desks which were the same height for a long period of time and concentrate on schoolwork. Learning wasn't a comfortable experience and this caused behaviour problems in many classes.

Some changes did occur in the design to improve things in the classroom - for example the tilting desk lids on the box-desks were replaced by a shelf under the desk. This made it easier for students because you didn't have to clear the desk to get something out of the storage part and also easier for teachers because there was less noise made in getting stuff in and out of the desk.

When the government gave schools more control over the design of buildings they also got more freedom in the choice of furniture they could use and this encouraged more competition among furniture manufacturers. So there was more incentive for them to change the design of the furniture to make them more attractive to the schools to buy.

Furnware, a Hastings based school furniture manufacturer, decided that to increase its sales it would have to try to produce a range of furniture that was better for the students . But the new furniture could not be too expensive and would still have to be easy to maintain and last a reasonable length of time.

Furnware decided to invest money to find out how classroom furniture was being designed and used in other parts of the world and also looked at research findings that clearly showed that the mismatch between the classroom furniture currently in use in schools and the differing body sizes of students was affecting the way students learn and also causing physical problems later in life.

They decided that they would have to go inside schools and get alongside not only the teachers and students that used the furniture every day but also the people responsible for maintaining the furniture and cleaning the classrooms and the people who were responsible for buying the furniture. Focus groups involving all of these people were set up and the differing and often competing needs of each group identified, for example students wanted lots of different sizes of desks and chairs to fit their differing heights and weights but the school caretakers wanted them to be easy to clean, stack and maintain and the school principals wanted to keep the costs low enough to be able to afford the new designs.

Furnware then moved into a design phase in which they would try to meet all these differing needs.

[2] The outcome of the development work was the Bodyfurn classroom furniture system providing a range of desks and chairs matched to student size using a six tiered height banding system. The chairs are designed to allow students to lean backwards and forwards and to shift the way they sit in the chair on a regular basis. This allows them to be more settled at the desk and free to concentrate on class work for longer periods. These improvements in student comfort did not come at the expense of any of the traditional features required of them – they still had the required strength and stability and met the caretakers need to be easily cleaned and repaired.

One design problem initially raised by teachers was the lack of storage space at the desk. So a lot of experimentation with alternative systems was carried out however further design changes to the desk enabled a clip on side storage unit to be developed which seems to have solved the problem to everyone's satisfaction.

To make sure the cost of the finished products still fitted in with the available school budgets changes were made to the manufacturing process to ensure that efficiencies could be produced. These included the use of robot welders to speed up the manufacture of the metal frames and reduce the labour requirements. The company also gained Environmental Choice certification which enabled it to be able to bid more competitively for supplying furnishings to the increasing number of new schools looking to attain 'green building' classification.

	Grade Boundary: Low Achieved
5.	For Achieved, the student needs to demonstrate understanding of sociocultural factors, and how competing priorities are managed, in technology. This involves: • describing the interactions between sociocultural factors and technological developments in a field of technology • describing the relationships between competing priorities and aspects of technological practice in a field of technology • describing the competing priorities that were managed within a development in a field of technology. The student described interactions between economic, environmental, political and social factors within the field of medical equipment technology (1). This included describing the effects of lower manufacturing costs and considering the end user. The relationship between competing priorities and aspects of technological practice in aspects of medical equipment technology including identification of need, design, material selection, manufacturing requirements were described (2). Competing priorities that were managed within the development of the IV infusion flow controller were described (3). This included balancing the need for input from technical expertise with the cost of such input, and selecting materials for manufacturing that fitted with the budget. For a more secure Achieved, the number of interactions identified between socio-cultural factors and technological developments should be increased. This would better enable the competing priorities involved to be described. Identifying more than one innovation would provide greater opportunity to extend the detail encompassed in the range of management strategies described.

[1] The field of medical equipment technology is one where ongoing innovation is often closely related to socio-cultural factors acting at the particular time.

Economics will be an important factor in most developments with many pieces of new equipment developed in a way that allows them to be sold at a lower cost than standard equipment already in use and so bringing the cost of treatment down to a more affordable level and extending the potential market for the new equipment.

Another factor in developments in this field is where the equipment is going to be used and who is going to use it. The development of equipment which is designed to be used by trained medical professionals in a modern hospital will be different to things which are designed to be used by non-trained people in less patient-friendly places.

Social issues will also impact significantly on developments in medical equipment technology. Low cost infant incubators are now more readily available in developing countries to try to lower the unacceptably high death rate of newly born babies.

In an international market place cultural differences will invariably impact on the way a medical product is viewed and used. If a product is to be effectively used in the way that is intended then cultural influences need to be clearly identified and addressed in the development process.

[2] Developments in medical equipment will start from a specific need or opportunity. This need may be to lower the cost to the purchaser to increase usage and so increase profits . It could also be to produce new equipment to work better than equipment that is already available or to be easier for the user to operate. Sometimes making something work better will increase the cost and this may affect potential sales.

In designing the equipment both form and function are important. The equipment has obviously got to be able to do what it is intended to do but sometimes this can affect the 'look' of the device and put potential users off. Where it is to be used and whether it will be used by trained medical professionals can also influence design decisions that have to be made.

Material choices will most often be made to match the properties of materials and their costs to the desired performance requirements of the equipment being developed. In the hospital environment this choice often hinges on sterility and durability issues. However when the equipment is designed to be used in more remote requirement the ability to be easily transported, assembled and serviced may be equally important.

How the product is actually manufactured could also be influenced by competing priorities such as the need to manufacture cheaply in bulk, but also to do this in a way that takes into account the needs of the people involved in the manufacturing process

[3] The Acuset IV infusion flow controller was developed to administer medicines and rehydration fluids safely and accurately to patients in developing countries. In a hospital situation this medical procedure is most often carried out using microprocessor controlled syringe pumps by trained medical staff. In under developed counties this procedure often has to be carried out in the field by non-trained staff or by the patients themselves or close family members using roller clamp devices. Although these roller clamps are cheap to manufacture they can be inaccurate and difficult to control with the result that many patients end up not surviving when they should have.

Medicine Mondiale picked up initial designs for a device developed by a partner not-for-profit organisation and had the immediate problem of identifying and engaging the technical expertise which would be required to develop these initial design ideas within the limited budget available.

Using existing social entrepreneur networks a like minded industrial designer was engaged without cost. The designer focused on the duel demand of ensuring both the functionality of the device and the need for a design that could be effectively operated by an inexperience user working in the field.

The final device would have to be not only accurate and reliable but also inexpensive and so affordable in developing countries. This was achieved by a final design which would be re-usable rather than disposable.

This involved careful selection of materials. Because of the need to manufacture in bulk the construction material had to be relatively inexpensive, so plastic was the obvious choice. However the plastic chosen would have to be able to be machined accurately and also be strong enough to resist any movement from the pre-set flow rate while in use.

With a workable prototype now developed additional funding had to be found to make the equipment needed for commercial manufacture. The task of finding additional funding was helped by identifying both a like minded funding partner and a totally different market for the device.

	Grade Boundary: High Not Achieved
6.	For Achieved, the student needs to demonstrate understanding of sociocultural factors, and how competing priorities are managed, in technology. This involves: • describing the interactions between sociocultural factors and technological developments in a field of technology • describing the relationships between competing priorities and aspects of technological practice in a field of technology • describing the competing priorities that were managed within a development in a field of technology. The student described some social and cultural influences on the design and use of school classroom furniture (1). This included consideration of the physical size of the users. Some competing priorities have been identified in terms of economics and functionality. The student described how these were managed within the design and manufacture of an industry's classroom furniture range (2). To reach Achieved, the student would need to describe a greater number of interactions between a broader range of socio cultural factors in the field of classroom furniture technology. More consideration should be given to specifying competing priorities which had to be addressed in the development work.

[1] The design and manufacture of the furniture used in New Zealand schools has traditionally been targeted at meeting the needs of the school rather than the needs of the students who use the furniture for most of the day. As schools have got bigger and rolls increased the major factors which have driven design changes have been keeping costs down and making sure that the furniture was strong enough to stand up to the daily wear, had surfaces that could be easily cleaned and were able to be repaired by the caretakers when damaged and could be stacked easily by students when they needed to be.

Over the last 100 years the physical size of students has changed but these changes have not been taken into account in the design of desks and chairs which up until recently looked much the same as they did for much of the last 100 years.

But recently things have been changing. Students are not only physically bigger than they used to be but there is a greater mixture of cultures in the classroom . This is now encouraging principals to try to make sure that the size of the desks and chairs has a better match to the size of the students in the school.

[2] One company working in the field of classroom furniture design that has tried to adapt to the range of body sizes in the schools is Furnware which has its factory in Hastings. This company has made a lot of different wood and metal products since it originally started but has been making desks for New Zealand primary and secondary schools for a number of years now. Up until recently the company focus has been more on how the chairs have been made rather than how well they suited the people working in the desks.

Their new Bodyfurn classroom furniture range of desks and chairs is very much different from the furniture it has been designed to replace. It is still hard wearing and easy to maintain, but has also been designed to be able to more closely fit the needs of the students working in the classrooms.

One problem that students have is that they get restless and then they rock backwards and forwards on their chairs. This still makes for a noisy classroom with 30 students all rocking backwards and forwards and there's always the odd one that rocks too far back and falls over . So the company decided to make the chairs out of a plastic that could bend more and pivot a bit which is much safer and quieter.

The desks were changed so that they came in more than one size and this meant that students wouldn't knock things like books and pens off the top as easily. The surface of the desk was also made of a special plastic that can be cleaned more easily and they supply a special liquid that can be kept in the classroom and used to wash off marks when they are made.

One problem that the company had with their old desks and chairs was students unscrewing the screws used to fix the wood and plastic to the metal frames. They solved this problem by using a specially designed screw that can only be unscrewed using a special tool which only the caretakers usually have access to.

The chairs are designed so that the metal legs have protective plastic on them to stop the floors from scratching if the chairs slide across. And a new side storage unit has been developed so that the students' books don't have to be stored underneath the desks or in tote trays with those of the other students.

Although the new designs have meant that the furniture is more expensive than the old desks and chairs schools are still buying the new furniture. This is mainly because of the improved design suiting the students better and looks good in the classroom. The way the factory has been set up means that furniture is manufactured efficiently and to a high standard and everything they supply to schools will last an acceptable number of years before it needs to be replaced again.