“QUEST Sensors”

Food Packaging Sensors

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Executive Summary

QUEST Sensors (Australia) Pty. Ltd. is a start up company seeking to enter the food sensor market in Australia.

QUEST Sensors (Australia) Pty. Ltd is an innovative MicroElectroMechanical Systems (MEMS) company that will design, develop and market highly integrated, performance driven, affordable wireless, food-based sensors that will monitor food in real-time, while in transit. The sensors will combine MEMS technology with passive Radio Frequency (RF) technology to create a remote quality sensor with benefits that are way ahead of its competitors.

These sensors will outperform the remote sensors used in the Australian market, which use either colour indicators or serial downloading. Neither of these types of sensors offers the ability for remote real-time monitoring. QUEST Sensors will provide the ability to remotely view real-time information about food quality in a secure system, regardless of where the food is in the world.

The first two years of operation will be dedicated to designing and developing temperature sensor, base and satellite units to the production stage. Initial sales of the sensor and base unit will begin in the third year of operations. Design and development of a further three sensors will follow the temperature sensor.

Five research engineers at the Industrial Research Institute Swinburne (IRIS) formed QUEST Sensors in 2002. They bring with them to the management team experience in the food manufacturing industry, MEMS technology, RF technology, employee supervision, sales and operations management.

The initial funds required to start the business is $1.2 Million with a projected return of $22 million dollars in 5 years. The founders will raise $500,000 and $700,000 will be required from Angel Investors. A further $1 million dollars is required from Venture Capitalists midway through the second year of operations. This is to assist with pre-production testing and to bring the product to market.

The internal rate of return over 5 years is calculated to be 161%.

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1 Company Overview

1.1 Company Objectives

The principal objectives of QUEST Sensors (Australia) Pty. Ltd. is to become the market leaders in Australia in food sensor technology by:

- designing and developing food grade sensors for the food and food transport industry which combine MircoElectricalMechanical Systems (MEMS) and Radio Frequency (RF) Technology.
- commence production and introduce the temperature sensor and readers into the market within 24 months of company start-up
- achieve $10 million in sales by the end of the fifth year
- raise $700 thousand from Angel investors for the first year of operation and $1million from Venture Capitalists in February 2005 (Quarter 5 year two)

1.2 Corporate goal

QUEST Sensors (Australia) Pty. Ltd is an innovative MicroElectroMechanical Systems (MEMS) company that designs, develops and markets highly integrated, performance driven, affordable, wireless sensors. These sensors will monitor food conditions at all points of the supply chain in real time in real-time, including in secure containers.

1.3 Description of company activities

The principle activities of QUEST Sensors (Australia) Pty. Ltd include:

- research and development of a MEMS based temperature sensor within 24 months, incorporating passive RF capabilities and internal non-volatile memory
- continual development and release of new sensors, including humidity and oxygen sensors
- research and development of base units by 12 months, including a larger transport unit and a smaller portable unit
- develop statistical analysis software that will interrogate collected data for indications of non-uniform food storage conditions, using an alarm to notify personnel
- develop real-time monitoring capabilities via a centralised location that can be accessed at the QUEST Sensors website or the customers website

- nurture customer base by distributing an educational newsletter to customers and interested parties

- attend relevant trade shows for maximum exposure

1.4 Company Summary

QUEST Sensors (Australia) Pty. Ltd. will research, develop and market unique and patented sensor technology and support technology that will allow food distributors and manufacturers to proactively monitor food in transit in real-time. It is an Australian company founded by a team of research engineers from Industrial Research Institute Swinburne (IRIS) in 2002 with expertise ranging from MEMS packaging to telecommunications and food manufacturing.

2 Products

2.1 Product Description

The following is a general description of the products and services that QUEST Sensors (Australia) Pty. Ltd. will provide over the next 5 years.

Passive RF Sensors They will consist of temperature, humidity and oxygen-content sensors that are powered by RF radio transmissions. These unique and patented sensors will log the sensor readings each time the presence of specific RF frequency is detected. The sensors will time stamp the data as well as transmit the results to an external reader on command.

Base Unit Reader These units dictate when a sensor takes a reading, by periodically transmitting specific radio frequencies. They collect data with the ability to monitor up to 500 sensors, sending an alarm to appropriate personnel when specific events occur. Remote real-time capabilities can be added to provide updated quality control facilities.

Portable Unit Reader These units will perform the same function as the base reader units however they will have the added ability of being portable. Batteries with a life of approximately 10 years will power them.

Satellite Unit The satellite unit is used to boost the signal from the sensor so that it can be sent over a longer distance. The range between sensor and base unit is approximately 10

meters. The satellite unit boosts this to approximately 500 meters. This will allow large areas like ship cargo holds to be monitored easily. These will be powered by batteries, which last for up to 10 years.

Customer Website Exporters and importers can access a secure website, which provides real-time information on cargo in transit. This allows the customer to view current and historical data about their cargo and receive an e-mail, which alerts them if specific events occur. This facility would be available to all shipping options, including land, sea and airfreight.

Table 2.1 describes each of the products, including their commercial name; key function and whether the sensors used are enclosed (internal) or exposed to the environment (external).

Product Name	Product Description	Sensor Type
T2000	Temperature Sensor	Internal
H2000	Humidity Sensor	Internal
O2000	Oxygen Sensor	External
BR2000	Base Unit Reader	NA
PR2000	Portable Unit Reader	NA
SU2000	Satellite Unit	NA

Table 2.1 Product Names and Descriptions

2.2 Pricing

Table 2.2 shows the manufacture and distribution costs, the sales price and the profit margin of each product. The manufacture cost includes assembly and packaging.

Product Description	Manufacture Cost	Distribution Cost	Sales Price	Profit Margin
Internal Sensors	$1.00	$0.04	$12.50	$11.46
External Sensors	$1.50	$0.04	$16.00	$14.46
Base Unit Reader	$25.00	$5.00	$230.00	$200.00
Portable Unit Reader	$30.00	$5.00	$230.00	$195.00
Satellite Unit	$25.00	$2.00	$150.00	$120.00
Software	$2.00	$0.00	$75.00	$73.00

Table 2.2 Product Pricing

The main competitor in the Australian fruit and vegetable market is Cox Technologies. The cost of a reusable Cox sensor ranges between $135 - $2000,

depending on functionality. The costs of their disposable sensors range from $33 to $40. It is clear from the table above that QUEST Sensors has a distinct price advantage over Cox Technologies. This allows customers to purchase more sensors to fully satisfy their quality requirements.

2.3 Technology

The QUEST Sensor system uses innovative MicroElectroMechanical System (MEMS) technology to create leading edge passive RF monitoring sensors. This allows for previously unattainable miniaturisation of temperature sensing technology that is both inexpensive and easy to use. All sensors will be packaged in plastic materials which comply with Australian Standard AS2070-1999 "Plastic materials for food contact use". They will also comply with all FDA regulations. The radio transmitters operate on 433.92MHz licence free band and are fully approved for use in Australia and many other countries. The radio frequency system is interference-free from other equipment including mobile phones.

Figure 2.3 demonstrates the various components that would be required in the sensors developed by QUEST, consisting of the passive RF circuitry, Telemetry IC and the sensor. The key component of this technology is the RF circuitry, which allows these sensors to be passive, rather than active. An RF signal is received from the base unit, which transmits a special ID number as well as a time stamp. The RF signal is converted to energy that activates the Telemetry IC, which then checks if the ID number matches the ID of the chip. When this occurs the Telemetry IC reads the time stamp, activates the sensor and records data onto non-volatile memory with the time stamp. Data is then retransmitted back to the base unit and on to a PC with QUEST Sensor software.

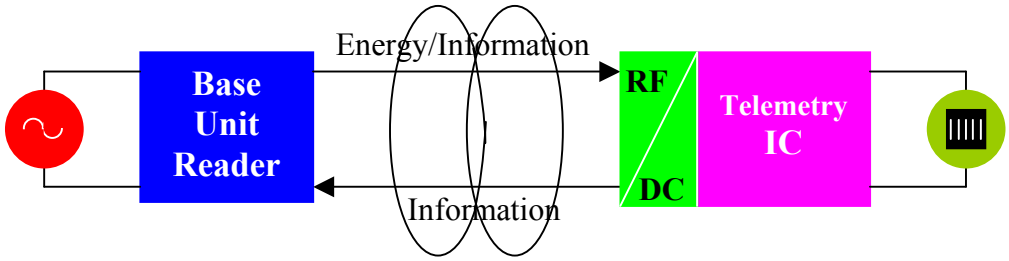


Figure 2.3 Block Diagram of QUEST Sensor

To enable the external reader and sensor to interact in this manner a propriety based communication protocol would be developed according to IEEE 1451. This is a new protocol that was developed to provide a useful framework for these types of applications.

2.4 Benefits

QUEST Sensor (Australia) Pty. Ltd. sensors have the following benefits

- the sensors are able to operate reliably and accurately in harsh condition (i.e., temperature ranges of –25 to 125 C and humidity from 0 to 100%)

- the product would be packaged in polymers graded as suitable for food and pharmaceutical products. (AS2027 – 1999)

- polymer-based MEMS technology is cheaper to manufacture, smaller and more flexible. It is suitable to place under or on labels.

- develop real-time monitoring capabilities via a centralised location that can be accessed at the QUEST Sensors (Australia) Pty. Ltd. website or the customers website

- sensors are strategically placed as reusable at a price cheaper than the main competitor

- products enable transport firms to provide real-time monitoring of their own distribution networks

2.5 Current Status and Position

The process in which the products would be developed is a four-stage process, consisting of discrete system design, MEMS translation, prototyping and pre-production. The discrete system design is where the sensor modules would be developed from discrete components and tested for performance and reliability. This is followed by the MEMS translation stage, where the discrete design is changed to MEMS components and tested using simulation software. Once a design is decided upon, various iterations of prototypes will be developed till approximately 100 working prototypes are produced. Finally once the sensor designs are verified, production methods will be prepared and the sensors will go into production. Currently QUEST Sensors (Australia) Pty. Ltd. are in the discrete system design phase.

2.6 Product Protection

Provisional Patents of each sensor will be applied for with the help of a patent attorney once each sensor has been developed, prior to the prototyping stage. Therefore at the end of 5 years QUEST Sensors (Australia) Pty. Ltd. will own patents on the five sensors developed incorporating the data communication protocol.

3 Market and Marketing Strategy

3.1 The problem

Australia: the lucky country, an island with rich and fruitful bounty. Why not benefit by selling this produce to our pacific neighbours? We do; or we try anyway, but the equatorial voyage takes its tole, leaving over a quarter of Australia's fruit and vegetable produce to waste. That's potentially about $200 million lost on apples, pears and stone fruit alone.

Producers and transporters would applaud any development that could prevent this 'sensless' loss. Current sensor technology is expensive, cumbersome and not ideally suited to food monitoring requirements. Typically, only 2 *cox* sensors are fitted every 20 pallets, providing hardly any indication of food conditions. Although some competitors are now emerging, there is strong demand for sensors that are cheap, reliable and robust, have low power requirements. The ability to monitor secure containers in real-time without breaching the seal would also benefit many customers.

3.2 Describe market

3.2.1 Summary

Our product incorporates MEMS technology with radio frequency (RF) technology. The function of our product is to serve the food industry; however, our most likely customers are in the packaging industry. Therefore, these four areas have been investigated and key findings are presented in sections 3.2.2 – 3.2.5.

MEMS is currently experiencing a massive growth of 20 – 30 % every year; RF and emerging MEMS applications expanding even faster. The packaging industry is the third largest industry in the world and is considered recession-proof. Food exports from Australia are growing and technology is required to improve the control of food conditions in transit.

3.2.2 MEMS and RF market potential

"MEMS is destined to become a hallmark 21st century manufacturing technology."

"The U.S. MEMS industry is experiencing phenomenal growth, change and success…MEMS will soon contribute to every aspect of our daily life. From palm-sized high-definition projection displays to grain-of-rice sized implantable medical devices." said Ken Gabriel, co-director of MIG and professor of electrical and computer engineering and the Robotics Institute at Carnegie Mellon University [Commsdesign, 2002].

The total market size of MEMS quoted by various sources varies significantly, probably because the definition used varies. A market research report from the Network of Excellence in Multifunctional microsystems (NEXUS), a marketing organisation for

the microsystems industry predicted that the worldwide market for microsystems technology (MST) would grow from $30 billion in 2000 to $68 billion in 2005. NEXUS defines MST as all products that are microstructures in design, including monolithic and hybrid components and silicon-based devices, as well as anything micromachined [Thompson, 2002]. Analysts are in closer agreement when predicting the growth of this industry, however, with most predictions in the order of 20 – 30%. The growth of RF MEMS, especially in emerging applications, is expected to exceed this already modest figure [Thompson, 2002; Maseeh].

Despite very promising MEMS growth rates, the food industry has not been identified as a potential application. This fact, and the scale that MEMS allows sensors to be reduced to mean that QUEST Sensors (Australia) Pty. Ltd. should be an early entrant into a very promising market.

3.2.3 Sensors

"Increase Expected in Sensor Market", Sensors Online

"The potential market for wireless sensors is almost limitless. Everything from home automation to battlefield co-ordination could benefit from mature wireless sensor networks." Michael R. Moore and Stephen F. Smith, Oak Ridge National Laboratory

According to a NEXUS task force report, the combined North American and European market for temperature sensors exceeds US$1.2 billion. Global revenues for IC/silicon temperature sensors are projected to reach US$159 next year [Sensors Business Digest]. The Freedonia Group, Inc. has projected 6.7% annual growth in the American sensor market, reaching US$ 13.4 billion in 2006. However, sensors, transducers and associated housings were included in this prediction.

3.2.4 Food market

Trends in the food industry suggest that the demand for improved temperature sensing will increase significantly during the next few years; consumers expect health and safety standards never before reached. Capabilities such as more sensors, real time monitoring, increased durability and reliability are becoming more important to food manufacturers and at present these demands are not met.

In an increasingly global market, food manufacturers have tended towards out-sourcing their packaging operations [O'Sheeran]. Therefore, the food industry is not directly a potential market. However, it is their brand name the consumer will associate with any short-fall in quality expectations. It is also the food manufacturers who choose which packager to patronise. Therefore, an understanding of the needs and scale of the Australian and world-wide food industry is required.

Information on the size and make-up of the Australian food industry, and its place in the international market, was obtained from "Australian Food Statistics, 2002", released by The Department of Agriculture, Fisheries and Forestry, Australia. The total

value of farm and fisheries food production last year was about AUS$29 billion, and has exhibited an average annual growth of 3.3% since 1989-90 in constant dollar terms. This translated to total retail turnover of food and liquor of AUS$71 billion, which was an increase of 5.8% from 1999-2000. The value of Australian food exports increased by 20% to AUS$25 billion in 2000-01. The main exports were meat, grains and dairy products and the most growth was seen in exports of wine, live animals, dairy products, oilseeds and fresh seafood. Although fruit and vegetables account for only 5% of Australian food exports, current sensor technology inhibits this trade. The introduction of improved sensor technology, such as QUEST Sensors (Australia) Pty. Ltd. aims to provide, should enable much better quality control during transit. Therefore Australia, a major producer of quality fresh fruit, would be able to sell these products to customers worldwide.

QUEST Sensors (Australia) Pty. Ltd. will initially focus on the supply of temperature sensors for monitoring chilled food. Literature suggests that consumers still regard chilled food and fresher and of a higher quality that of frozen food, for example. According to Brian Day, principal research officer at the Campden & Chorley Food Research Association (CCFRA), more retail area is being devoted to chilled foods, replacing frozen and ambient-stable foods [Food Engineering International, 1999]. Another trend that implies growth in the sensor industry is the replacement of super-market butchery with case-ready meats.

Australian spoilage data indicates that about 25% of fresh fruit and vegetables is lost as spoilage and about 5% of meat and dairy [Billing, 2002]. We believe that fruit and vegetables are the products that could benefit the most from improved sensing technology. In fact, the export of fresh fruit and vegetables could be revolutionised. To gain an idea of the size of the food temperature sensor market, we have used information about New Zealand kiwi fruit exports [Food Science Australia, 2001; Tanner, 2002]. We hope that international markets will accept Australian produce in the way that kiwi fruits are recognised as ‘kiwi’ produce. In 2000, New Zealand exported kiwi fruits valued at NZ$750 million to 60 countries. A study conducted by Food Science Australia has revealed that the temperatures experienced by kiwi fruits in transit range from -2°C to 6°C. To provide sufficient information about the entire shipment, temperatures must be recorded at the core and surface of the pallet. Dr David Tanner believes that a minimum of 3 per pallet would provide the necessary information. At present, only two readings per container (20 pallets) are available.

3.2.5 Packaging market

“I think it (food safety) is the number one issue and it won’t go away. All of the folks we work with are seriously and actively involved with ensuring safe products for the consumer.” Jim Shelley of Dupont packaging, when speaking of food safety issues.

Packaging is the third largest industry in the world with annual revenues of US$450 billion, approximately 65% of which is related to food packaging [Dolan, 2001]. Packaging is regarded as a recession-proof industry, with continued worldwide growth of 3 – 5 % per year [Doba, 2001]. Paper, followed by plastic, experience the

fastest growth. Europeans are the oldest and most innovative in the packaging industry. Developments such as colour changing tags gave been popular in Europe and Asia for some years. Packaging adds an average of 2% to the cost of food products.

Most of the information about the Australian packaging industry has been sourced from Australian packaging – issues and trends, issues paper number 18. The value of packaging produced in Australia is about $AUS 7 – 7.5 billion, 65 – 70% of which is used in the food and beverage sector. The two major packaging manufacturers in Australia are almost entirely Australian owned. International customers mean that Australian packaging must meet standards of international best practice. Since Australian packaging is internationally competitive, our product, while only sold in Australia, will be exposed to potential customers around the world.

The Australian packaging industry is split into several sectors: glass containers, corrugated boxes, aluminium cans, paper/board cartons, steel cans and plastics. Each sector is highly consolidated, with an average of two competitors each. The plastics sector is the least concentrated packaging material sector (the least barriers to entry) but as producers become more established, the trend towards concentration will take effect.

The fact that the food industry is of critical importance to the packaging industry will be important to our business plan.

3.3 Spoilage

When transporting tropical fruits, a chain wide-approach is required, as managing the quality of tropical fruits is difficult for one individual link in the supply chain. To expand the worldwide tropical fruit market, it is essential to enhance customer satisfaction and provide consistent quality. Therefore, research into supply chain management, which manages information collection and exchange between different stages of the process, is increasing [SPOT-IT]. Spoilage models are being developed (e.g. Hertog, M.L.A.T.M. et al. (1999) have developed a model for the spoilage of strawberries). Diagnostic techniques, such as temperature monitoring, are very important when applying these models to real life in order to reduce spoilage.

The value of fresh apples, pears and stone fruit that Australia exported to Asia in 1998/9 was about $120 million and was predicted to grow 33% up to the present day. [Food Science Australia, 1998/9]. ‘Fruit into Asia’ is a co-operative initiative to enable Australian fruit producers to deliver fresh produce in peak condition to markets all over the world. The Australian Fresh Fruit Company (AFFCO) is a co-ordination company that represents about 80% of apple and pear exporters and also stone fruit and grape growers.

Over 25 % of fresh fruit and vegetables produced in Australia go to waste. About 5 % of meat and dairy produce are also wasted. Just in the case of apples, pears and stone fruit, this equates to a loss of about AUS$ 200 million every year. The financial gains and value of senor investment are obvious just based on those figures.

3.4 Market size

The potential market for QUEST Sensors (Australia) Pty. Ltd. is almost limitless. Our financial plan is just an example of how we could make a moderate profit from a relatively small sector of the Australian market (apples, pears and stone fruit). Options to expand this market would start with other fruit and vegetables. Meat, fish and dairy products are among other possibilities. The ability to monitor conditions inside secure containers would benefit many customers. International trade would hopefully commence quickly; trade show attendance should ensure this.

(75 ships x 5000 pallets) + (15,000 40 ft containers x 20 pallets) = 675,000 pallets pa.
1 pallet contains 100 boxes of approximately 100 fruit each.
∴ about 2 million temperature sensors would be required if they were only used once. However, our sensors will be re-usable. Therefore, we assume the kiwi fruit exporters would require about 500,000 sensors. With an average life-time of 2 years, this amounts to 250,000 per year after the initial investment.

Produce	Annual value (AUS$ million)	Amount produced annually (kt)
Kiwi Fruit (New Zealand)	*NZ$ 750*	
Apples	274	320
Pears	72	159
Stone fruit	250	172

Table 3.3: Annual production of some fruits in Australia compared with New Zealand kiwi fruit

Exports of apples, pears and stone fruit (estimate) = 160 million
Therefore, percentage of apples, pears and stone fruit exported = 160/(274+72+250) ~ 25%
Therefore, total tonnage of apples, pears and stone fruit exported from Australia
= (320 + 159 +172)*0.25 = 165 kt
1 box of fruit contains approximately 10 kg of fruit.
∴ Total apple, pear and stone fruit production requires 600 kt/ 10 kg = 600,000,000/10 = 60 million boxes per year.
Total apple, pear and stone fruit production exported requires 15 million boxes.
Since 1 pallet contains 100 boxes, 150,000 pallets would be exported and 600,000 containers would be required altogether. Therefore, at three per pallet, the maximum sensor market for the Australian fruits selected is about 2 million sensors, with 450,000 sensors exported.

3.4 Competitive Analysis

All companies manufacturing sensors for the food and food transport industry are potential competitors. The following are the major sensor manufacturing companies and a brief description of their product and the technology they use.

- UPTIME DEVICES – USA
- Pyrosales Pty Ltd – Australia
- VERITEQ and WTL Temperature - Canada
- Thermo Technology - USA
- Cox Technology - Australia
- ICESPY - UK

UPTIME DEVICES manufactures and provides sensors for temperature and humidity. The sensors are connected to the sensor Probe via standard 15 feet long cables with secure connections. The temperature range is -55°C to +125°C, while for relative humidity the range is 0 to 100% (-20°C to +60°C). They are not using wireless technology, however, the company is currently developing a way to monitor critical temperature via a network. But even with this technology they need to plug the sensors in to download the data.

PYROSALES PTY LTD is an Australian company specializing in manufacturing temperature and humidity sensors. The sensors have battery-powered memory and are placed in position for a period of time until the data is downloaded from the sensor to PC via cables.

VERITEQ and WTL Temperature are Canadian companies, both using similar technology to that used by PYROSALE PTY LTD.

COX TECHNOLOGIES is an Australian company, which produces a board range of products that monitor temperature, humidity and other important variables in the transport of foods and other sensitive commodities. The technology they use is Vitsab®temperature monitoring labels, which travel with cartons of perishables and signal by means of color changing dots.

Thermo Technology manufactured products are mainly focused on frozen food and they use color indicator technology to monitor temperature and humidity variations.

ICESPY is UK based company, which use the radio linked monitoring systems for temperature and humidity sensors. The sensors have battery powered memory and record temperature and humidity over time. Whenever required, the sensors will send the information collected, via radio frequency to the base unit and a PC.

Our sustainable competitive advantage will be based on our ability to transform the existing technologies into a new advanced and marketable product through continuous research and development. All other competitors except ICESPY, use color indicators or plug in technologies. The advantage of QUEST Sensors (Australia) Pty. Ltd. over these technologies is the ability to provide real time data in secure systems.

While the method of sensing and data retrieval used by ICESPY is very similar to QUEST Sensors (Australia) Pty. Ltd. the technology is not. QUEST Sensors (Australia) Pty. Ltd. use MEMS technology combined with RF technology to produce a much cheaper sensor. The low cost of QUEST Sensors (Australia) Pty. Ltd. is the main advantage held over Cox Technology. Our product provides a fair technological advance over existing technologies in sensor manufacturing.

3.5 Needs identification

Quote Dr Ron Thomas, Clemson University, SC, professor and chairman, department of packaging science, "Electronic sensors become more critical in terms of ensuring food quality (as international distribution increases)…The product losses will be large until these challenges are met."

Demands from sensor users [Sensormag, 2001]:
- Increased reliability
- Significantly reduced cost
- Smaller sensors
- More robust (to oxygen, temperature, humidity, vibration, etc.)
- Real-time remote monitoring
- Increased range of RF sensors (from 10s of metres to kilometers)
- Appropriately low-power format

Retailers:
- Longer shelf-life

Producers:
- Less spoilage
- Eliminate spoilt produce reaching shelves
- Desire secure container monitoring

External pressures to improve diagnostic techniques:
- Increasingly stringent regulation regarding packaging environments fuelled by consumer pressure
- Spoilage models and supply chain management

3.6 Unique capabilities

The most critical challenge to MEMS product commercialisation is the length of development. The median time to develop a prototype is 3.2 years (up to 8 years) with a further 2.2 years (and a maximum of 6 years) for the transition from prototype to product. The reasons for this lengthy period include a historic MEMS technology push, lack of expertise and manufacturing obstacles. In a study conducted by IntelliSense, 41 % of companies were involved with MEMS because of the 'technology excitement' and 46 % because of the business opportunities. Therefore, the technology development often leads the application identification. The consequences of this technology push are

that 45% of the companies surveyed state that current research does not complement industry needs.[Maseeh, Swiecki and Finch]. Therefore, our approach to MEMS commercialisation is different in that we will carry out research in house and we have already identified the application. This will result in faster development because we have the expertise and have already established our research direction.
Australia has good year-round fruit growing conditions

3.7 Sales/Promotion Plans

Our sales strategy has two main thrusts: direct advertising and strategic partnerships.

3.7.1 Direct advertising

The market research undertaken so far has assumed all customers would be Australian. However, profit potential would be reasonably restricted if this were the case and so QUEST Sensors (Australia) Pty. Ltd. aim to sell to the international market. Therefore, financial and market estimates cited in this report are very conservative. As our markets are both the food and transport companies, we would distribute using direct sales, wholesale and the Internet.

- We will issue a bi-monthly newsletter to customers and interested parties. This will detail promotional material for each sensor reader and software as it is launched. Companies on the mailing list will be approached by QUEST Sensors (Australia) Pty. Ltd. to obtain orders.
- We will attend food technology and sensor trade shows to advertise to the international market and generate useful contacts. We hope to identify international companies willing to promote our products, which will be contacted at a later date.
- Our web-site is likely to have the greatest exposure. In addition to detailing QUEST Sensor products, customers can place orders on-line.

3.7.2 Partnerships

QUEST Sensors (Australia) Pty. Ltd. will work closely with industry from the outset. We will develop a close relationship with one or two major players and establish a mutual benefit agreement. We would offer them discounts and advanced availability in return for prototype testing. There are many marketing possibilities, and a few are explained below:

- **Food industry**: although they are not direct customers, if they have been exposed to our product they may prefer packagers to use them, creating a ‘pull’ effect. Another incentive is based on the image of Australian produce as being ‘clean’ and the desire to maintain this image.
- **Packaging industry**: packaging is a low margin industry. If packagers could be convinced that margins would increase by adding value in the form of sensors, they would then ‘push’ the sensors to their customers in the food industry. An incentive for them would be to maintain the Australian packaging industry’s position as a

world leader of innovative packaging. Since the packaging industry is highly concentrated, even one customer would represent up to half of the market.

- **Sensor Vendor**: we could sell our sensors to a sensor vendor.

All of these options would provide a gorilla to protect us as well as an obvious exit strategy.

3.8 SWOT Analysis

Strengths	**Weaknesses**
• Provide currently unavailable service • Passive sensors • Once market is penetrated, companies must buy this technology to compete • Much cheaper than alternatives • Improved health and safety guarantees • Can develop faster than average • Sensors are reliable • Able to do real time sensing in secure environments.	• Industry connections must be generated almost from scratch • Founding member investment weak (not through lack of commitment but lack of funds) • Competitors exist and will increase
Opportunities	**Threats**
• Can be used in many other applications • Can extend to cover entire supply chain • Several possible partnerships	• Might not convince industry of need • Concept may be stolen by gorilla • A technology emerges that can produce cheaper sensors

4 Operations

4.1 Product Strategy

The sensors sold by QUEST Sensors (Australia) Pty. Ltd. will be reusable, however environmental conditions and the manner in which a sensor is used may shorten its life span. The external sensors, including oxygen sensors may need to be replaced after a couple of months of use. To reduce unnecessary replacement, each sensor will have a simple diagnostic routine incorporated. This will indicate whether the sensor is or is not performing correctly. Internal sensors, such as temperature and humidity, should be able to operate reliably for a period of approximately 2 years.

4.2 Product Implementation Plan

Hardware design of the sensors, base units and repeater units is the first task in the production plan. It includes design of microsensor, memory converter, RF transmiter and reader circuitry. With the existing advances in MEMS and low-power wireless technology, the plan is to focus more deeply on the integration and customisation of the hardware so that it can outperform existing components and suit QUEST Sensors (Australia) Pty. Ltd. product requirements.

The software must be developed, tested and ready for use before the sensors go into production. The software development process has been divided into four segments controller interface, operating system, networking, and sensor input. The target date for hardware completion is 6 months and software completion is 15 months from start up. The aggressive development plan will require the addition of a skilled software designer to accomplish the task within the time frame allotted.

In an effort to reduce the development stage risk inherent to startup and to minimize financing needs, MEMS sensor manufacturing will be done by overseas subcontractors. The base unit, portable unit and satellite units will be manufactured locally. While a certain degree of control is sacrificed in a subcontracting scenario, management feels that its past experience and industry contacts will allow it to cost-effectively manage the flow of subcontracted material to QUEST Sensors (Australia) Pty. Ltd. plant. QUEST Sensors (Australia) Pty. Ltd. will expect quality service.

QUEST Sensors (Australia) Pty. Ltd. manufacturing operations will be comprised mainly of assembly and test operations. Aside from substantially reducing early-stage capital requirements, the assembly operation will reduce the labour costs of the company by being staffed with less-skilled workers. Nonetheless, QUEST Sensors (Australia) Pty. Ltd. will maintain full control over quality through a vigorous, multi-phased test process at four assembly stages and culminating with a 12-hour, hostile environment burn-in procedure.

4.3 Product Support/Customer Service

After product development and initial product market release has occurred, a Product Support Department will be established that will coordinate with the sales division to closely track and validate all customer needs. We will establish a web site, a toll-free phone line and will create a product warranting procedure to enhance customer service. All product sales and customer support operations will initially be handled out of the office. A complete operation procedures handbook will be developed pending initial funding for product R&D and manufacturing.

4.4 Research and Development

Continued research and development will be necessary to maintain a significant competitive advantage in the respective products' markets. As evidenced in the financial spreadsheets, a fairly healthy percentage of revenue is reinvested in R&D once production has commenced to maintain market share. Based on the premise that the

technology sits in front of its competition, it is paramount that R&D receives financial attention. R&D will focus on both creating new products and improving and revising existing products.

4.5 Distribution Strategy

To distribute the products locally, interstate and internationally, third party couriers and distribution companies would be contracted to deliver the products. The pricing for the delivery would be limited by the size that we package the units in and we plan to negotiate special rates from the various transport providers. The price of delivering each product to a customer would be included in the cost of the sensors, readers and software.

5 Company Management

5.1 Management Personnel

The success and failure of QUEST Sensors (Australia) Pty. Ltd. depends upon the capabilities of the managing team. The required skills and capabilities of the management team are listed below:

Kelly Armitage -----Finance Manager

BE - Mechanical Engineering, Swinburne University of Technology, Australia

Kelly has a background in the food manufacturing industry where she worked for Unilever Australiasia for a period of two years. During the first year she provided Engineering Support, where she was the responsible for planning capital expenditure budgets and managing important capital projects. She also worked in Production Support implementing Total Productive Manufacturing (TPM) to improve the efficiency of manufacturing. This entailed working with different teams, establishing quality control procedures, as well as consultancy to various project teams. Her employer considered her an integral part of the business and offered incentives to stay.

Eleanor Binner -----Sales and Marketing Manager

M.Eng., Chemical Engineering - Imperial College of Science and Technology

During her undergraduate years Eleanor gained extensive sales and marketing experience, working in a wide range of sales enterprises. These include working in the communications media of direct and phone sales as well as customer service. Her current research at IRIS investigates processing within the food industry.

Stephen Beasley ----- Research and Development Manager

M.Eng in Telecommunication at the University of Melbourne

Stephen has worked as a Research and Development Engineer at OmniTel (Australia) Pty. Ltd., during which he gained knowledge and experience in research and development of telecommunications products. He also worked in the role of product engineering with NEC for period of 1 year. He has a food science technology background as he partially completed a Food Science degree at RMIT University. His current research project is to investigate the feasibility of gathering data telemetry from racing cars using radio frequency technology.

Tony Liu ------Production Manager

BE - Material Engineering, Shandong University, China,

With eight years in the manufacturing industry, Tony has broad expertise within production, design, management, maintenance and process control. This includes 4 years as a Project Manager with LED Science, taking new projects, from concept design, production line search, planning and installation to making the product and bringing it to market. Currently, he is investigating new packaging techniques and methodologies that can be used for quick connectors in MEMS based microfluidic applications.

Abdirahman Yussuf ------Personnel Manager

BSC and M.Eng in Chemical Engineering at RMIT University

Yussuf worked as a process engineer and supervising engineer in United Arab Emirates and Turkey for petroleum and petrochemical industries for a period of 3 years. During which he supervised more than 100 technicians and engineers. He has also been involved in polymer-processing projects, which included polymer evaluation testing such as mechanical, rheological and thermal properties.

5.2 Skills to be Developed

Two key areas where we as a team lack knowledge are MEMS design and finance. To design our MEMS, Stephen and Tony will investigate the literature and technology that can be used to develop specific MEMS devices as well as begin to learn different design and simulation tools. The tools that we have identified are MEM Pro and Ansys from Leap Australia Pty. Ltd. As Kelly Armitage has had experience with finance, she will manage the finance with some assistance from an accountant. The cost of gaining this expertise has been budgeted for.

5.3 Company Structure

The structure of the company (eg., Figure 5.2) is simple and straightforward to enhance the ability for rapid changes and growth in production designs. It consists of two main sections, the board and the rest of the company. The board will consist of the founders and representatives of other investors. Initially the company will employ one software developer.

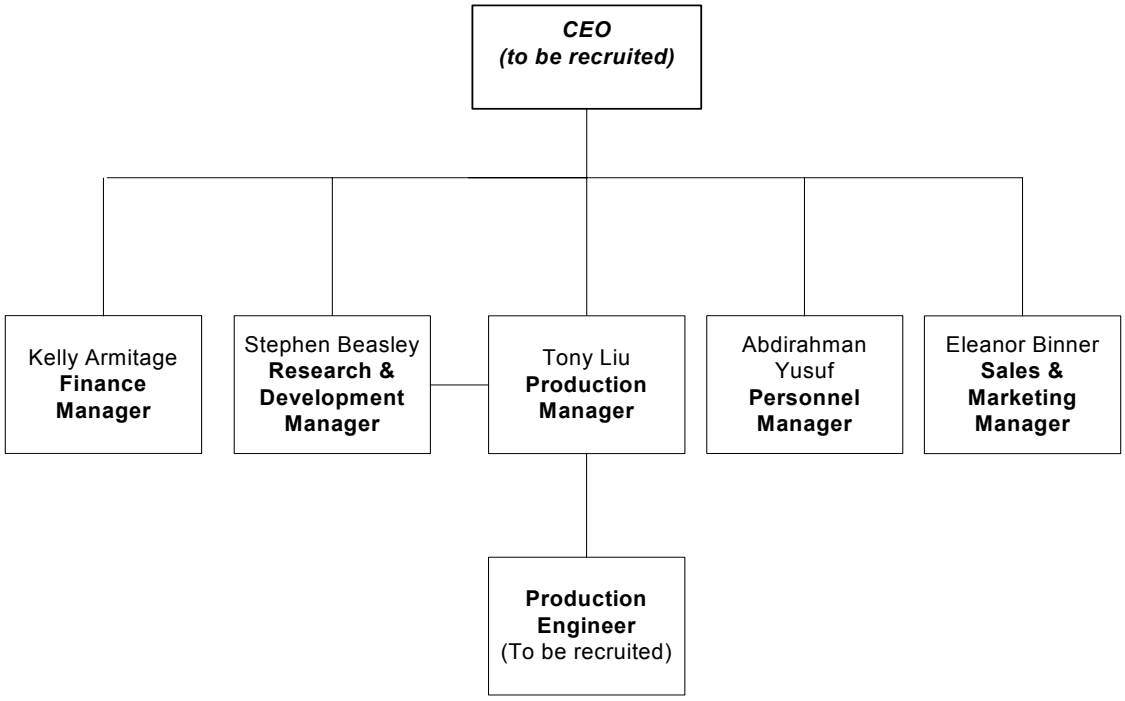


Figure 5.2 – Company Structure

Once production of the sensors begins, low skilled staff will be employed to assemble the units. In the first month of production two assemblers will be employed. A further two will be employed in the second quarter of that year with two more in the final quarter taking the total to six assemblers. In year 5 a further two assemblers will be employed. As the company continues to grow, so will the number of employees.

A production engineer has already been identified and has expressed interest to work in our company. He has 6½ years experience as an R&D engineer with the Japan firm Denso corporation with expertise in hardware and software design. His role will initially include R&D and then be extended to production engineering roles as required. A CEO will be appointed by our investors, giving greater control over their investment.

6 Financial Analysis

6.1 Assumptions

- Sales forecast is accurate assuming we limit sales to the Australian market
- 5% growth in industry each year
- Development and prototyping goes to plan and is available Apr 04, Q3 year 2
- Tax is paid at a rate of 30% on profit.

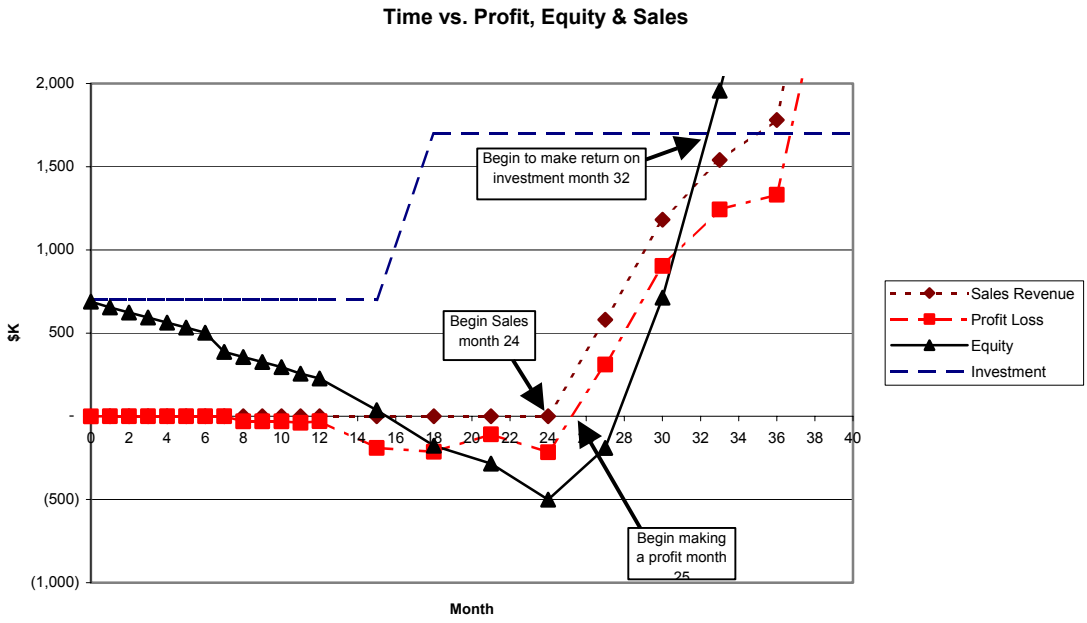
6.2 Overview – Costs & Returns

6.2.1 Business Start up Costs

- The total cost of start up including equipment is $465,081
- The monthly average cost to run the business in first two years is $19,428 plus prototyping costs
- The cost of Prototyping by a MEMS foundry is $200,000 per sensor.
- Will begin selling temperature sensors, base units and software in Aug 04 (beginning of year 3).

6.2.2 Returns

- Sales begin in October 2004 (month 24)
- We begin making a profit in November 2004 (month 25)
- We begin to make a real return on investment in June 2005 (month 32)
- Equity after five years operation is approximately $22 Million
- After tax profit after 5 years of operation is approximately $10.5 Million



Graph 6.2 Time vs Profit. Equity and Sales

6.3 Funding sources and Type

- Owners equity, contributed by group members - $500,000 at start up
- Angel Investor - $700,000 at start up
- Venture Capitalist - $1,000,000 in February 04 (Q3 year 2)

6.4 Sales Forecast

- Sales begin in Aug 04 (beginning of year 3).
- Initially only the temperature sensor and base unit will be available.
- The humidity and portable base unit will be available for sale in Dec 04.
- The predicted sales figures are shown in table 1

Unit	Aug 05 - Oct 05	Nov 05 - Jan 06	Feb 06 - Apr 06	May 06 - Jul 06	Aug 06 - Jul 07	Aug 07 - Jul 08
Base Unit	75	80	84	89	414	523
Satellite Units	225	239	253	268	1243	1569
Software	10	20	30	40	340	500
Portable unit		50	100	150	1500	2300
Temp Sensor	45000	70200	85662	96427	465720	593611
Humidity		23850	37206	45401	230223	296641
Oxygen						48000
Sensor 4						12641
Total Sensor Sales	**45000**	**94050**	**122868**	**141828**	**695943**	**950893**

The sales forecast is based on the following assumptions:

- Sell 50% each year to renew existing sensors
- 30% growth in sales in the first two years
- Selling only to the Australian fruit export market
- Based on selected fruit and vegetable products

Actual sales figures may be higher than those quoted above, as it is likely that our products will be used in larger range of fruit and vegetables than the figures are based on. It is also likely that our sensors will be sold worldwide, which will also increase the sales figures above.

7 Offering

7.1 Proposal and Terms for Potential Investors

We are looking for investors willing to invest $700,000 in this start up company in both or either of two ways.
$200,000 will be as 28% owners of the company and a position on the board

$500,000 will be as a loan, repaid after 5 years. The amount repaid will be 10 times that invested.

We will be seeking a further $1,000,000 from Venture Capitalists in February 2004 (Quarter 3 year two). This will be as a loan, repaid after 3.5 years at 6 times the amount invested.

The rate of return over the 5 years is estimated at 161%, which is an average of 32.2% per year.

7.2 Exit Strategies

There are two possible exit strategies

7.2.1 Sell the company

This would involve one or all of the owners selling their share of the company at an agreed time, most likely after 5 years. It is estimated that after 5 years of operation the before tax profit will be $10,907,137. Assuming the value of the company is three times the before tax profit, then company will be worth $32,721,411.

7.2.2 Public Issue

The company would be listed publicly with the number of shares and price set to give the required funds to pay back investors. Owners may recruit a management team to run the company while they receive dividends or they may choose to continue managing the company.

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