

**A BUSINESS PLAN FOR A SMALL MATERIALS
ENGINEERING CONSULTING COMPANY**

OCKERT JACOBUS VAN DER SCHIJFF

B.Sc., B.Eng.(Chemical), B.Eng.(Honns)(Metallurgical),

M.Eng.(Metallurgical), Ph.D.(Metallurgy)(Connecticut)

**Mini-dissertation submitted in partial fulfilment of the requirements
for the degree Master in Business Administration of the
Potchefstroomse Universiteit vir Christelike Hoër Onderwys**

Supervisor: Professor J.G. Kotzé

September 2000

Potchefstroom

DISCLAIMER

This document is intended solely for academic use and is in no way whatsoever representative of the business policies, views, and/or strategies of the management of Altran Corporation.

EXECUTIVE SUMMARY

The Materials Engineering Division of Altran Corporation is an U.S.A.-based engineering consulting company specialising in consulting services related to materials engineering, metallurgical engineering, root cause failure analysis, biofouling, and mitigation, biomaterials, product development, and litigation support. The company is currently experiencing rapid growth from a small business to a mid-size business which necessitates deliberate medium to longer-term business planning.

The careful formulation and execution of a business plan will result in the achievement of the following goals:

- Steady growth in revenue of at least 20% per year through the year 2002.
- Increased profit margin.
- Improved management of accounts receivable.
- Improved cash flow situation.
- Focusing on increasing and diversifying the client base.
- Establishment of a firm foothold in the biomaterials sector.
- Capitalising on strengths in individual disciplines and the division's association with world-renowned institutes of learning.
- Attainment of target revenue of \$3.8 million in the year 2002.

Following an analysis of the market in which the division operates, four market sectors to be targeted for the development of new business opportunities, were identified.

These sectors are:

- Electronic manufacturing
- Light industrial manufacturing
- Biomaterials and biomedical implants
- Litigation support and insurance claim subrogation

The following business plan charts the course for the division's growth and expansion for the three-year period from 2000 to 2002. It lays out the steps to achieve growth in revenue, from approximately \$2,58 million at the end of 2000 to \$3,83 million at the end of 2002. The resulting net profit will grow from \$1 234 or 0,05% of revenue at the

end of 2000 to \$348 675 or 9,11% of revenue at the end of 2002. A summary chart with the most notable revenue highlights is shown as Figure 1.

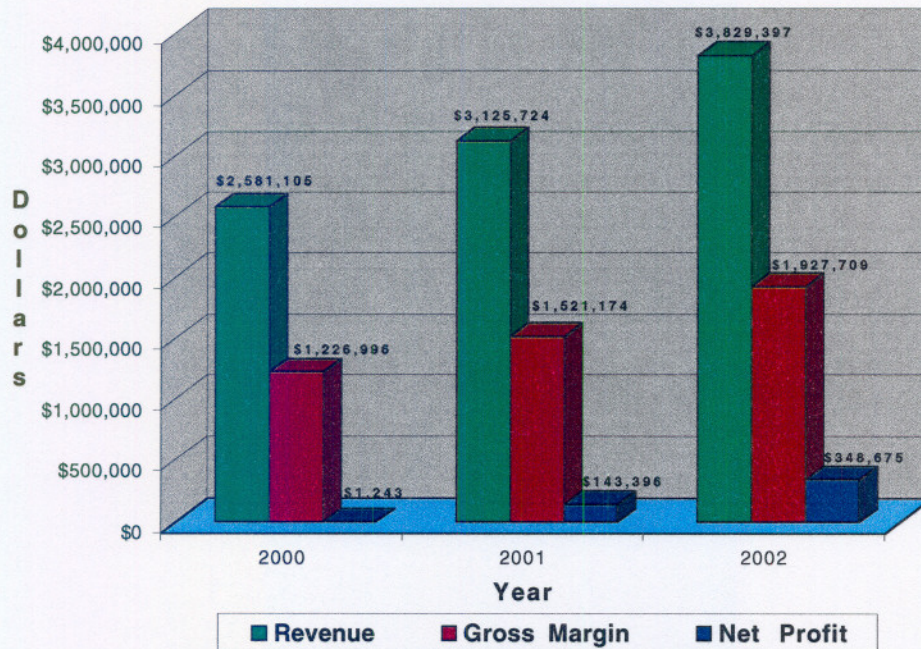


Figure 1. Revenue highlights for 2000 to 2002. (Source: Internal company forecast)

In order to reach and penetrate these market sectors, the division will embark on a multi-faceted marketing and promotion campaign by means of which new markets in the industrial sector will be reached. Direct mailings, newsletters, surveys, postcards, press releases, brochures, technical notes, and seminars and workshops will all be utilised as integral parts of this campaign to capture and grow new business.

As the division's business activities grow and expand, personnel will be added to effectively serve new clients. A laboratory manager will be appointed as soon as possible to manage the day-to-day administrative activities of the laboratory. Directors for distinctive disciplines will be appointed from within if possible, or recruited from outside the division. Technical support staff will be recruited on an as-needed schedule. In the third year covered by this business plan, a full time marketing professional will be appointed to assume promotional and marketing responsibilities that are currently shouldered by engineering and scientific staff members.

Cash flow is set to improve resulting in an increase in the available cash balance from \$24 410 at the end of 2000 to \$328 777 at the end of 2002. Figure 2 shows a chart depicting the cash flow. This is notwithstanding the fact that considerable expenses are planned for upgrading and improvement of the laboratory infrastructure.

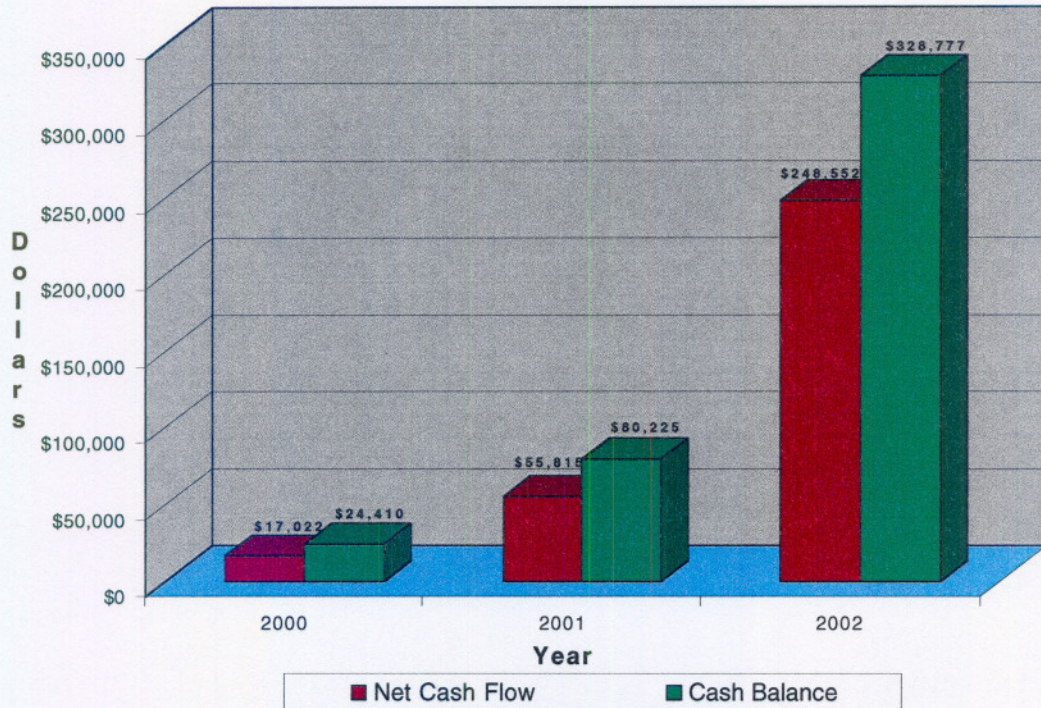


Figure 2. Cash flow figures for 2000 to 2002. (Source: Internal company forecast)

In order to be successful in this endeavour, the following keys to success were identified:

- Excellence in fulfilling the promise - reliable, trustworthy, and consistent expertise and work product.
- Developing greater visibility and name recognition, both nationally and internationally to generate new business leads.
- Leveraging from a very specialised and limited clientele into multiple stand-alone revenue generation opportunities.
- Diversification into a number of lucrative market sectors that are very strongly represented in the New England area.

BESTUURSOPSOMMING

Die Materiaalingenieurswese Divisie van Altran Korporasie is 'n V.S.A.-gebaseerde konsulerende ingenieursfirma wat spesialiseer in raadgewende dienste in materiaalingenieurswese, metallurgiese ingenieurswese, falingsanalise, biobevuiling, biomateriale, produk-ontwikkeling en litigasie ondersteuning. Die maatskappy ervaar huidiglik snel groei vanaf 'n kleinsakeonderneming na 'n mediumgrootte besigheid. Hierdie groei noodsaak die formulering van 'n besigheidsplan vir medium tot langtermyn beplanning.

Die formulering en uitvoering van 'n besigheidsplan sal uitloop op die suksesvolle bereiking van die volgende doelstellings:

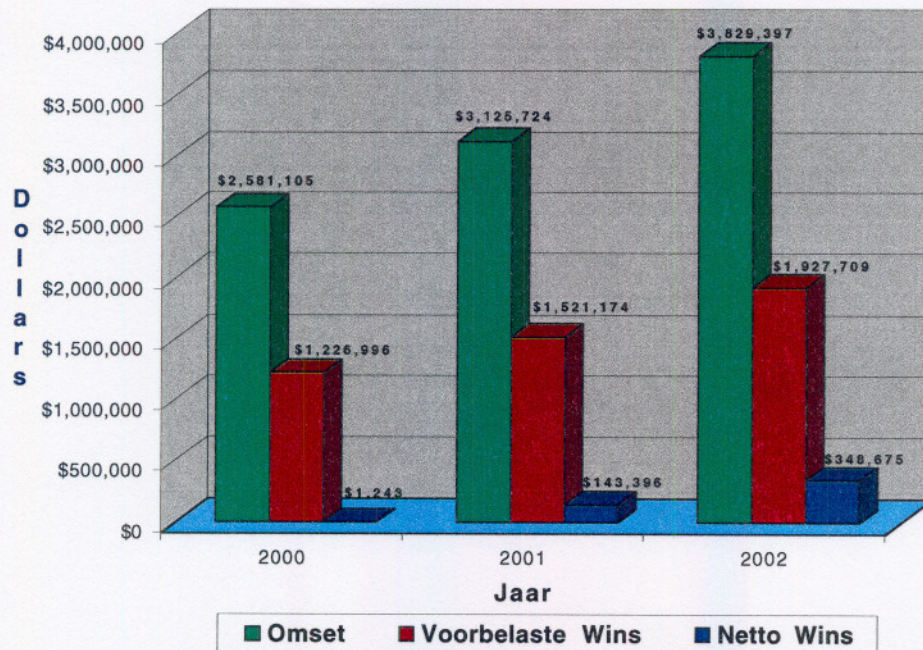
- Bestendigde groei in omset van tenminste 20% per jaar tot en met die jaar 2002.
- Verhoogde winsmarge.
- Verbetering in die bestuur van debiteurerekeninge.
- Verbeterde kontantvloei situasie.
- Fokus op vergroting en diversifikasie van die kliëntebasis.
- Vestiging van 'n kliëntebasis in die biomateriale sektor.
- Kapitaliseer op sterkte in individuele dissiplines en die divisie se assosiasie met wêreldbekende tersiêre inrigtings.
- Bereiking van doelwit inkomste van \$3,8 miljoen in die jaar 2002.

Ná 'n analise van die mark waarin die divisie meeding is vier marksektore geïdentifiseer as fokusmarkte met die oog op bemarkingsaktiwiteite. Hierdie marksektore is:

- Elektroniese vervaardiging
- Ligte industriële vervaardiging
- Biomateriale en biomediese inplanteerbare toestelle
- Litigasie ondersteuning en versekeringseise

Die hieropvolgende besigheidsplan dien as riglyn vir die divisie se groei en uitbreiding vir die drie jaar periode wat strek vanaf 2000 tot 2002. Dit definieer die stappe wat geneem moet word om groei in omset vanaf ongeveer \$2,58 miljoen aan die einde van

2000 tot \$3,83 miljoen aan die einde van 2002 te behaal. Resulterende groei in netto wins sal wees vanaf \$1 234 of 0,05% van omset teen die einde van 2000 tot \$348 675 of 9,11% van omset teen die einde van 2002. 'n Samevattende grafiek met die mees relevante data verskyn hieronder as Figuur 3.



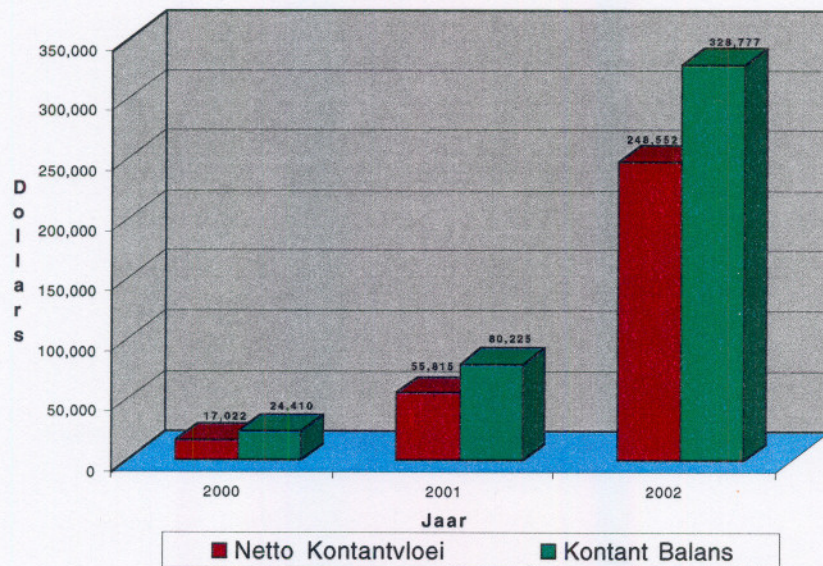
Figuur 3. Inkomste hoogtepunte vir 2000 tot 2002. (Bron: Interne maatskappy voorspelling)

Ten einde die bogenoemde markte te bereik en die gekose marksektore te penetreer, sal 'n multi-faset bemarkings- en promosieveldtog van stapel gestuur word. Direkte posbemarking, nuusbriewe, opnames en vraelyste, poskaarte, persverklarings, brosjures, tegniese notas, seminare en werksinkels sal gebruik word in 'n geïntegreerde veldtog om nuwe besigheid te ontwikkel.

Soos die divisie se aktiwiteite groei en uitbrei sal personeellede bygevoeg word ten einde op die mees effektiewe wyse aan kliënte se behoeftes te voldoen. 'n Laboratoriumbestuurder sal so gou as moontlik aangestel word om die dag tot dag administrasie van die laboratorium te behartig. Direkteure sal mettertyd aangestel word om die aktiwiteite van spesifieke dissiplines te bestuur. Hierdie aanstellings sal verkieslik vanuit bestaande personeel gedoen word, maar andersins van buite die

organisasie gewerf word. Tegnieuse ondersteuningspersoneel sal aangestel word soos en wanneer benodig. 'n Voltydse bemarker sal in die derde jaar wat deur hierdie plan gedek word aangestel word ten einde die verantwoordelikhede vir promosie en bemarking by ingenieurspersoneel, wat dit tans behartig, oor te neem.

Kontantvloei sal verbeter in terme van 'n toename in die kontant voorhande vanaf \$24 410 teen die einde van 2000 tot \$328 777 teen die einde van 2002. Figuur 4 toon 'n grafiek wat die kontantvloei gedurende die drie jaar ter sprake weergee. Dit is nie teenstaande die feit dat substansiële uitgawes vir die uitbreiding en modernisering van die laboratorium infrastruktuur beplan word.



Figuur 4. Kontantvloei syfers vir 2000 tot 2002. (Bron: Interne maatskappy voorspelling)

Die volgende is geïdentifiseer as sleutelsuksesfaktore in die uitvoering van die besigheidsplan:

- Uitnemendheid in nakoming van die beloftes – betroubare, geloofwaardige en konsekwente deskundigheid en werksproduk.
- Ontwikkeling van beter sigbaarheid en naamherkenning in sowel nasionale as internasionale verband om sodoende nuwe besigheidseleenthede te kan ontgin.
- Hefboomwerking vanaf 'n uiters eksklusiewe en gespesialiseerde kliëntebasis na 'n diverse kliëntebasis met vele onafhanklike winsmoontlikhede.

- Diversifikasie in 'n aantal potensieël winsgewende marksektore wat baie sterk in die New England area verteenwoordig is.

TABLE OF CONTENTS

CHAPTER 1. NATURE AND SCOPE OF THE STUDY.....	1
1.1 Introduction.....	1
1.2 Problem Statement.....	2
1.3 Objectives of the Study.....	2
1.4 Scope of the Study.....	2
1.5 Further Development of the Study.....	3
1.6 Conclusion.....	4
CHAPTER 2. THE COMPANY.....	5
2.1 Introduction.....	5
2.2 Company Ownership.....	5
2.3 Company History.....	5
2.4 Business Description.....	6
2.5 Company Locations and Facilities.....	7
2.6 Vision.....	8
2.7 Mission.....	8
2.8 Situation Analysis.....	8
2.8.1 Strengths.....	8
2.8.2 Weaknesses.....	9
2.8.3 Opportunities.....	9
2.8.4 Threats.....	10
2.9 Business Objectives.....	10
2.10 Business Goals.....	10
2.11 Keys to Success.....	11
2.12 Conclusion.....	11
CHAPTER 3. COMPANY SERVICES.....	12
3.1 Introduction.....	12

3.2	Service description	12
3.3	Important Service Features and Comparison	14
3.4	Technology and infrastructure	15
3.5	Future services and infrastructure	16
3.6	Conclusion	18
CHAPTER 4. MARKET ANALYSIS.....		19
4.1	Introduction.....	19
4.2	Industry Analysis.....	19
4.3	Market Segmentation.....	19
4.4	Competitive Forces.....	20
4.5	Main Competitors.....	21
4.6	Market Forecast.....	22
4.7	Conclusion	23
CHAPTER 5. BUSINESS STRATEGY AND IMPLEMENTATION.....		24
5.1	Introduction.....	24
5.2	Target Markets	24
5.2.1	Electronic manufacturing	24
5.2.2	Light industrial manufacturing	25
5.2.3	Biomaterials and biomedical implants	25
5.2.4	Litigation support and insurance claims.....	26
5.3	Marketing Strategy	27
5.4	Promotion Strategy.....	28
5.4.1	Direct Mailings	29
5.4.2	Newsletters	29
5.4.3	Surveys	29
5.4.4	Postcards.....	30
5.4.5	Press Releases.....	30
5.4.6	Brochures.....	30

5.4.7	Technical notes	31
5.4.8	Seminars and Workshops	31
5.5	Pricing Strategy	31
5.6	Strategic Alliances	32
5.7	Conclusion	33
CHAPTER 6. ORGANIZATION.....		34
6.1	Introduction	34
6.2	Organisational Structure	34
6.3	Management Team	35
6.4	Management Team Gaps	35
6.5	Personnel Plan	36
6.5.1	Current Personnel Situation.....	36
6.5.2	Future Personnel Plan	37
6.6	Conclusion	38
CHAPTER 7. FINANCIAL ANALYSIS		39
7.1	Introduction	39
7.2	Financial plan	39
7.2.1	General assumptions	39
7.2.2	Anticipated personnel expenditures	39
7.2.3	Anticipated capital expenditures.....	40
7.3	Pro forma income statement.....	41
7.4	Pro forma cash flow analysis	42
7.5	Pro forma balance sheet	44
7.6	Business ratios.....	45
7.7	Conclusion	46
CHAPTER 8. CONCLUSIONS		48
BIBLIOGRAPHY		50

APPENDIX A. NEWSLETTER.....	51
APPENDIX B. SURVEY.....	54
APPENDIX C. POSTCARD	56
APPENDIX D. BROCHURE	58
APPENDIX E. TECHNICAL NOTE	63
APPENDIX F. FLYER.....	66
APPENDIX G. RATE SCHEDULES.....	69
APPENDIX H. COMPENSATION FORECAST.....	74
APPENDIX I. REVENUE FORECAST.....	78

LIST OF TABLES

Table 7. 1	Company Ratios and Figures.....	39
Table 7. 2	Anticipated Personnel Expenditures	40
Table 7. 3	Anticipated Capital Expenditures	40
Table 7. 4	Pro Forma Income Statement.....	41
Table 7. 5	Pro Forma Cash Flow Analysis	43
Table 7. 6	Pro Forma Balance Sheet.....	44
Table 7. 7	Business Ratios	45

LIST OF FIGURES

Figure 1. Revenue highlights for 2000 to 2002.	42
Figure 2. Cash flow figures for 2000 to 2002.....	43
Figure 3. Projected division performance in terms of profit variables.....	46

CHAPTER 1. NATURE AND SCOPE OF THE STUDY

1.1 Introduction

In the rapidly changing, modern day economic environment it is essential for any commercial enterprise to plan the organisation's longer-term direction, develop effective strategic moves and approaches, and then execute the strategy in ways that produce the intended results. A comprehensive, yet concise business plan is a fundamental part of this process. The business plan not only defines the goals and objectives that the company is striving to achieve, but also provides a roadmap with practical guidelines and plans on how to achieve them.

Thompson and Strickland (1999:3) define five tasks that are interrelated and are fundamental for the achievement of success in implementing a business strategy. These tasks are:

- Developing a concept of the business and forming a vision of where the organisation needs to be headed.
- Converting the mission into specific performance objectives.
- Crafting a strategy to achieve the targeted performance.
- Implementing and executing the chosen strategy efficiently and effectively.
- Evaluating performance, reviewing the situation, and initiating corrective adjustments in mission, objectives, strategy, or implementation in light of actual experience, changing conditions, new ideas, and new opportunities.

The first three tasks on the aforementioned list culminates in a business plan that provides the guidelines and gameplan by which the organisation will operate (i.e. implementation). The last task emphasises the fact that any business plan is in fact, a "living" document that needs revision and updating on a continuous basis in response to rapidly changing economic conditions.

1.2 Problem Statement

There exists the pressing need within the Materials Engineering Division of Altran Corporation for an instrument to facilitate the expansion of the division for the next three years, guiding it through a period of significant structural changes while maintaining high service standards and continuously improving profitability and the efficient use of capital.

1.3 Objectives of the Study

The main objective of this study is to formulate a comprehensive business plan that addresses all of the relevant factors that will influence the growth and profitability of the Materials Engineering Division of Altran Corporation. This includes details for sustaining and increasing revenue from current clients while actively growing the size of the division's customer base. In addition it will define methods to stimulate active growth of activities in industry sectors other than the sectors where the division is already well represented while taking full advantage of Altran Corporation's integrated engineering capabilities. Finally, it will identify specific industries of high growth and need and methods to pursue these.

1.4 Scope of the Study

The Materials Engineering Division of Altran Corporation is currently experiencing organic growth that is likely to transform it from a typical small business to a mid-size business. Due to the pitfalls associated with such a transition, it is essential to enter into this phase of company development with a well defined and meticulously formulated business plan charting a clear and unambiguous course for the next several years. Historically, many small businesses fail to make this transition smoothly as a result of lack of planning and anticipation of the requirements, demands, and stresses that come to bear on the organisation and its personnel stemming from rapid growth and expansion of business activities.

All too often the founder/s of a small business recognises the onset of this phase too late, ultimately resulting in a slowdown of growth and stagnation. Company founders sometimes resist this transition for fear of loss of control and often resort to “micro-management”. This, in turn, can potentially result in a loss of motivation and morale amongst personnel and ultimately the departure of key staff members thus setting back the company development with several years. Early recognition, careful formulation of an appropriate business plan, and meticulous execution of such a plan are essential aspects required in making the transition as smoothly and successfully as possible.

1.5 Further Development of the Study

Various aspects that factor into effective business management are analysed and addressed in the course of this study. The following chapters each focus on one or more specific aspects as follows:

Chapter 2 provides historical background information about the company, defines and describes the business, and analyses the current situation of the company in terms of strengths, weaknesses, opportunities, and threats.

Chapter 3 focuses on the services that the division provides and identifies important services features. It further reviews the current state of technology within the division and also identifies plans for future expansion and acquisition of state of the art technology.

Chapter 4 examines the current state of the market in which the division is active. An analysis of the industry is followed by a breakdown in terms of market segments. The competitive forces at work in these segments are analysed, main competitors are identified, and finally, a forecast of future market conditions is formulated.

Chapter 5 defines the business strategy by identifying target markets, defining marketing, promotional, and pricing strategies and discussing possible strategic alliances that may be beneficial in achieving specific goals and objectives.

Chapter 6 examines the current state of the organisation and its management team. Specific management team gaps are identified and a personnel plan for the next three years is formulated.

Chapter 7 analyses the present and future financial state of the division. A financial plan is formulated and pro forma income statements, cash flow statements, and balance sheets for the three year period from 2000 to 2002 are presented. Finally, relevant business ratios that provide some insight into the financial health of the division are presented.

1.6 Conclusion

The Materials Engineering Division of Altran Corporation has an excellent reputation amongst the clients it serves as a provider of quality materials engineering consulting services and for being innovative and responsive in an ever changing technological age. It has a vision of growing into a respected provider of materials engineering services of which the quality and integrity are accepted universally as the best in the industry. This can only be achieved by the implementation of a carefully conceived plan based on an analysis of the division's current situation and an assessment of future challenges and opportunities. The following chapters examine the different factors pertinent to the formulation of a business plan that encompasses all of these relevant influencing factors.

CHAPTER 2. THE COMPANY

2.1 Introduction

Altran Corporation is an U.S.A.-based engineering consulting company specialising in the provision of high-technology consulting services to industry. The Materials Engineering Division of Altran Corporation is operated as an independent profit centre and specialises in consulting services related to materials engineering, metallurgical engineering, root cause failure analysis, biofouling, biomaterials, product development, and litigation support. The company is currently experiencing rapid growth from a small business to a mid-size business which necessitates deliberate medium to longer term business planning. This business plan applies to the Materials Engineering Division and sets out plans for the period January 2000 to December 2002.

2.2 Company Ownership

Altran Corporation is an employee-owned company. The major shareholders are the two founders with several current and former employees as minority shareholders. The company operates a profit sharing plan by which stock options are awarded to key employees based on the company's yearly financial performance. In addition to its full-time employees, the Materials Engineering Division also has an association with three academics from the Massachusetts Institute of Technology and one from Harvard University. These associates conduct all of their consulting under the Materials Engineering Division banner and receive a monthly retainer as compensation.

2.3 Company History

The Materials Engineering Division of Altran Corporation was founded in April, 1992 by a group of materials experts who sought a creative outlet for their diverse engineering and failure analysis talents. The new venture, known at the time as Altran Materials Engineering, Incorporated was formed as a subsidiary of Altran Corporation, an engineering services firm founded in 1986.

By incorporating under the Altran umbrella, the engineering skills of the Altran Materials Engineering founders were integrated with the existing engineering design and analysis capabilities and experience base of the parent organisation as the basis for launching a materials engineering company.

Altran Materials Engineering, Inc. was established with the goal of offering superior quality, broad-based materials engineering services with a degree of technical capability and client interaction that sets it apart from the competition.

In early 1993, Altran Materials Engineering, Inc. acquired the assets and personnel of ManLabs Testing Services, an established materials testing service laboratory. The addition of the ManLabs infrastructure and staff greatly extended the in-house analytical and testing capabilities of Altran Materials Engineering, Inc. while expanding the client list considerably.

In the spring of 1998, Altran Materials Engineering, Inc. became the Materials Engineering Division of Altran Corporation, operating as an independent profit centre.

2.4 Business Description

The Materials Engineering Division of Altran Corporation provides focused materials consulting and testing services. The staff members are experienced in product development, materials engineering, performance enhancement, life assessment, life extension, failure analysis, and litigation support. A key to the company's ability to solve problems is the breadth of the staff's experience both in the range of materials and in their degradation mechanisms. The company has strong capabilities in metals, dielectric materials, polymers, ceramics, concrete, and composites. A wide variety of degradation mechanisms varying from the common and expected to the unusual and rarely seen in all these materials are regularly investigated and analysed.

Altran Corporation's breadth of technical and engineering capabilities enables the company to address a wide range of problems. In addition to its materials

engineering capabilities, the Engineering Services Division of Altran Corporation has distinctive capabilities in stress analysis, heat transfer, fluid flow analysis, fracture mechanics, dynamics, and related fields. The Materials Engineering Division staff regularly work as a team with these resources to provide a comprehensive analysis of the total system. When necessary, the company is able to draw upon consultants from local universities and research institutions, such as the Massachusetts Institute of Technology (MIT) and Harvard University.

2.5 Company Locations and Facilities

Altran Corporation's corporate offices are located in the Fargo Building in South Boston. Approximately 11000 square feet of mixed office space and laboratory space are leased on the ground level of the same building by the Materials Engineering Division. The Engineering Services Division is housed on a different floor in the same building.

The space occupied by the Materials Engineering Division include individual laboratories for:

- Analytical chemistry and corrosion engineering
- Metallography
- Scanning electron microscopy
- Photography and light microscopy
- Mechanical testing
- X-ray diffraction and hardness testing
- Biomaterials and biochemistry
- Polymer science

With the exception of the biomaterials and biochemistry laboratory, all of the other laboratories are well equipped to perform almost every task and/or analysis they are intended for. In addition there is also a fully equipped machine shop and a multi-purpose laydown area with a full-size loading dock for the receipt and shipping of larger components. Cubicle space for twelve engineers and/or technicians and offices for five senior engineers or managers

form part of this facility. The space also includes a conference room, lunchroom, computer room /equipment storage room, and sample storage room.

Smaller Altran Corporation Engineering Services Division field offices are located in Charlotte, North Carolina, San Francisco, California, and Toronto, Canada. However, none of these have any laboratory capabilities and all of the materials engineering laboratory capabilities are centred in the Boston office. All laboratory work originating from field offices are conducted on an inter-divisional contract basis in the laboratories of the Materials Engineering Division in Boston.

2.6 Vision

The vision of the Materials Engineering Division of Altran Corporation is to grow into a respected and world renowned provider of materials engineering services of which the quality and integrity are accepted universally as the best in the industry.

2.7 Mission

The Materials Engineering Division of Altran Corporation strives to provide focused and high quality materials consulting and testing services at a competitive price. The division specialises in failure analysis, product development, materials selection, performance enhancement, life assessment, life extension, and litigation support. In addition, comprehensive laboratory services are offered in the fields of metallography, chemical analysis, mechanical testing, biological testing and corrosion testing and evaluations.

2.8 Situation Analysis

2.8.1 Strengths

- The Materials Engineering Division has been experiencing strong and rapid growth in revenue during the past two years.

- The Materials Engineering Division staff is well trained, very proficient, and well recognised in the industry in their respective fields of materials expertise.
- A well equipped and newly designed laboratory puts the Materials Engineering Division well ahead of its competitors.
- Synergy resulting from the co-location of the Materials Engineering Division and the Engineering Services Division enables the company to take on complex and integrated tasks.
- An existing in-house quality assurance programme mandated by the nuclear industry, can readily be expanded to facilitate ISO9001/2 certification which may be required in some of the future target markets such as biomaterials.

2.8.2 Weaknesses

- Company as a whole too dependent on a few large nuclear power generation customers.
- Too little depth of expertise (very limited ability to “backfill” in times of high volume of work).
- Materials Engineering Division has not reached “critical mass” yet, especially in terms of support services for engineering staff.
- The laboratory function is dependent on several contractors for services such as chemical analysis, radiological “hot lab” work and other very specialised services.

2.8.3 Opportunities

- The U.S. Economy is in a state of unequalled expansion and growth.
- Manufacturing companies operating at full capacity resulting in higher probability of failures and materials-related manufacturing problems.
- In-house resources to deal with materials related problems are limited or non-existent in many of the sectors served by the Materials Engineering Division.

- The turnkey nature of the division's materials engineering services is attractive to potential clients due to their limited staff commitment and no overhead costs.
- Strategic alliances with other companies providing specialised services such as high speed video photography, polymer testing, concrete testing and others can greatly expand the array of services offered with minimal financial outlay.
- Recent closure of several commercial "hot labs" where low-level radioactive specimens can be processed, opened up the opportunity for the Materials Engineering Division to fill the void and capture the business.

2.8.4 Threats

- Loss of certain key clients/contracts may have a severe impact on revenue.
- Lack of a deliberate and measured programme to upgrade laboratory equipment leaves the Materials Engineering Division vulnerable with respect to competitors that have the latest equipment and/or software.
- A downturn in the U.S. economy could have a severe impact on the revenue stream.

2.9 Business Objectives

- Sustained and increased revenue from current clients while actively increasing the size of the division's customer base.
- Active growth of activities in industry sectors other than the sectors where the division is already well represented.
- Taking full advantage of Altran Corporation's integrated engineering capabilities.
- Identify and pursue interests in specific industries of high growth and need.

2.10 Business Goals

- Maintain steady growth in revenue of at least 20% per year through the year 2002.

- Increase profit margin.
- Improve the management of accounts receivable.
- Improve the cash flow situation.
- Focus on increasing and diversifying the client base.
- Establish a firm foothold in the biomaterials sector.
- Capitalise on strengths in individual disciplines and the division's association with world-renowned institutes of learning.
- Attain target revenue of \$3.8 million in the year 2002.

2.11 Keys to Success

- Excellence in fulfilling the promise - reliable, trustworthy, and consistent expertise and work product.
- Developing greater visibility and name recognition, both nationally and internationally to generate new business leads.
- Leveraging from a very specialised and limited clientele into multiple stand-alone revenue generation opportunities.
- Diversification into a number of lucrative market sectors that are very strongly represented in the New England area.

2.12 Conclusion

In this chapter the company as a whole, and more specifically the Materials Engineering Division, was examined to provide a snapshot of its current situation. A situation analysis revealed the strengths, weaknesses, opportunities, and threats that the division is currently facing. Goals and objectives were defined and keys to success were identified. The services that the division provides and important distinguishing features are examined and analysed in the following chapter.

CHAPTER 3. COMPANY SERVICES

3.1 Introduction

The company and the services it provide are identified and analysed in the following paragraphs. Distinctive features that differentiate the Materials Engineering Division of Altran Corporation from its competition are identified and examined. The current state of technology and infrastructure within the company is analysed and plans for future expansion, updating, and modernisation are outlined.

3.2 Service description

The Materials Engineering Division of Altran Corporation provides a large variety of scientific and materials engineering services including:

- General laboratory and analytical services
- Metallurgical engineering
- Metallography
- Scanning electron microscopy (SEM)
- Energy dispersive X-ray spectroscopy (EDS)
- Wavelength dispersive X-ray spectroscopy (WDS)
- Optical microscopy
- X-ray diffractometry
- Corrosion engineering
- Condition assessment
- Failure analysis and root cause investigation
- Forensic engineering
- Accident reconstruction
- Mechanical testing
- Fracture mechanics
- Coating assessment and specification
- Polymer engineering
- Commercial grade dedication
- Microbiologically influenced corrosion and biofouling

- Biomaterials testing and evaluation
- Materials selection and engineering
- Simulation
- Field testing
- Training
- Litigation support

These services usually consist of a laboratory component during which tests and analyses are performed to determine specific physical and chemical characteristics of the materials involved. Depending on the nature of the project, various combinations of the skills and equipment listed above are utilised. The analysis and interpretation of the laboratory data is a facet of the service that is often neglected by other laboratory service companies. A distinctive feature of the division's services is that it does not only provide scientific data and root causes, but also works extensively with the client after completion of the root cause failure analysis to come up with practical, viable, and cost effective solutions for the identified problem/s.

In addition to these services, the Engineering Services Division offers a variety of engineering design and support services which can be accessed on an as-needed, contract basis by the Materials Engineering Division. These include:

- Structural and mechanical design and analysis
 - Finite element analysis
 - Seismic qualification
 - Building and equipment foundation analysis
 - Fluid dynamics
 - Pipe stress analysis
 - Valve qualification
- System design and analysis
 - Operational evaluation
 - Design basis assessment
 - Design modification
 - Pipe re-routing

- Life extension
- Licensing services
 - Configuration management
 - Verification of plant operating procedures
 - Design basis accident trees
 - Evaluation of technical specification limits
- Programmatic studies
 - Ageing management
 - Design change process improvements
 - Failure prediction
- Computer software development
 - Simplified piping analysis (Smartpipe)
 - Pipe integral attachment qualification (AltraLUG)
 - Time dependent temperature analysis (TempTran)
- Field engineering

3.3 Important Service Features and Comparison

The diversity and broad base of staff expertise is the most important distinguishing feature of the division's materials engineering services. In addition to the traditional metallurgical laboratory services that competitors provide, the division also offers a diverse range of expertise and services that are not usually offered by a materials-orientated laboratory. The Materials Engineering Division has been successful in breaking down the traditional barriers that exist between individual disciplines such as materials engineering, mechanical engineering, polymer engineering, chemistry, chemical engineering, biochemistry, and biomedical engineering. This enables the division to provide a fully integrated service, which is one of the most important features that sets it apart from its competition. The ready availability of, and synergy with the Engineering Services Division within the company, provides another competitive edge that cannot be matched by any of the direct competitors.

3.4 Technology and infrastructure

The acquisition of Manlabs provided the Materials Engineering Division with a fully operational materials testing laboratory with all the basic apparatus and laboratory equipment in place and operational. Since the acquisition, some of the equipment have been upgraded or augmented and substantial investments into new equipment to expand the division's capabilities, have been made.

Presently, the division has the following capital intensive items of operational equipment:

- Cambridge Stereoscan scanning electron microscope (SEM) with Noran energy dispersive X-ray spectroscopy (EDS) attachment
- Amray scanning electron microscope (SEM) with Microspec wavelength dispersive X-ray spectroscopy (WDS) attachment
- Phillips X-ray diffractometer (XRD) with MicroVAX controller and analyser
- Instron 56000 pound servo-hydraulic loadframe with environmental chamber
- MTS 24000 pound servo-hydraulic loadframe
- Physmet charpy V-notch impact tester
- Wilson digital hardness tester
- Leitz microhardness tester
- Nanometrics infrared microspectrophotometer
- Nikon Optiphot reflected/transmitted light microscope
- Zeiss universal stereomicroscope
- Olympus universal stereomicroscope with video display
- Perkin Elmer differential scanning calorimeter (DSC)
- Beuhler metallurgical saw
- Beuhler grinding and polishing benches
- EG&G Potentiostat
- Singleton salt spray chamber
- Blue M controlled temperature and humidity chamber

The laboratories are well equipped with standard laboratory equipment and consumables such as glassware, wet and dry chemicals, small tools, balances, hot plates, ovens, furnaces, vacuum pumps, cameras, and personal computers. In addition, the division also has a wide array of portable field testing equipment that enable engineers to perform on-site field tests and evaluations.

3.5 Future services and infrastructure

Within the time period covered by this business plan, the following major pieces of laboratory equipment will be acquired to enhance the division's analytical and laboratory services capabilities:

- Gas chromatograph
- Fourier transform infrared spectrophotometer
- Equipment for small scale batch processing of polymer compounds
- Digital image acquisition and colour printing capability
- Autoclave for microbiology laboratory
- Anaerobic chamber for microbiology laboratory
- Biological safety cabinet with HEPA filtration for microbiology laboratory
- Fluorescence microscope for microbiology laboratory
- Two incubators (two different temperatures) for microbiology laboratory

In addition, several existing pieces of equipment will be upgraded and enhanced to ensure that the Materials Engineering Division remains competitive and on the cutting edge of technology in its historical areas of strength. This will include:

- Overhaul, electronic controls upgrade, and software upgrade of Instron and MTS servo-hydraulic mechanical testing loadframes.
- Software upgrade for the potentiodynamic polarisation corrosion measurement system.

In order to expand the diversity and depth of services offered, the following infrastructure enhancements will be made to the laboratory infrastructure within the next 3 years:

- Acquisition of a “hot lab” license which will allow the Materials Engineering Division to receive, store, and ship low-level radioactively contaminated pieces. To date, this type of work has been accomplished by means of an agreement with the MIT hot laboratory who would receive, store and ship pieces on behalf of the Materials Engineering Division for a fee. Currently, all laboratory work on such pieces is also performed in the MIT laboratory under the terms of the agreement. However, the continued growth in the frequency and volume of such work necessitates the acquisition of an individual company license. This would have the added benefit of vastly simplifying the logistics associated with the performance of radiological work. The award of such radiological licenses is controlled by a Massachusetts state agency and the application process could be quite involved and lengthy. Initial financial outlay will be substantial and will include the dedication of a room for radiological storage and the acquisition of monitoring equipment, shielded storage containers, signage and dedicated small tools for radiological work. Direct cost in the form of a yearly licensing fee is minimal.
- Upgrading of the existing basic microbiology laboratory into a full-fledged biomaterials and microbiology laboratory. Several pieces of vital equipment as indicated above will be acquired to enable the division to compete effectively in this arena.
- Upgrading of the existing local area computer network to a virtual area network which would facilitate instantaneous electronic communication between individuals within the division as well as clients and remote field offices. In addition, this would also provide individual high speed desktop access to the Internet which is continuously growing in stature and efficiency as a research and development tool.

3.6 Conclusion

The division is well positioned within the materials engineering services market to provide unique and high quality consulting services. The division has state of the art infrastructure that enables it to compete with the best in the field. The diversity and high level of expertise of the staff is a significant competitive advantage that must be exploited to the maximum. The current market conditions and strategies to take advantage of existing opportunities are examined in the following chapter.

CHAPTER 4. MARKET ANALYSIS

4.1 Introduction

The current status of the industry in which the company is operating is an important parameter influencing future planning and positioning. In the following paragraphs, the market in which the Materials Engineering Division is active, is analysed and discussed. Market segments, an important factor to determine the appropriate market positioning strategy, are identified. The main competitive forces and competitors are identified and analysed. Finally, a three-year forecast of market conditions within the market segments in which the company is planning to be active, is formulated.

4.2 Industry Analysis

The industrial power utility and manufacturing market is very large and diverse, encompassing everything from heavy manufacturing and power generation to biomaterials and micro-electronics. Traditionally, most of the Materials Engineering Division's work originated from the nuclear power generation industry, but in an effort to diversify its client base and lessen the company's dependence on a single market sector, the emphasis is shifting towards the high-tech manufacturing industry. The problem solving expertise and analytical capabilities that the division offer, are applicable to a large number of industrial markets and attractive opportunities exist within several segments. The challenge is to identify specific market segments and/or sectors within which Altran is most likely to succeed.

4.3 Market Segmentation

From the perspective of the Materials Engineering Division, the industrial market (excluding nuclear power generation) can be segmented into the following sectors:

- Non-nuclear power generation and distribution (i.e. fossil, co-generation, hydro)
- Other public and private utilities (i.e. water, natural gas)
- Chemical manufacturing
- Petroleum refining
- Biochemistry and biomaterials
- Pulp and paper
- Manufacturing and development
- Transportation
- Shipping
- Litigation support and insurance claims
- Construction

In order to compete effectively and render quality services, the Materials Engineering Division has to be selective in entering these market sectors. A finite number of these market sectors which exhibit the best fit with the Materials Engineering Division's capabilities, infrastructure, and long-term goals and strategies will be identified and targeted as part of the marketing plan for the next three years.

4.4 Competitive Forces

The failure analysis and materials engineering services offered by the Materials Engineering Division are mostly reactive in nature and as a rule highly time sensitive. In most instances these services are provided on an "emergency" basis and often at unconventional times and places. Altran's flexibility, continuous state of readiness, and ability to mobilise its forces within a short period of time is one of the most important competitive advantages that it has over its larger competitors. Although often logistically challenging, the urgency associated with these projects also allows the division to demand premium rates. The high public profile of disastrous failures often attract extensive press coverage which has the added benefit of free advertising and wide exposure for the company.

The Materials Engineering Division's past experience in especially the nuclear power generation industry provides it with a competitive advantage in the sense that a rigorous quality assurance (QA) programme is already in place and functioning very effectively. In the highly regulated arena of nuclear power generation this cannot be discounted, since the Nuclear Regulatory Commission (NRC), which is a U.S. Government agency, mandates that only approved vendors with an approved quality assurance programme in place, be contracted to perform consulting work. Although qualified in some disciplines, none of the division's competitors has the breadth and depth of its capabilities. The requirements of an approved quality assurance programme and the time, cost and effort in setting up such a system is an important barrier to entry for prospective competitors.

Another important barrier to entry to this field is the cost associated with setting up a facility with the scientific and analytical capabilities that the Materials Engineering Division possesses. The acquisition of a fully operational metallurgical testing laboratory at a relatively low cost provides a competitive advantage, which cannot easily be duplicated by competitors.

Past experience has shown that clients are relatively cost-insensitive in emergency type of projects where timeliness of services is the requirement. In these instances the division can demand a premium for its services. In other, less time-sensitive projects, competitive pricing is a definite issue. As a result, the division has to continuously monitor the pricing of its main competitors.

4.5 Main Competitors

The services offered by the Materials Engineering Division take advantage of the full diversity of its staff expertise. The competition varies depending on the specific topical area. In the area of nuclear power generation, noteworthy competitors include:

- Thielsch Engineering
- APTECH

- Protopower Corporation
- Tordonado Consultants

However, these companies are not as diverse in nature and do not offer substantial competition in the other industrial areas.

Companies that do offer competition in the general area of materials engineering include:

- Lucius Pitkin (Failure analysis, laboratory services)
- Structural Integrity Associates (Mechanical integrity issues)
- Failure Analysis Associates (Failure and root cause analysis)
- Massachusetts Materials Incorporated (Failure analysis and laboratory services)
- Cortest (Corrosion testing services, failure analysis)

However, comparative analysis has shown that no single one of these companies matches up with the Materials Engineering Division in terms of the diversity of its physical infrastructure or depth and breath of the expertise of its staff's capabilities.

4.6 Market Forecast

According to the U.S. Government Commerce Department figures published on the Internet, the United States economy continues to expand at a rate of between 4% and 5% on an annual basis. Inflation is virtually non-existent at an annualised rate of 2.5%. Interest rates continue to remain the lowest they have been in the past 30 years. Unemployment continues to remain low at 4.2% on an annualised basis.

All of the above economic indicators are conducive to vigorous expansion and growth in all sectors of the U.S. economy. With the manufacturing industry running at maximum capacity, the possibility of equipment failures due to more wear and tear and/or less frequent maintenance, increases considerably. This

translates into an anticipated increase in materials failure related projects coming the Materials Engineering Division's way. The high level of industrial activity leads to higher demand for electric power which, in turn, also translates to less frequent maintenance shutdowns of power plants and a subsequent increase in preventable equipment failures. Increased activity in all other manufacturing sectors spells a continuously growing increase in the demand for the type of materials engineering services that the division offers. Based on conservative US Government estimates for the industrial growth rate over the next three years, coupled to planned expansion into previously untapped market sectors, it is estimated that the division's revenue can comfortably grow at a minimum of 10% per year. More optimistically and based on the past two year's performance, the annual growth rate can potentially be as high as 30%.

4.7 Conclusion

The materials engineering consulting market was examined and analysed in the preceding paragraphs. The competitive forces and the division's main competitors were identified and analysed. Based on that analysis, specific market sectors were identified as target markets to be pursued and penetrated with a view to develop a larger and more diverse customer base. This will be instrumental in implementation of the goal to grow while at the same time diversifying into previously untapped market sectors. In the following chapter, a strategy and implementation plan will be developed to facilitate this diversification and growth of the division's client base.

CHAPTER 5. BUSINESS STRATEGY AND IMPLEMENTATION

5.1 Introduction

Careful identification and selection of target markets to pursue is one of the most important aspects of a successful business plan. The following paragraphs addresses this issue and then sets out a plan to reach the identified markets by means of a well planned marketing campaign. The various individual components of the implementation plan are identified and discussed. Finally, pricing strategies are discussed and possible candidates for the formation of strategic alliances are identified.

5.2 Target Markets

While maintaining and continuously growing the division's strong presence in the nuclear power generation market, a concerted effort will be launched with the objective to gain a much stronger foothold in specific markets within the high tech industrial manufacturing sector. This will serve as a vehicle to diversify and broaden the division's client base with the long-term objective to lessen its dependence on the nuclear power generation industry. By achieving this goal, the company will decrease its vulnerability to the business cycles which inevitably occur in the nuclear power generation industry.

The following market sectors will be targeted specifically:

5.2.1 Electronic manufacturing

A large number of small and medium sized companies that manufacture manufacturing machinery and/or components for the electronic manufacturing industry are located in the Northeast. Due to the chemically aggressive environment in which electronic products are processed, corrosion is an ever present concern and problem. These companies typically do not have in-house materials engineering expertise and rely almost exclusively on consultants for such needs. Over the course of the past year, limited efforts to break into this

market have been quite successful, but there is much scope for a larger presence in this field. The extensive corrosion testing capabilities of the division provide an excellent entry vehicle into this market sector and marketing efforts will be focused on these capabilities.

5.2.2 Light industrial manufacturing

The Northeast is the traditional cradle of light precision manufacturing. Several firearms manufacturers such as Smith and Wesson, Marlin, and Colt were founded and are still headquartered in New England. The same applies to well known bearing manufacturers such as Barden and Torrington and the world-renowned toolmaker, Stanley. All of these manufacturing companies deal with materials related problems and challenges on a daily basis. Due to cost cutting and downsizing in recent years, many of these companies have lost the in-house capability to deal effectively with such challenges. This also applies to qualification and certification of new products and product ranges. As a result, these tasks are routinely subcontracted. With the expertise and infrastructure at its disposal, the Materials Engineering Division is well positioned to capture a sizeable portion of this business.

5.2.3 Biomaterials and biomedical implants

In very much the same way that Silicon Valley in California is recognised as the epicentre of computer software development, the Boston area is recognised for its leadership in the bio-engineering field. Several well-established companies such as Genzyme, Boston Scientific Corporation, and Nitinol Medical Technologies are headquartered in the Boston area. The close proximity and proliferation of related companies provide a unique opportunity to position the Materials Engineering Division as a provider of high quality materials engineering and testing services.

The opportunities for the Materials Engineering Division are found in the offering of value-added service to the research and development departments of medical device companies. The division's service capabilities for this sector

include mechanical testing, microbiological analysis, and coatings development, corrosion testing and evaluation, surface analysis, polymer formulation, and failure analysis. As with the nuclear power generation market sector, the biomedical business is heavily regulated by government bodies on a world wide basis. However, to date the regulations have typically not been as strict for manufacturers of medical devices. Growth in this sector is expected to increase with changes in patient demographics; the leading edge of the “baby-boom” generation is now 54 years of age. The increase in the relative proportion of ageing adults will continue for at least the next 15 years. A coincident demand for implantable devices such as hip replacements, knee replacements, stents, heart pacemakers and others, can therefore be expected. The regulatory environment is expected to become more restrictive as the demand and associated competition increase. It is anticipated that materials science will assume a more important role in this highly regulated business environment. In addition, it is expected that product claims will face greater scrutiny and new devices and/or materials will require more extensive validation studies. Infection resistance, biocompatibility, and biodeterioration issues may well become more significant over the next years. An independent materials science and design engineering consultant who can effectively address these issues in a highly regulated environment, will be successful in developing new business with emerging small to medium sized companies. As the trend towards downsizing and/or closing of R&D departments at larger manufacturers continue, their materials science-related business may also be captured.

5.2.4 Litigation support and insurance claims

The Materials Engineering Division has built good relationships with local law firms and insurance adjusters as a reputable provider of independent, third party materials engineering support services. However, the total revenue from this sector remains comparatively low and there is much scope to expand the division’s presence and involvement. The division’s association with world-renowned experts in their respective fields provides an unique opportunity and vehicle to establish a firm foothold in this sector. Due to the adversarial nature of litigation, independent experts with impeccable credentials and associations

are a much sought after commodity. Due to its wide recognition as centres of excellence, the professors from MIT and Harvard Universities are often retained by law firms and insurance companies as expert witnesses in their respective fields. Under the current agreement, all of the associated laboratory testing and analyses are performed by Materials Engineering Division staff in its facilities. Revenue from depositions and testimony in litigation are channelled through the division. Due to the substantially higher rates that can be demanded for such services, the profit margin on these services is higher than with normal industrial or power utility related consulting. To date, all of this work has been performed on a time and materials basis, but the possibility of providing these services on a contingency basis, will be pursued as part of this plan. A concerted effort to aggressively expand this market sector both locally and nationally will be launched during 2000.

5.3 Marketing Strategy

Since its founding, the Materials Engineering Division of Altran Corporation has relied on past customers and word-of-mouth referrals to market its services. This approach has worked well in those years where the division remained small and flexible. However, it was recognised that in order to realise and sustain significant growth, attain the goal of broadening its client base, and establish itself in the specified target markets, a more formal and deliberate marketing strategy would have to be devised to augment the existing methods. In response, the decision was made to embark on a programme of process marketing as one of the vehicles to achieve these goals.

Process marketing is consistent marketing activity undertaken over the long term that utilises the laws of probability to achieve results. A process marketing programme is comprised of a series of promotional activities that, when repeated enough and over a long enough period of time, will build a firm's name recognition and reputation, establish the firm as the expert in a particular market sector, generate new leads, and improve its closing rate.

The benefits of process marketing can be summarised as follows:

- Generates opportunities efficiently.
- Makes the company more resilient over time.
- The process is controllable.
- It encourages the client to initiate the first contact instead of the company calling on the client.
- Enables the company to target a specific group of clients.
- Communicates complicated messages effectively.
- Evens out the firm's revenue peaks and valleys.
- Success can be measured.
- Positions the company as an experts in its field.

5.4 Promotion Strategy

A twenty-four month positioning effort using direct mail will be utilised as the main process marketing vehicle. The purpose of the campaign is to maintain the strong Altran brand name among current clients, and to build name recognition with potential clients where the company has no current presence.

The key to a successful direct mailing campaign is a diverse and extensive mailing list. A mailing list database was compiled from the following sources:

- The original Materials Engineering Division industrial contacts database. This effort yielded approximately 1300 names.
- Input of select individuals (by position) from the organisation charts of target customers using sources such as business cards collected at trade shows, the Thomas Register, and the New England High Tech database.
- Purchased mailing lists of industrial manufacturing decision makers. These lists are purchased on a per-use basis, and the objective is to build a mailing list of approximately 3500 names.
- Names submitted by staff members.

A mailing house contracted by the division will refine the various databases and perform a "merge-and-purge" operation to produce a single mailing list with no

duplications. They will then fold the item to be mailed, address and fill the envelopes and mail the pieces using bulk mail or regular business mail.

5.4.1 Direct Mailings

A minimum of 20 direct mailings will be sent out in the next twelve months.

These will consist of:

- Four newsletters
- Four personal letters sharing interesting news and “war stories”
- Four surveys
- Four survey results
- Four postcards

In addition to the direct marketing pieces identified above, twelve press releases will also be issued.

5.4.2 Newsletters

A newsletter geared towards industrial manufacturing clients, and named “Industrial Insights”, is a single sheet document that will consist of two articles on topics of interest to the industrial decision maker, along with related sidebars and a calendar of events. The articles are not intended to be blatantly self-serving to the Materials Engineering Division’s interests, but rather to provide interesting information to the reader with a view to stimulate their interest into contacting the division when the need for such services arise. In an effort to contain cost, the conceptualisation, layout design, and production to the point of camera-ready proofs will be conducted in-house by Altran Corporation staff. Printing and mailing will be subcontracted. A sample copy of a newsletter is included as Appendix A.

5.4.3 Surveys

Surveys will be conducted on issues integral to the manufacturing industry. These surveys will provide insights on the division’s client base, as well as additional contacts. For both current and potential clients the survey results will

provide an industry wide perspective on trends. Survey recipients will typically be given about two weeks to respond. After tabulating and analysing the results it is then mailed to all the recipients within two months - whether they responded or not - providing another four direct mailing pieces. The surveys are intended to elicit information that is newsworthy and therefore survey results may also be published as press releases. A sample copy of a survey is included as Appendix B.

5.4.4 Postcards

Topical postcards will have announcements, reminders of upcoming events such as workshops, and small tidbits of useful information. A sample copy of a postcard with a reminder for a workshop is included as Appendix C.

5.4.5 Press Releases

In addition to the direct marketing pieces, press releases will be issued on a regular basis. Each press release will contain newsworthy information that is relevant to existing and prospective clients. These press releases will be sent electronically via Business Wire to individuals on the industrial press list. Subject matter for press releases will be derived from a number of sources, including survey results, newsletter articles, general announcements, and announcements for future seminars.

5.4.6 Brochures

Several four-page, full colour brochures highlighting various areas of expertise within the company will be produced as an integral part of this campaign. These brochures will be used as marketing tools during face-to-face client contacts and will also be mailed to various focus groups within the mailing list. A sample copy of a brochure on corrosion engineering, which is the first of the series of brochures to be produced under this programme, is included as Appendix D. Topics to be covered by subsequent individual brochures include biomaterials engineering, biofouling and its control, failure analysis and forensic engineering and general laboratory services.

5.4.7 Technical notes

Altran Technical Notes are a series of single-sheet “product data sheets” showcasing the Materials Engineering Division’s capabilities in emerging technical issues. They will normally consist of a background, technical discussion, an overview of the division’s involvement and capabilities in the particular issue, and one or more case studies. As part of this campaign, six technical notes have been selected to be distributed via mass direct mail, along with a cover letter by the division’s expert/s on the subject. The purpose of the cover letter is to convey tips and hints on dealing with the issue, further underscoring the division’s expertise and experience. A sample copy of a Technical Note is included as Appendix E.

5.4.8 Seminars and Workshops

The Materials Engineering Division will host three to five for-fee seminars or workshops per year on a variety of engineering topics of interest to industry and industrial decision makers. It is anticipated that these seminars will be two to three days in length, hosted in Boston, and have a target attendance of 20 to 50. Direct mail pieces announcing the seminars will be sent out to all the recipients on the mailing list. Seminars and workshop are good vehicles to establish contact with potential clients and bring them to the division to see the laboratories and meet its staff. A sample copy of a workshop flyer and registration documentation is included as Appendix F.

5.5 Pricing Strategy

The Materials Engineering Division generates its revenue by selling both staff time and laboratory time to its clients. Most projects are conducted on a time and materials basis in accordance with rates that are revised on a yearly basis. However, in rare cases and upon special request from clients, projects are performed on a fixed cost basis. This is only acceptable when the project scope is well defined and the division has adequate experience and confidence that the work can be completed within the constraints of the negotiated time and budget.

The division has a three-tier rate schedule. Rates for projects performed for the nuclear power generation industry are negotiated on a yearly basis and are generally lower than the rates that can be demanded from industrial clients. For this reason a distinction is made between power utility rates and industrial rates. Litigation and insurance claim related projects are charged in accordance with the litigation rate schedule. Copies of the rate sheets for the three categories are included in Appendix G. In cases where projects are performed on an emergency basis, a premium of 15% is charged over and above the applicable hourly rate. This applies to staff time as well as laboratory and instrument usage.

5.6 Strategic Alliances

The formation of strategic alliances with companies that offer services in support of the division's core business, is a cost effective way of expanding its capabilities with a very limited investment. Services that lend themselves to such arrangements are:

- non-destructive testing which include:
 - radiography
 - liquid penetrant testing
 - acoustic emission testing
 - ultrasonic inspection
 - magnetic particle testing
 - eddy current testing
- high speed videography
- cathodic protection
- protective coatings application and installation
- concrete testing

All of these support services are accessed on an as-needed basis by the Materials Engineering Division. However, the volume and frequency of such work does not justify the capital commitment to acquire the equipment and trained staff to provide these services. In many instances, especially in the non-

destructive testing field, alliances already exist and are functioning well. In other fields such as cathodic protection and protective coatings, possible allies have to be identified and agreements have to be put in place.

5.7 Conclusion

A thoughtful, but pragmatic promotion and marketing plan is an integral part of any well-structured business plan. In the preceding paragraphs, practical steps and actions that will enable the division to get its message across to the previously identified target market sectors, were laid out. In the following chapter, the state of current staffing will be examined and future personnel needs and requirements will be identified.

CHAPTER 6. ORGANIZATION

6.1 Introduction

It is widely recognised by management scholars that a one of the keys to building successful companies is the creation of an organisation in which the members feel responsible for and involved in the management of the organisation (Lawler, 1992:3). This can be achieved by correctly structuring the work, the provision of good leadership, and by putting appropriate management practices in place. The following paragraphs will examine and analyse the current organisational state of the Materials Engineering Division with a view to set the stage to achieve the business goals and objectives defined in Chapter 2.

6.2 Organisational Structure

As a modern day, technically orientated organisation, the Materials Engineering Division does not have a highly formalised organisational structure. Due to the short term nature of project work, project teams are formed and dissolved on an as-needed basis. Team members are selected on the basis of their specific experience and expertise and project leaders often preside over team members who are on a higher hierarchical level than themselves. This approach is followed consistently in the Materials Engineering Division where the success of any given project depend on the smooth and seamless co-operation between team members from various disciplines and divisions.

In terms of hierarchical levels the division can therefore be best described as a “flat” organisation with no well-defined hierarchy. However, the basic elements for the creation of a typical matrix organisation are in place and will become more pronounced as the division grows. Matrix structures are especially applicable to organisations that are required to respond rapidly to changes in their operating environment (Gibson, 1991:451). It is therefore considered to be the most appropriate organisational structure for the division.

6.3 Management Team

The management team of the Materials Engineering Division currently consists of the company president, a vice president, the chief financial officer and the engineering manager. Both the company president and the chief financial officer fulfil this role for all divisions of the company and as such are not viewed as full-time employees of the Materials Engineering Division. The division makes an annual corporate overhead payment to cover the cost of their and other administrative services to the division. Individual staff members with expertise in particular disciplines are co-opted on an ad-hoc basis to deal with specific issues related to their area of expertise should the need arise.

6.4 Management Team Gaps

The most noticeable gap in the Materials Engineering Division management team is that of a full time laboratory administrator. Currently, the day-to-day management and administration of the laboratory is shared by the engineering manager and senior engineers. However, this arrangement is less than optimal since highly billable engineering time is spent on administrative tasks that can be handled much more efficiently and cost effectively by an administrator. As such, the recruitment of a suitable person to fill this position is a high priority.

Over the longer term, as the different disciplines within the division grow and expand, the appointment of team leaders or directors with specific responsibility for individual disciplines such as biomaterials, corrosion engineering, polymer engineering, and biofouling may become necessary. In some instances the talent to assume such a leadership role already exist within the division, but in other cases such as biomaterials and biofouling, staff with such capabilities will have to be recruited. The most pressing need is currently for a director of biofouling and biomaterials and a suitable person will be recruited in 2000. The need for a full-time marketing manager will become more and more pronounced as the division grows and revenue goals are met. It is foreseen that a full-time marketing professional will be hired in the third year of the period covered by this business plan.

6.5 Personnel Plan

6.5.1 Current Personnel Situation

The current staff complement includes the following filled positions. Their respective areas of training and expertise, which naturally is also be their major areas of responsibility within the division, are also listed:

- **Vice President (Master of Science in Materials Engineering)**
Materials engineering, product development, polymer engineering, failure analysis, materials selection, forensic engineering, plant surveys, scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy, wavelength dispersive X-ray spectroscopy.
- **Engineering Manager (Ph.D. in Metallurgy)**
Corrosion and wear, metallurgy, mechanical testing, failure analysis, materials selection, metallography, corrosion engineering, corrosion evaluation and testing, forensic engineering, plant surveys, exposure testing, environmental testing.
- **Senior Engineer (Ph.D. in Metallurgy)**
High temperature corrosion and wear, metallurgy, failure analysis, phase equilibria, plant surveys, X-ray diffraction.
- **Lead Engineer (Bachelor of Science in Polymer Engineering)**
Polymer engineering, product development, mechanical testing, failure analysis, and forensic engineering.
- **Scientist (Master of Science in Microbiology)**
Microbiology, biologically induced corrosion, biological fouling, biological corrosion, culturing, isolation, and identification of micro-organisms, biological contamination control.

- **Scientist (Bachelor of Science in Metallurgy)**
Scanning electron microscopy, energy dispersive X-ray spectroscopy, wavelength dispersive X-ray spectroscopy, metallography, X-ray diffraction.
- **Materials Engineer (Master of Science in Mechanical Engineering)**
Mechanical testing, failure analysis, concrete testing, manufacturing support.
- **Materials Engineer (Bachelor of Science in Mechanical Engineering)**
Polymer engineering, compounding, manufacturing support, failure analysis.
- **Technical Supervisor (Associates degree in Electrical Engineering)**
Failure analysis, electrical testing, infrared spectroscopy, scanning electron microscopy, energy dispersive X-ray spectroscopy, wavelength dispersive X-ray spectroscopy, information systems support.

In support of the above technical personnel, the division also employs an administrative assistant and one technical assistant.

6.5.2 Future Personnel Plan

In order to attain the goals set for the next three years, a substantial expansion of the current personnel complement will have to be accomplished.

During 2000, a laboratory administrator will be recruited to manage the day-to-day administration of the laboratory. The support staff for engineers and scientists will be strengthened with the appointment of a technician with machining and maintenance capabilities. Towards the middle of the year, a lead engineer with capabilities and experience in the biomaterials field will be recruited.

In an effort to strengthen the microbiology and biomaterials expertise, a senior scientist with the appropriate background and experience will be recruited early in 2000. This individual will be charged with the responsibility of developing marketing materials in this sector, the development of infrastructure, building of the product line to a viable and sustainable level, and the provision of leadership to staff. Towards the middle of the year, it is anticipated that administrative needs will necessitate the recruitment of a receptionist to assist with the fielding of incoming telephone calls and general administrative support.

During 2002 a senior engineer with a metallurgical or manufacturing background will be recruited. In addition, two engineers, one with a mechanical engineering background and one with a chemical or corrosion engineering background, will be recruited. This will become necessary as a result of the anticipated growth in revenue from the target sectors. Another laboratory technician to support the increased laboratory activity will be hired at the beginning of this year.

6.6 Conclusion

Personnel needs for the next three years will largely be determined by the level of success achieved during the implementation of growth and expansion plans previously laid out. It is often extremely difficult to make a decision with regard to the timing of a new hire, especially in the consulting business where the skills and experience of specific individuals are key. The ultimate goal is to time recruitment such that the new employee can “hit the ground running” in the sense that adequate business will have been generated to achieve a fairly high and consistent utilisation rate from the outset. The personnel plan described in the preceding paragraphs is structured toward that goal. The following chapter will examine the financial situation of the division and will formulate a financial strategy aimed at the improvement of the financial health of the division over the course of the next three years.

CHAPTER 7. FINANCIAL ANALYSIS

7.1 Introduction

The ultimate vehicle for any organisation to achieve its goals and objectives, is a sound and feasible financial plan. The financial plan enables employees to take the steps and acquire the necessary tools and/or services to “make things happen”. In addition it also provides a quantifiable yardstick by which success or failure can be measured. The following paragraphs examine some of the historical financial performance of the division and lays out plans for the next three years in terms of financial goals and objectives.

7.2 Financial plan

7.2.1 General assumptions

The following table lists general assumptions regarding the expected state of the U.S. economy and certain key company ratios and figures that apply for the purposes of this analysis:

Table 7. 1 Company Ratios and Figures

	2000	2001	2002
Short term interest rate %	7.50%	7.75%	8.25%
Long term interest rate %	7.00%	7.50%	8.00%
Accounts payable days outstanding	35	35	35
Collection days	45	45	45
Tax rate %	25%	25%	25%
Sales on credit %	100%	100%	100%
Benefits burden %	12%	12%	12%

(Source: Internal company forecast)

7.2.2 Anticipated personnel expenditures

Projected personnel expenditures are based on current staff salaries with a 12% benefits burden. A yearly salary increase of 2% is taken into account for all staff. The retainers for University associates are negotiated on a three-year cycle and are not affected by this business plan. Detailed monthly compensation forecasts are included in Appendix H.

Table 7.2 Anticipated Personnel Expenditures

Position	2000	2001	2002
Vice President	\$95,004	\$96,900	\$98,844
Retainers: Associates	\$192,000	\$192,000	\$192,000
Engineering Manager	\$80,004	\$81,600	\$83,232
Laboratory Administrator	\$37,919	\$66,300	\$67,620
Engineering/Scientific Staff	\$306,843	\$397,958	\$510,816
Technical Support Staff	\$93,004	\$99,960	\$133,500
Administrative Support Staff	\$24,000	\$37,430	\$47,772
Subtotal	\$828,774	\$972,148	\$1,133,784
Benefits (12%)	\$99,453	\$116,658	\$136,054
Total	\$928,227	\$1,088,806	\$1,269,838

(Source: Internal company forecast)

7.2.3 Anticipated capital expenditures

In order to expand the technical capabilities of the laboratory and continuously update existing equipment, a number of capital intensive expenditures are planned. During the first year, these expenditures will be focussed on enhancing the capabilities of the biochemistry laboratory. In the following two years the focus will shift towards updating and modernisation as outlined in Table 7.3.

Table 7.3 Anticipated Capital Expenditures

Capital Item	2000	2001	2002
Anaerobic Chamber (Used)		\$18,000	
Biological Autoclave (Used)			\$22,000
Biological Safety Cabinet (Used)		\$12,000	
Biological Incubators (2)	\$24,000		
Desktop Computers	\$20,000	\$25,000	\$35,000
Digital Imaging Equipment		\$12,000	
Flourescence Microscope			\$26,000
FTInfrared Spectroscopy Microscope		\$65,000	
Frequency Response Analyzer			\$33,000
Gas Chromatograph			\$60,000
Polymer Processing Equipment		\$40,000	\$70,000
Radiological "Hot" laboratory	\$6,000	\$6,000	\$12,000
Upgrade of loadframes	\$40,000		
Upgrade of Computer Network	\$20,000		
Total capital expenditure	\$110,000	\$178,000	\$258,000

(Source: Internal company forecast)

7.3 Pro forma income statement

The pro forma income statement is an important tool to judge the profit or loss performance of a company. It provides an overview of the projected performance at the end of each of the three years covered by this plan. Comparison to actual income figures will facilitate timely evaluation of how well the plan is being executed and if revenue targets are indeed being achieved.

Table 7.4 Pro Forma Income Statement

	<u>2000</u>	<u>2001</u>	<u>2002</u>
Revenue	\$2,581,105	\$3,125,724	\$3,829,397
Cost of Sales			
Direct Labour:	\$828,774	\$972,148	\$1,133,784
Benefits (12% of Direct Labour)	\$99,453	\$116,658	\$136,054
Total Labour & Fringe Benefits	\$928,227	\$1,088,806	\$1,269,838
Other:			
Subcontractors Direct (7% of Revenue)	\$180,677	\$218,801	\$268,058
Travel (6.5% of Revenue)	\$167,772	\$203,172	\$248,911
Other Expenses (3% of Revenue)	\$77,433	\$93,772	\$114,882
Total Other	\$425,882	\$515,744	\$631,851
Total Cost of Sales	<u>\$1,354,109</u>	<u>\$1,604,550</u>	<u>\$1,901,689</u>
Gross margin	\$1,226,996	\$1,521,174	\$1,927,709
Gross margin percent	47%	49%	51%
Operating expenses:			
Labour - Eng. Serv. Div. (10% of Revenue)	\$258,110	\$312,572	\$382,940
Corporate Overhead (5% of Revenue)	\$129,055	\$156,286	\$191,470
Marketing (2% of Revenue)	\$51,622	\$62,514	\$76,588
Leased Equipment	\$30,000	\$20,000	\$10,000
Utilities 5%	\$42,000	\$44,100	\$46,305
Insurance 5%	\$50,000	\$52,500	\$55,125
Depreciation	\$94,926	\$104,419	\$114,860
Rent 2%	\$550,000	\$561,000	\$572,220
Other	\$0	\$0	\$0
Total Operating Expenses	<u>\$1,205,714</u>	<u>\$1,313,392</u>	<u>\$1,449,508</u>
Profit Before Interest and Taxes	\$21,282	\$207,782	\$478,201
Interest Expense ST	\$8,775	\$5,738	\$2,450
Interest Expense LT	\$10,850	\$10,850	\$10,850
Taxes Incurred	\$414	\$47,799	\$116,225
Net Profit/(Loss)	\$1,243	\$143,396	\$348,675
Net Profit/Revenue	0.05%	4.59%	9.11%

(Source: Internal company forecast)

Revenue forecasts are based on the assumption that engineering and scientific personnel will maintain an average personal utilisation rate of 80% together with a laboratory utilisation rate of 40% for each staff member. These assumptions are based on the average utilisation rates for the past two years. However, utilisation of instrumentation that are charged on an individual hourly basis, such as scanning electron microscopy, is included in the laboratory utilisation projections for the purpose of revenue forecasts. Detailed monthly revenue forecasts are included in Appendix I. Figure 1 shows a chart highlighting the most important revenue figures.

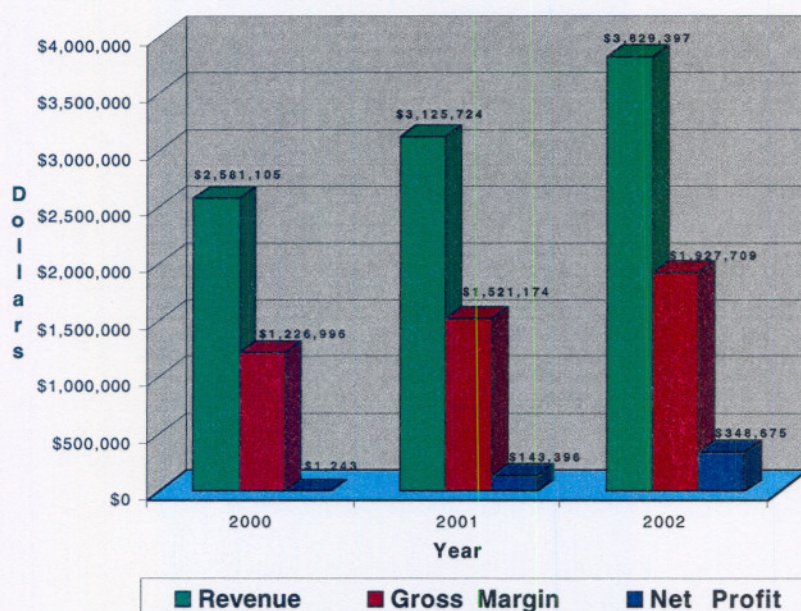


Figure 1. Revenue highlights for 2000 to 2002. (Source: Internal company forecast)

7.4 Pro forma cash flow analysis

The pro forma cash flow analysis is an important tool for predicting the day-to-day liquidity of an enterprise. Requirements for acquisition or repayment of loans as well as requirements for capital expenditure factor into the cash flow analysis which enable the management to plan ahead and secure prior financing in a timely fashion. When compared to actual figures, it also serves as a fairly accurate yardstick of how well the business plan is actually implemented.

Table 7.5 Pro Forma Cash Flow Analysis

	2000	2001	2002
Net Profit:	\$1,243	\$143,396	\$348,675
Plus:			
Depreciation	\$97,826	\$133,426	\$185,026
Change in Accounts Payable	\$12,500	\$15,000	\$13,764
Change in Accounts Payable (Interdivision)	\$6,000	\$9,000	\$12,000
Current Borrowing (Repayment)	\$0	(\$50,000)	(\$50,000)
Increase (decrease) Other Liabilities	\$17,453	\$50,993	\$70,087
Long-term Borrowing (Repayment)	\$0	(\$50,000)	\$0
Capital Input	\$0	\$0	\$0
Subtotal	\$135,022	\$251,815	\$579,552
Less:			
Change in Accounts Receivable	\$10,000	\$15,000	\$65,000
Change in Accts Receivable (Interdivision)	(\$2,000)	\$3,000	\$8,000
Change in Other Short Term Assets	\$0	\$0	\$0
Capital Expenditure	\$110,000	\$178,000	\$258,000
Subtotal	\$118,000	\$196,000	\$331,000
Net Cash Flow	\$17,022	\$55,815	\$248,552
Cash Balance	\$24,410	\$80,225	\$328,777

(Source: Internal company forecast)

Figure 2 shows a comparative chart of salient cash flow figures for the years 2000, 2001, and 2002.

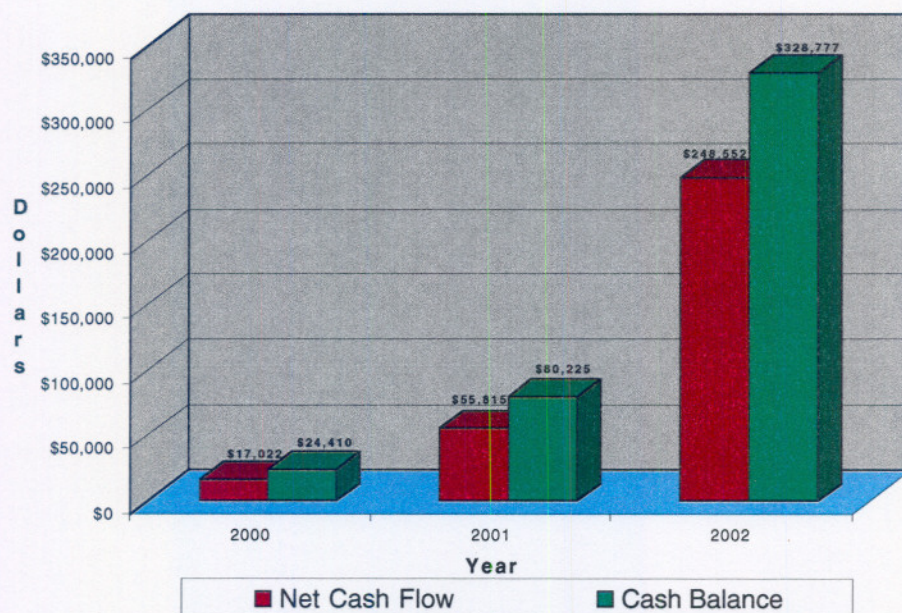


Figure 2. Cash flow figures for 2000 to 2002. (Source: Internal company forecast)

7.5 Pro forma balance sheet

The pro forma balance sheet provides a summarised snapshot of the assets and liabilities of an enterprise at a specific point in time. In this case, the projected balance sheets on December 31st of 2000, 2001, and 2002 respectively, are presented. It is a valuable predictive tool to be used to judge how well the business plan is being implemented and if projected financial targets are being met or exceeded during the course of the three-year implementation period.

Table 7.6 Pro Forma Balance Sheet

Assets	Starting Balances	2000	2001	2002
Cash	\$7,388	\$24,410	\$80,225	\$328,777
Accounts receivable	\$367,723	\$377,723	\$392,723	\$457,723
Accounts receivable (Interdivision)	\$19,488	\$17,488	\$20,488	\$28,488
Prepaid Expenses and Other Assets	\$0	\$0	\$0	\$0
Subtotal: Current Assets	\$394,599	\$419,621	\$493,436	\$814,988
Capital Assets - Gross	\$379,130	\$489,130	\$667,130	\$925,130
Less: Accumulated Depreciation	(\$174,196)	(\$272,022)	(\$405,448)	(\$590,474)
Subtotal: Capital Assets	\$204,934	\$217,108	\$261,682	\$334,656
Total Assets	\$599,533	\$636,729	\$755,118	\$1,149,644
Liabilities and Equity				
Current Liabilities				
Accounts Payable	\$50,933	\$63,433	\$78,433	\$92,197
Accounts payable (Interdivision)	\$41,633	\$47,633	\$56,633	\$68,633
Notes Payable	\$135,000	\$135,000	\$85,000	\$35,000
Other Short Term Liabilities	\$7,961	\$25,414	\$76,407	\$146,494
Subtotal Current Liabilities	\$235,527	\$271,480	\$296,473	\$342,324
Long-term Liabilities				
Long Term Loan	\$155,000	\$155,000	\$105,000	\$105,000
Subtotal Long Term Liabilities	\$155,000	\$155,000	\$105,000	\$105,000
Total Liabilities	\$390,527	\$426,480	\$401,473	\$447,324
Investors Capital	\$200,000	\$200,000	\$200,000	\$200,000
Retained Earnings	(\$21,728)	\$9,006	\$10,249	\$153,645
Yeartotal Net Income	\$30,734	\$1,243	\$143,396	\$348,675
Total Equity	\$209,006	\$210,249	\$353,645	\$702,320
Total Liabilities and Capital	\$599,533	\$636,729	\$755,118	\$1,149,644
Net Worth	\$209,006	\$210,249	\$353,645	\$702,320

(Source: Internal company forecast)

7.6 Business ratios

Business ratios provide valuable insight with regard to the effectiveness of the financial management of an enterprise. Profitability ratios show the combined effects of liquidity, asset management, and debt management on operating results (Brigham, 1998:881). Activity ratios are indicators of how effectively the firm is managing its assets (Brigham, 1998:876). Debt ratios provide information regarding the extent to which borrowed funds are used to finance assets and also show to what extent fixed charges are covered by operating profits (Lambrechts, 1990:127). The liquidity ratios reveal whether the firm will be able to meet its maturing obligations (Brigham, 1998:874).

Table 7.7 Business Ratios

	2000	2001	2002
Profitability Ratios:			
Gross margin	47.00%	49.00%	51.00%
Net profit margin	0.05%	4.59%	9.11%
Return on Assets	0.20%	18.99%	30.33%
Return on Equity	0.59%	40.55%	49.65%
Activity Ratios			
Accounts Receivable Turnover	6.53	7.56	7.88
Collection days	55.12	47.59	45.71
Total asset turnover	4.05	4.14	3.33
Debt Ratios:			
Debt to net Worth	2.03	1.14	0.64
Short-term Debt to Liabilities	0.64	0.74	0.77
Liquidity ratios:			
Current Ratio	1.55	1.66	2.38
Quick Ratio	1.55	1.66	2.38
Additional ratios:			
Assets to revenue	0.25	0.24	0.30
Debt/Assets	67%	53%	39%
Current debt/Total Assets	43%	39%	30%
Utilization Ratio	11.89	11.94	11.44
Total Asset Turnover	4.05	4.14	3.33

(Source: Internal company forecast)

7.7 Conclusion

Figure 3 summarises the key financial benchmarks for the next three years. Revenue will steadily increase to a ratio of 1,21 in 2001 and 1,48 in 2002 when compared to the projected revenue for the year 2000. That meets the targeted increase in revenue of at least 20% per year over the next three years.

Gross margin percentages show a slight increase from 47% in 2000 to 49% in 2001 and 51% in 2002 respectively. Expressed as ratios relative to the gross margin percentage for the year 2000, it translates to 1,04 in 2001 and 1,09 in 2002.

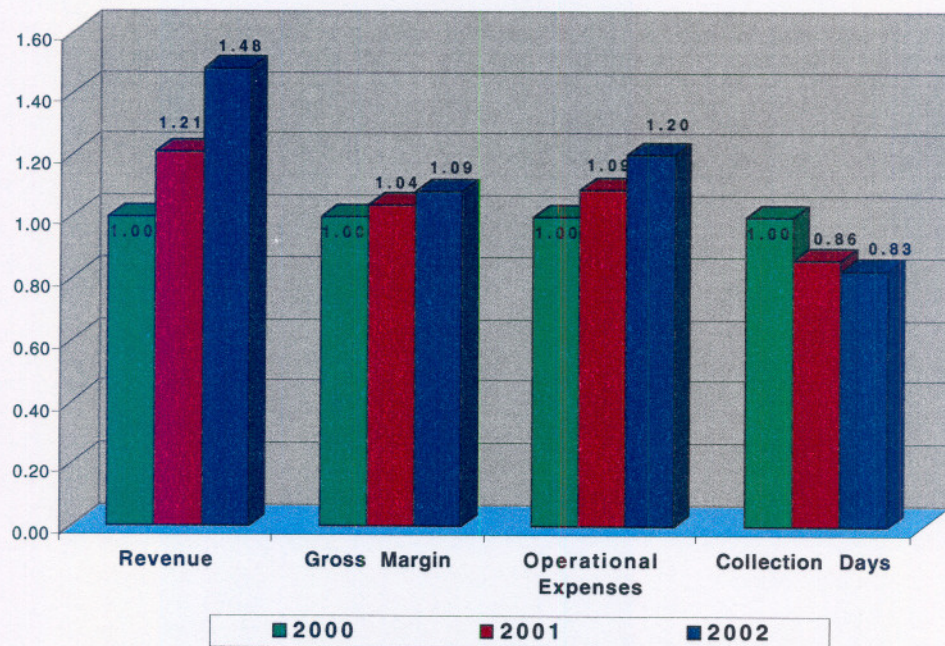


Figure 3. Projected division performance in terms of profit variables.

(Source: Internal company forecast)

Operational expenses will be kept in check as evidenced by moderate increases of 8,9% in 2001 and 10,4% in 2002 while over the same time period the net profit to revenue ratios will increase to 4,59% in 2001 and 9,11% in 2002 respectively.

Improvements in debt management is evidenced by the decreasing trend in collection days from the average of 55.12 days in 2000, to 47.59 days in 2001, and 45.71 days in 2002. This is also in line with stated goals and objectives.

CHAPTER 8. CONCLUSIONS

The preceding business plan is designed to guide the Materials Engineering Division of Altran Corporation through a period of significant change during which the major emphasis will be on growth and the improvement of profitability. The division is well positioned to take advantage of the sustained and ongoing boom in the American economy, provided that proper planning is performed and that such plans are executed properly and completely.

The following keys to success were identified:

- Excellence in fulfilling the promise - reliable, trustworthy, and consistent expertise and work product.
- Developing greater visibility and name recognition, both nationally and internationally to generate new business leads.
- Leveraging from a very specialised and limited clientele into multiple stand-alone revenue generation opportunities.
- Diversification into a number of lucrative market sectors that are very strongly represented in the New England area.

This business plan focuses on strategies and steps that can be taken proactively to achieve these keys to success.

In order to remain competitive and on the cutting edge of technology, provision is made for capital expenditures for the acquisition of several new pieces of analytical equipment. In addition, several existing pieces of equipment will be upgraded and enhanced. The materials engineering consulting market, the competitive forces, and the division's main competitors were identified and analysed. Based on that analysis, specific market sectors were identified as target markets to be pursued and penetrated with a view to develop a larger and more diverse customer base. A process marketing strategy utilising direct mailings, press releases, and seminars and workshops will be launched to facilitate the positioning of the division as a preferred provider of materials engineering services. Where feasible, strategic alliances will be forged with other enterprises to augment the services of the division.

This plan also makes provision for measured growth in terms of staffing with the goal of developing into a matrix type organisational structure by the end of 2002. Immediate needs such as the appointment of a full-time laboratory administrator will be addressed within the first year, while longer term needs such as directors for the individual disciplines will be dictated by the rate of growth and expansion. The appointment of a full-time marketing professional as soon as possible, but definitely by the beginning of 2002, is seen as a crucial element for the success of marketing efforts. At that point in time the direct mailing campaign will be well underway, and follow-up, face-to-face contact with potential new clients will be essential for an improvement in the closing rate.

Financially, the emphasis will be to accelerate revenue growth the targeted level of at least 20% per year over the next three years. The projected profit margin will increase from 0,05% in 2000 to 9,11% in 2001, facilitating capital expenditures for improvement of infrastructure as previously defined.

The achievement of all the goals and objectives outlined in this plan by the end of 2001 will place the division in a position of not only excellent financial health, but will also position it to continue strong and healthy growth in years to come.

BIBLIOGRAPHY

- Adams, B., *Complete business plan*, Adams Media Corporation, 1998.
- Arkenbauer, James B., *Guide to writing a high-impact business plan – A proven blueprint for entrepreneurs*, McGraw-Hill, 1995.
- Bhalla, S.K., *The effective management of technology*, Batelle Press, 1978.
- Brigham, E.F & Gapenski, L.C., *Financial management – Theory and Practice*, 9th Edition, The Dryden Press, 1998.
- Cohen, W.A., *Model business plans for product businesses*, J. Wiley & Sons, 1995.
- Covello, J.A. & Hazelgren, B.J., *The complete book of business plans*, Sourcebooks, Inc. 1995.
- Gibson, J.L., Ivancevich, J.M. & Donnelly, J.H., *Organizations: Behavior, Structure, Process*, 7th Edition, Irwin, 1991.
- Goodstein, L., Nolan, T, & Pfeiffer, L.W., *Applied Strategic Planning: How to Develop a Plan That Really Works*, McGraw-Hill, 1992.
- Jacksack, S.M. (Editor), *Business plans that work for your small business*, CCH Incorporated, 1998.
- Katzenbach, J.R., *Real change leaders – How you can create growth and high performance at your company*, Nicolas Brealey Publishing Limited, 1998.
- Kotler, P., *Marketing management – Millennium Edition*, 10th Edition, Prentice Hall, 1999.
- Lambrechts, I.J. (Editor), *Finansiële Bestuur*, 4th Edition, J.L. Van Schaik, 1990.
- Lawler, E.E., *The ultimate advantage – Creating the high involvement organization*, Jossey-Bass Publishers, 1992.
- Mancuso, Joseph R., *How to prepare and present a business plan*, Simon and Schuster, 1992.
- McKeever, M., *How to write a business plan*, 5th Edition Nolo Press, 1999.
- Pinson, L. & Jinnett, J., *Anatomy of a business plan*, Upstart Publishing Company, 1996.
- Thompson, A.A. & Strickland, A.J., *Strategic Management: Concepts and Cases*, 11th Edition, Richard D. Irwin Press, 1999.
- Tushman, M.L. & Moore, W.L. (Editors), *Readings in the management of innovation*, 2nd Edition, Ballinger Publishing Company, 1988.

APPENDIX A.

NEWSLETTER

Why Systems Fail

In mechanical systems, a *failure* is defined as the inability of a component to continue functioning as designed. Failures may occur in the short term or may result in reduced life expectancy. Determining the root causes of failure provides essential information for:

- Improvements in design
- Increased safety margins
- Revised operating procedures
- Improved application of components and/or materials
- Determination of liability in matters of litigation

Failure of a single component in a system may lead to a series of events that may promote destruction of the entire system. According to the "weakest link principle," the integrity of a system is only as sound as its weakest link. Throughout the life of a system, changes in loads and/or environmental conditions may take a component beyond its design basis, possibly undermining the original safety margin. Unforeseen applications or stress exposures may also shorten the useful life of components. As life extension becomes more prevalent for extending the useful economic life of systems such as power and manufacturing plants, applications of components extend into areas not predictable in the original design.

There are several fundamental sources of failure, and understanding them is key to preventing future failures.

Deficiencies in design. This is a very common cause of failure. The size and shape of the components of a system are typically predicated by stress analysis, geometric constraints, and materials/cost considerations. The design process must fully consider the type of materials used and the processing necessary for achieving the desired product. Materials must be considered in terms of chemical composition, processing conditions, and environmental suitability necessary to deliver the intended performance. Fundamental properties such as corrosion resistance must be carefully considered in terms of the average operating conditions and extraordinary conditions that might be caused by malfunctions in the system, changes in the local environment due to contingency operation, and other events that might be predictable. While much of the design process is clinical, the "art" of proper design is conducted by engineers sufficiently astute to anticipate all possible

exposures of materials. Faulty design may lead to ductile, brittle, or fatigue fractures; high temperature failures; or static delayed fractures. Mark Szarek, manager of **Cogeneration Management Company** (Boston, MA), says, "We have experienced stress corrosion cracking due to faulty design, which was unable to tolerate unexpected environmental conditions such as changes in temperature and changes in pressure."

Improper service conditions. Maintenance of equipment ranges from painting surfaces to cleaning and lubrication, and its neglect may lead to failure. For example, forensic analyses of components have shown that 44% of aircraft component failures are caused by improper maintenance. Misdirected maintenance or repairs leading to component failure may result from improper welding, grinding, punching holes, or cold straightening, for example. Corrosion, whether caused by chemicals or micro-organisms, can also lead to failure. Some engineering industry investigations reveal that corrosion is the direct cause of 29% of system failures.

Short-term maintenance, such as proper lubrication or cleaning, may be expected to prevent high costs in the long-term. Glenn Harris, superintendent of technical support for **Carolina Power and Light Company** (Roxboro, NC) says, "The failure of a battery system in our company caused a significant amount of turbine damage that required a lot of repair work and unit downtime at a critical load period. After the failure of the battery system, we took a closer look at our preventive maintenance program and instituted a more rigorous testing of our battery sets, which is something we hadn't done in the past. Although we've always had a preventive program for periodic checks on batteries, we recognized that we needed to improve on periodic load testing."

Imperfections in materials and errors in assembly. This is also a common problem, causing an estimated 40% of failures in some engineering industry investigations. This cause of failure is often difficult to prevent because it is rooted in the application of materials. Errors in assembly include leaving off a bolt or a washer, or using an incorrect lubricant. Careless assembly might include mismatch of mated parts, entrained dirt or abrasives, residual stresses, and gouges or surface damage to components.

(cont. on Page 2)

FACTOIDS

Failure Analysis:

The top origins of failure are:

- Improper material selection (38%)
- Fabrication defects (15%)
- Faulty treatments (15%)
- Mechanical design fault (11%)
- Unforeseen operating conditions (8%)

Most metallurgical failures involve fracture of the component. Therefore, most failure analyses routinely involve examination of the mechanical loading situation. However, with this approach many other important causes of failure may be overlooked.

The top origins of failure in aircraft components are:

- Improper maintenance (44%)
- Fabrication defects (17%)
- Design deficiencies (16%)
- Abnormal service charge (10%)
- Defective material (7%)

Source: G.J. Davies, "Performance in Service" in E.J. Bradbury (ed.) *Essential Metallurgy for Engineers*.

Microbiologically-induced Corrosion (MIC):

More than 90% of MIC manifests itself as pitting or crevice corrosion.

The microbes create conditions where corrosion may occur, but do not participate in the corrosion reaction itself.

Most of the final products of MIC community metabolism are short-chain fatty acids (acetic acid is the most common). Acetic acid is very aggressive to carbon steel when concentrated under a colony or other deposit.

Other Types of Corrosion (not normally associated with MIC):

- Uniform corrosion
- Galvanic corrosion
- Corrosion fatigue
- Stress corrosion cracking
- Flow accelerated corrosion
- Selective leaching

Detecting Microbiologically-Induced Corrosion

Microbiologically-induced corrosion (MIC) accounts for 15% to 30% of corrosion failures in the gas and nuclear industries alone. This is a major cause of failure in the water treatment and chemical industries, and is also associated with corrosion failures and souring in gas and oil production and storage. Several of the bacteria related to corrosion processes have a common function: to form part of the sulfur cycle in nature. Some microorganisms facilitate the corrosion process by actively changing the environment surrounding the metal surface thus encouraging or initiating a corrosion process.

Detecting Microbiologically Induced Corrosion.

The prevalence of microbiologically-induced corrosion, the threat it poses to a system, and the high costs of failure make it imperative that it be discovered as soon as possible. Three questions must be answered when examining metal for possible microbial corrosion:

1. Is the environment suitable for microbial growth?

The first problem is to certify the biological origin of the metal failure. This requires some detective work to rule out abiotic causes of corrosion. For instance, in an environment of approximately neutral pH and no oxygen, microbiologically induced corrosion of iron would be negligible. Factors that might indicate that the corrosion is biotic include: a high corrosion rate, localized characteristics of the attack, and the type of corrosion products.

2. Are the environmental conditions suitable for microbial growth?

Water is the main requirement for microbial life and the associated corrosion. Biocorrosion cases

occur in the presence of water or an aqueous phase. Even in the case of fuel/water systems, minimal concentrations of water are sufficient to support microbial growth and to sustain metabolic activity.

3. Are the characteristics of the metal attack and the corrosion products consistent with those expected when microbial activity is present?

The characteristics and morphology of the attack may provide additional information. In certain cases, the corrosion product is loosely adherent to the metal, and when removed, bright metal is revealed in the exposed pit. A simple visual examination can detect the presence of biological fouling at the corrosion site. The black appearance of the corrosion products and the strong rotten-egg smell of hydrogen sulfide is an indication of the possible presence of sulfate-reducing bacteria. The appearance of deposits can also be useful for detecting the presence of fungi or algae.

A common method for detecting microorganisms causing microbiologically-induced corrosion involves taking samples from fouled industrial materials or systems and growing the microorganisms in laboratory cultures. From growth cultures, microbiologists can determine the bacterial load and what species are present in contaminated materials or systems (especially if the corrosion is caused by a microbial consortium growing as a biofilm).

This is the first in a two-part series examining the effects of microbiologically-induced corrosion on industrial processes. Next issue: "Preventing Microbiologically-Induced Corrosion."

Why Systems Fail

(cont. from Page 1)

Misuse. This cause of failure occurs when the component is placed under conditions for which it was not designed. Eliminating other causes of failure, such as faulty design or errors in assembly, can help determine if misuse is the problem. William Webb, manager of materials and corrosion engineering at **Raytheon Engineers and Constructors, Inc.** (Cambridge, MA) explains, "Misoperation of the equipment is often a problem. For instance, we looked at a sensor and heater malfunction that was caused by extremely high temperatures which the system could not

tolerate. A pipeline cracked because the temperature sensor was not replaced." Misuse of a system often results in abnormal operating temperatures, severe vibration, sonic vibrations, unforeseen collisions, or thermal shock.

Understanding these causes of failure, and incorporating them in a proactive plan will significantly reduce failure rates in a component or a system and lower the costs of repair, replacement, health and safety, and litigation.

CALENDAR OF EVENTS

July 12-16

3rd Pacific Rim International Conference on Advanced Materials & Processing

Honolulu, Hawaii

For more information, contact TMS at tel: 412-776-9000, ext. 270; fax: 412-776-3770; or e-mail: csc@tms.org.

July 19-22

Innovations in Materials Conference (IMC)

Washington, DC

For more information, contact IMC Headquarters at tel: 814-863-9983; fax: 814-863-7040; or e-mail: kathymoir@psu.edu.

July 19-24

25th Annual Review of Progress in Quantitative NDE

Snowbird, Utah

For more information, contact Connie Nesso or Sarah Kallsen at tel: 515-294-9749; or fax: 515-294-2367.

July 26-29

31st International Metallographic Society (IMS) Convention

Ottawa, Ontario

For more information, contact ASM International at tel: 800-336-5152, ext. 900 or 440-338-5151; fax: 440-338-4634; or e-mail: cust-srv@po.asm-intl.org.

July 26-29

Gordon Conference on Education in Materials Science

Plymouth, New Hampshire

For more information, contact Drs. Tom Stoebe or Tom Pearsall at tel: 206-543-2600; or fax: 206-543-3100.

August 16-19

37th Conference of Metallurgists

Calgary, Alberta

For more information, contact Louisa Davis at tel: 514-939-2710 (ext. 317); fax: 514-939-2714; or e-mail: melsoc@cim.org.

CORROSION RELATED WEBSITES

- The International Corrosion Council at <http://www.cp.umist.ac.uk/ICC/index.htm>
- National Association of Corrosion Engineers International at <http://www.nace.org>
- Protective Coatings, Linings and Related Resources at <http://www.corrosion.com>
- Institute of Building Materials, Materials Chemistry and Corrosion (IBWIK) at <http://www.ibwk.baum.ethz.ch/w+k/research.html>
- International Biodeterioration & Biodegradation Journal at <http://www.elsevier.nl/80/inca/publications/store/>
- The Biodeterioration Society at <http://www.shu.ac.uk/biodetsoc/>

APPENDIX B.

SURVEY



Thank you for participating. By completing and returning the enclosed questionnaire, you are providing a valued perspective on issues integral to industry. When combined with the responses of others, this information can provide a glimpse of important trends. Please return this survey in the enclosed postage-paid envelope or via fax no later than December 1, 1998. You will receive a copy of the survey results once they are tabulated.

**Confidential
Survey
on
Corrosion Control**

In your line of business, how often does corrosion come up as an issue?

- Frequently
- Occasionally
- Never

How does corrosion impact the performance of your product/service?

- Cosmetically, but of no functional consequence
- Limits the functionality or operability of the system
- Renders the system inoperable
- Other (please specify)

In designing or specifying new products and/or systems, do you include materials selection for corrosion resistance as part of the design process?

- Always
- Only when corrosion is known to be an issue
- Never
- Other (please specify)

In your experience, what means do you use to control corrosion (Please check all that apply)

- Protective coatings
- Selection of corrosion-resistant materials
- Cathodic or anodic protection
- Environmental control (e.g., humidity, temperature)
- Limiting the use of corrosive chemicals
- Use of inhibitors
- Regular maintenance
- Proper mechanical design (e.g., avoid stagnant zones, insulate galvanic couples)
- Other (please specify)

In what environment/application do you most frequently have to deal with corrosion problems?

- High humidity
- High temperature
- Chemically aggressive (e.g., acid vapors, submerged parts)
- High pressure/stress
- Atmospheric exposure (e.g., marine, industrial)
- Microbial
- Sea Water
- Other (please specify)

Does your company provide training to employees to increase the awareness and/or recognition of corrosion?

- Yes
- No

What kind of equipment does your company operate that is mostly affected by corrosion? (Please rank - 1=least affected; 5= most affected; or N/A)

- _____ Pressure vessels
- _____ Materials handling equipment
- _____ Cooling systems
- _____ Fire protection systems
- _____ Chemical processing equipment
- _____ Above ground storage tanks
- _____ Underground storage tanks
- _____ Concrete structures (e.g., rebar corrosion)
- _____ Piping
- _____ Other (please specify)

How would you characterize your industry?

- Rubber and Misc. Plastics
- Fabricated Metal Products
- Industrial Machinery & Equipment
- Electronic & Other Electric Equipment
- Utility
- Biomedical
- Other (please specify)

What is the size of your organization?

- Less than 100
- 100-499
- 500-999
- 1000-2499
- 2500+

Please fax to:

Dr. Ockert Van Der Schijff
Altran Corporation
451 D Street
Boston, MA 02210

Fax: 617/204-3080
Tel: 617/204-1000

May we further share your ideas and insights?

- I am willing to share my industry experience and knowledge in an interview for a future issue of Altran Corporation's Industrial Insights.

Your Name _____
 Title _____
 Company _____
 Address _____
 City _____ State _____ ZIP _____
 Phone _____ Fax _____
 E-mail/Website _____



This survey is conducted by Altran Corporation to provide information of value to industrial facility decision makers. Altran Corporation provides engineering, management consulting and materials engineering services to industry. For more information about Altran Corporation, please call us at 617/204-1000, or direct e-mail inquiries to Industrial@altran.com.

APPENDIX C.

POSTCARD

★ ALTRAN CORPORATION SPRING WORKSHOP ★

CORROSION

**DETECTION AND MITIGATION IN SERVICE WATER
AND FIRE PROTECTION SYSTEMS**

MARCH 17-19, 1999

Seaport Hotel and Conference Center, Boston, Massachusetts

presented by **ALTRAN CORPORATION**

State of the art lectures, hands-on laboratory workshops, and interactive discussions of case studies

Presenters:

Prof. Ronald M. Latanision, MIT

Prof. Ronald G. Ballinger, MIT

Prof. Ralph Mitchell, Harvard Univ.

with Altran Corporation staff and industry experts

This workshop will focus on the practical aspects of corrosion detection, recognition, prevention, and mitigation. Attendees will receive practical information that can be applied immediately to solve corrosion problems in service water and fire protection systems. The workshop will include hands-on laboratory sessions where attendees will have the opportunity to learn more about the field of corrosion.

There's still time to register. To reserve your place or for additional information, contact our Workshop Coordinator at:



617/204-1000



617/204-1020



workshops@altran.com

Look for future Altran Corporation workshops on **waterhammer, Failure Analysis, and Biofouling.**

APPENDIX D.

BROCHURE

Altran Corporation

CORROSION ENGINEERING



Failure Analysis
Electrochemical Testing
Exposure Testing
Materials Selection
Plant Surveys
Corrosion Monitoring and Mitigation
Microbiologically Influenced Corrosion

Corrosion Engineering at Altran Corporation

Corrosion Services

- **Standardized testing** (ASTM, NACE, API)
- **Electrochemical testing and evaluation**
 - Potentiodynamic polarization
 - Polarization resistance
 - Potentiostatic/galvanostatic polarization
 - Electrochemical impedance spectroscopy
- **Environmental testing**
 - Atmospheric
 - Salt spray exposure
 - Temperature/Humidity exposure
 - Environmental chamber (cyclic heating and cooling)
 - UV exposure
 - Soil box exposure
 - Cyclic loading
 - Customized environments (Pressure, temperature, stress, gas, and other)
- **Flow loop testing**
 - Elevated temperature
 - Low temperature
 - Closed loop
 - Refreshed loop
 - Atmospheric
 - Metal coupons
 - Electrochemical monitoring
- **High temperature corrosion**
 - Molten salts
 - Refractory degradation
 - Identification of eutectic phases
 - Materials testing and evaluation
 - Slag/refractory interaction
- **Heat exchanger corrosion**
 - Fouling evaluations
 - Chemical analyses
 - Monitoring
 - Hydrogen damage assessments
- **Coatings evaluation**
 - Salt spray testing
 - Cathodic disbondment testing
 - Atmospheric exposure testing
 - UV exposure testing
 - Direct soil burial testing
 - Electrochemical impedance spectroscopy
- **Flow-accelerated corrosion programs**

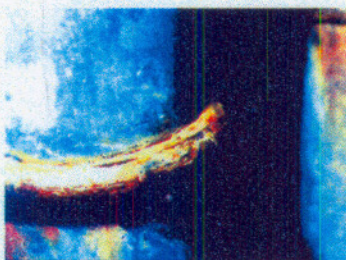
Altran Corporation provides a diverse range of corrosion engineering and testing services ranging from failure analysis to materials selection. Our staff consists of engineers and scientists covering a broad range of engineering disciplines including metallurgical, chemical, mechanical, civil, microbiological, aerospace, and electrical, with other practical and fundamental expertise in the supporting disciplines of chemistry, physics, polymer science, and materials science.

In addition to this significant in-house expertise, we have strong relationships with the Massachusetts Institute of Technology and Harvard University. The diverse nature of our technical and engineering capabilities enables us to address a wide range of corrosion-related problems.

At Altran, our engineering solutions are driven by physical evidence coupled with sound engineering principles. We place an emphasis on finding solutions that are practical and effective. Our goal is to effectively integrate technology into the engineering process and to balance engineering needs and economic constraints with realistic and practical solutions.



Coating failure resulting in corrosion of underlying steel.



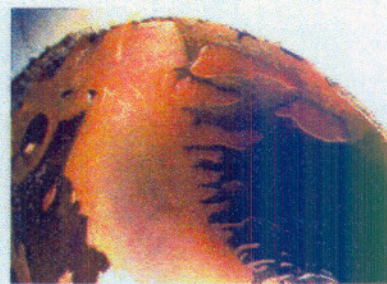
Galvanic corrosion of a steel clamp on copper pipe.

Failure Analysis

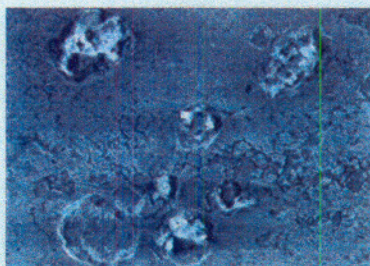
Altran Corporation has extensive experience in corrosion-related failure analysis. Our staff is well versed in forensic techniques and follow a multidisciplinary approach in the determination of root cause of failures. We emphasize a methodical process that focuses on the real cause of failure and the most effective mitigation and subsequent failure prevention recommendations.

Our failure analysis experience encompasses a wide range of industries including:

- Power generation (nuclear, fossil, hydro, and cogeneration)
- Chemical and petrochemical processing
- Packaging
- Manufacturing
- Transportation
- Medical devices
- Infrastructure



"Tiger striping" of power plant steam pipe due to flow accelerated corrosion.



Scanning electron micrograph of pitting and intergranular corrosion of type 304 stainless steel.

Both in-plant field services and laboratory-based services can be performed. We pride ourselves in our ability to go beyond laboratory analyses and failure root cause determination to provide valuable advisory services for failure mitigation and prevention. This may include modification to the design, materials selection, operations, maintenance, or environment.

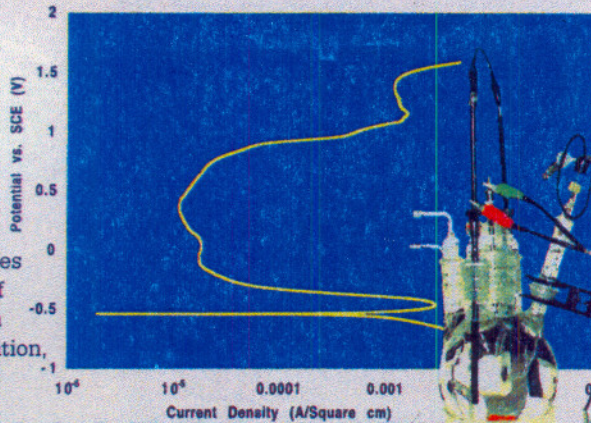
Testing/Simulation

Testing of selected materials during the design process can often avoid costly and time-consuming operational failures.

Altran's extensive electrochemical capabilities enable the performance of tests such as polarization resistance, cyclic polarization, potentiodynamic polarization, and electrochemical impedance spectroscopy under a wide range of environmental conditions.

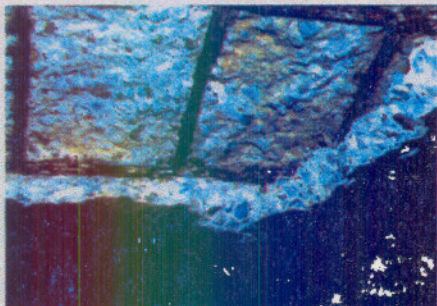
Available techniques include most standardized ASTM and NACE test methods.

Customized tests to simulate process or field conditions can also be designed and executed by Altran. We have in place certified test facilities to perform cyclic humidity testing, salt-spray testing, and microbiological exposure testing. Altran Corporation can also design and execute pilot-scale or in-service studies for on-site evaluations.



Potentiodynamic polarization diagram of 430 stainless steel in sulfuric acid, with corrosion test cell in the foreground.

- **Mechanical testing**
 - Slow strain rate
 - Crack growth
 - Cyclic loading
 - Creep rupture
 - Fracture toughness
 - Corrosion fatigue
 - SCC evaluation
- **Reinforced Concrete Evaluations**
 - Structure condition surveys
 - Core sampling
 - Potential mapping
 - Delamination surveys
 - Mechanical testing
- **In-plant corrosion monitoring services**
 - Design and configuration of metal coupon spoils
 - Installation of monitoring probes
 - Interpretation of monitoring data
- **Product qualification**
- **Design of custom testing programs and fixturing**
- **Microbiologically influenced corrosion**
 - MIC vs. chemical attack
 - Coatings susceptibility
 - Materials qualification and testing
 - Microbe isolation and identification
 - Biofouling investigations



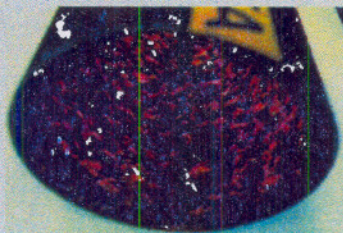
Corrosion in concrete rebar often remains undetected until its advanced stages. On the underside of this floor slab, cracks originating at the corroded rebar have resulted in spalling of concrete.

On-Site Corrosion Assessment, Control, and Mitigation

The need to conduct in-situ assessment and testing often arises in systems where systems cannot be taken out of service or are of a size and/or nature requiring on-site assessment. Altran has the expertise and equipment to conduct a variety of field tests and analyses. These include plant surveys, coating assessments, electrochemical potential mapping, and long term corrosion monitoring.

Workshops and Training

Corrosion science is a complex, continually evolving field. The staff at Altran Corporation has developed programs and materials to train and educate engineering managers, technicians, and operating and maintenance personnel. The content of these programs are custom-tailored to suit specific needs ranging from fundamental knowledge needed to make sound engineering decisions to raising the awareness and ability of operational staff to identify potential corrosion-related problems.



Section of cooling water pipe with tubercles resulting from microbiologically influenced corrosion (MIC).

Related Consulting Services

- **Failure Analysis**
- **Materials Engineering**
 - Metals
 - Composites
 - Polymer/Metal interfaces and interactions
 - Adhesives
 - Coatings
- **Pressure parts**
- **Corrosion control and inhibitor selection/design/evaluation**
- **Corrosion monitoring system design**
- **Fouling control – microfouling and macrofouling**
- **Product qualification**
- **Condition assessments**
- **Lifetime extension**
- **Cathodic Protection**

Training

- **Site/Application Specific Seminars**
- **Instructional workshops**
- **Field guides**
- **Custom training programs**

What We Can Do For Your Organization

At **Altran Corporation**, we understand the importance of providing solutions to our industrial customers. As plants age, the importance of understanding and correctly resolving corrosion and materials-related issues becomes more acute and has become a fundamental element of a plant optimization and reliability strategy. In addition, our experience with corrosion in manufacturing and product development environments uniquely enables us to provide practical and cost-effective solutions. Whether the need is to perform a failure analysis, resolve a materials performance issue, or provide assistance with materials selection, Altran's team of engineers, scientists, and technicians has the ability to take on challenging problems by being creative in providing integrated engineering, laboratory, and field testing services.



Credentials

Staff Expertise

- Polymer formulation and development
- Contamination control
- Materials selection and engineering
- Failure analysis
- Corrosion engineering
- Microbiologically influenced corrosion
- Biofouling
- Regulatory compliance
- Adhesives
- Mechanical testing
- Electrical insulation materials
- Coatings
- Stress analysis
- Fracture mechanics
- Fractography
- Material and component degradation
- Electrical components
- Welding engineering

Field Testing

- System diagnostics
- Waterhammer
- Equipment malfunction
- On-site data acquisition
 - Strain
 - Pressure
 - Displacement
 - Temperature
 - Flow
 - Corrosion rates
- High speed photography

Laboratory Infrastructure

- Microbial isolation and identification
- Antimicrobial development and evaluation
- Corrosion analysis and testing
- Mechanical testing (low and high temperatures)
- Electrical testing
- Scanning electron microscopy
- EDS and WDS analysis
- Optical microscopy
- X-ray diffraction
- Infrared spectroscopy
- Chemical analysis
- Biofouling and biodegradation analysis
- Hardness and microhardness testing
- Polymer formulation, characterization, and testing
- Polymer thermal and mechanical analysis
- Fluid dynamics testing
- High speed photography for kinematic characterization
- Product performance testing
- Specialized test fixturing
- Thermal aging
- Metallography

ALTRAN CORPORATION was founded in 1986 to provide engineering and management consulting services to industry. Since our founding, we have assembled a technically strong team of professionals who approach their work with insight and creativity. We've built a nationwide reputation for innovation and reliability.

Altran is an employee-owned company. Each and every one of us takes great pride in the skills and teamwork that enable us to successfully address both the engineering and management needs of our clients. They, in turn, have entrusted us with their most critical and challenging tasks. Take a look at some of the most challenging engineering issues confronting industry today. In many cases, you'll see the Altran name closely associated with the solution.

Altran's success can be measured by the continued development of the services and resources that we offer. We have carefully controlled the growth of our client base to match our own growth in capacity and capability. Maintaining a consistent excellence of services to all clients—old and new—remains our primary objective.

FRONT COVER PHOTOGRAPH: *Microbiologically influenced corrosion of service water pipe.*

At Altran...

OUR PRIMARY OBJECTIVE is to be responsive to client needs by providing excellence and innovation in problem resolution.

Altran Corporation
<http://www.altran.com/>

Corporate Headquarters:

BOSTON

451 D Street • Boston, MA 02210 • 617/204-1000

Offices:

CHARLOTTE

13801 Reese Boulevard West • Huntersville, NC 28078
704/875-8100

SAN FRANCISCO

150 Spear Street • San Francisco, CA 94105 • 415/543-6111

TORONTO

260 Thomlea Court • Waterloo, Ont. N2T 2M7 • 519/725-5783

altran

altranma@altran.com

altrannc@altran.com

altransf@altran.com

altranca@altran.com

APPENDIX E.

TECHNICAL NOTE

Corrosion: Corrosion is generally defined as the "destruction or deterioration of a material because of reaction with its environment". A medical device must be able to withstand the corrosive environment associated with body fluids and components of the cellular immune system. Corrosion of a medical device may cause:

- **Systemic reactions** with the corrosion byproducts affecting patient health^{5,12,14}
- **Local inflammatory reactions** with the corrosion byproducts affecting patient health and/or implant performance^{5,12}
- **Material/structural changes** affecting the performance of the implant^{1,9,11}

General Aspects of Corrosion

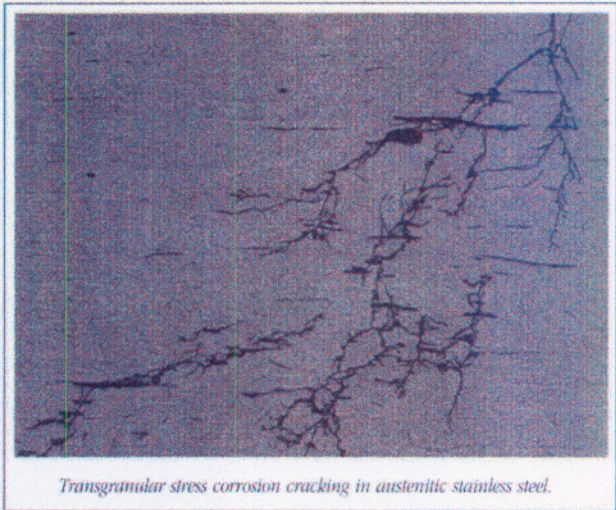
Corrosion in metals is a result of electrochemical reactions that occur at the interface of the surface and the environment. Electrochemical reactions can be categorized as oxidation (or anodic) and reduction (or cathodic) reactions. While simple systems, such as iron immersed in salt water, can be established experimentally and theoretically to understand corrosion electrochemistry, *in vivo* systems are difficult to simulate and model. Since medical devices are exposed to a variety of environments and applications, numerous mechanisms work independently or in concert to result in corrosion. Many forms of corrosion related to medical implants have been examined in the literature:

- galvanic corrosion⁶
- crevice corrosion¹
- pitting corrosion¹¹
- intergranular corrosion³
- erosion corrosion (including fretting corrosion)¹
- stress corrosion¹¹

The Role of Surfaces in Corrosion

Corrosion is a surface (and near-surface) phenomenon, by definition occurring at or near the interface to the environment. Most metals used in medical devices possess a passive surface layer which is a tightly adhered oxide that may be only a few nanometers thick. This passive layer, and its spontaneous regeneration when damaged under most conditions, is responsible for the corrosion resistance and biocompatibility of medical device materials. When this layer and its reformation process are disrupted, high rates of corrosion may occur. Despite the effective barrier that a passive oxide layer presents to corrosive attack, there is a continuous, low level dissolution of the underlying metal that takes place through the oxide^{3,13}.

The surface of a medical device is composed of various layers that impact corrosion resistance in the body. The surface might exhibit an



Transgranular stress corrosion cracking in austenitic stainless steel.

oxide/hydroxide layer, adsorbed organics and water, proteins and metallo-protein complexes, and cells. These various layers range in thickness from several nanometers to micrometers, and are thus very difficult to characterize in detail. Each of these layers may accelerate or retard corrosion. Hydrogen peroxide, for example, increases corrosion of titanium, a very corrosion resistant biomaterial, and white cells are known to produce hydrogen peroxide in small, concentrated areas⁵. In addition, different surface treatments affect the quantity and quality of formation of the various layers, influencing corrosion rates.

The modification of surfaces is one of the key areas of processing technology that may expand or improve the performance of biomaterials¹³. Much of the technology has been developed for applications in other fields such as aerospace, automotive and industrial engineering. Unlike the human body, the environment in these other engineering fields is often well defined and relatively stable. Transfer of surface treatment technologies to biomedical applications requires considerable material and device testing. Some of the modification technologies include diffusion or implantation of elements into the surface (such as carburizing, plasma nitriding, ion implantation, etc.), and deposition of a metallic or ceramic coating onto the surface (such as sputtering, cathodic arc deposition, and chemical vapor deposition).

Effects of Corrosion

Corrosion can lead to failure by changing the material or structural properties of the device. The most intuitive example is the structural strength of a device such as a hip implant. Some forms of corrosion are especially damaging to structures; namely, pitting and intergranular cor-

rosion. Both of these forms of corrosion involve a small loss of material that nonetheless creates a relatively deep pit, or crack, from the surface into the material. Such a deep, narrow pit or crack may act as a crack initiation site.

Corrosion can also lead to local inflammation in tissues surrounding the device. Metal ions are released from the device into the tissues or fluids around the device as free ions or metallo-protein complexes. The presence of corrosion products may lead towards inflammation⁵, causing discomfort or pain to the patient and subsequent removal of the device. Even if the inflammation is subclinical, it may lead to a device failure by, for example, preventing sufficient tissue fixation of the device.

Finally, corrosion may lead to a systemic allergic reaction, the severity of which will vary between patients. The ions and complexes referred to above can diffuse away from the device and be carried throughout the body. Antibodies form in reaction to the exsolved species, and lead to varying degrees of allergic reaction.

Methods of Corrosion Testing

Studies of implantable device corrosion behavior are challenging. It is often difficult to predict how biomaterials and devices will perform in the human body. However, before a new material or device is used in humans, it is critical to understand how they are likely to perform in the *in vivo* environment. The following are examples of several types of tests that are mentioned in the literature:

- Evaluating the degree of corrosion as a function of material and environment
 - Exposure testing¹³
 - Potentiodynamic testing⁷
 - Potentiostatic testing¹⁰
 - Electrochemical impedance spectroscopy²
- Evaluating the effects of corrosion on the device or material
 - Corrosion fatigue testing⁸
 - Stress-corrosion crack testing³
 - Fretting-corrosion testing^{3,4}
- Evaluating the effects of corrosion products on cells or organisms
 - *In-vivo* and *in-vitro* testing^{5,9}

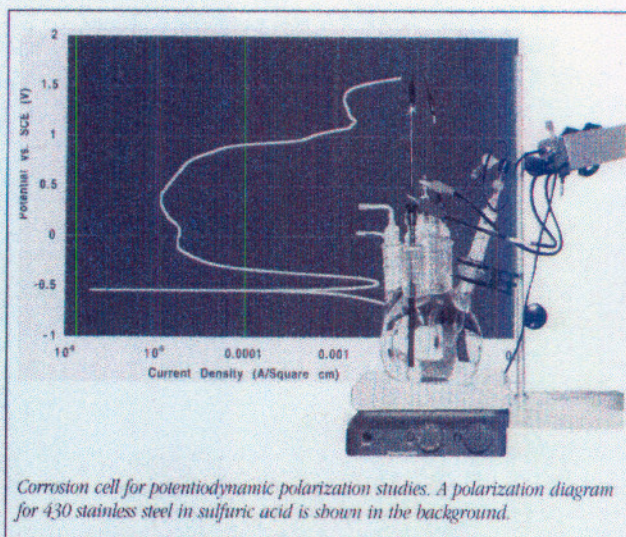
Corrosion Science and Engineering at Altran Corporation

Altran provides a comprehensive array of services from analytical testing to failure analysis, including finite element modeling and product development. Development stage materials evaluation, before a design or even a concept has been finalized, can help to avoid costly and time-consuming failures later in the program. Altran Corporation has the facilities and expertise to perform standard (e.g., ASTM) corrosion tests of materials or customized test protocols to evaluate the effects of materials, processes, and design on corrosion resistance. Altran will also perform validation tests of final designs for clinical and regulatory submissions. Altran has a staff that includes biomedical, corrosion, mechanical and metallurgical engineers along with scientists and technicians with many years of experience in corrosion testing and analysis.

Altran Corporation

451 D Street
Boston, MA 02210

For more information on Altran's capabilities in corrosion testing for biomedical devices, please contact Makoto Takeuchi at (617)204-1000.



Corrosion cell for potentiodynamic polarization studies. A polarization diagram for 430 stainless steel in sulfuric acid is shown in the background.

References

1. Brown, S.A., et al. Crevice and fretting corrosion of stainless-steel plates and screws, *J Biomed Mater Res*, v 15 1981 p 867-878.
2. Bundy, K.J., et al. Use of a.c. impedance methods to study corrosion behaviour of implant alloys, *Biomaterials*, v 14 1993 p 529-536.
3. Bundy, K.J., et al. Stress-enhanced ion release - the effect of static loading, *Biomaterials*, v 12 Sep 1991 p 627-639.
4. Gilbert, J.L., et al. Intergranular corrosion-fatigue failure of cobalt-alloy femoral stems. A failure analysis of two implants, *J Bone Joint Surg*, v 76 1994, p 110-115.
5. Lee, S.H., et al. Human monocyte/macrophage response to cobalt-chromium corrosion products and titanium particles in patients with total joint replacements, *J Orthop Res*, v 15 1997, p 40-49.
6. Lucas, L.C., et al. Investigations on the galvanic corrosion of multialloy total hip prostheses, *J Biomed Mater Res*, v 15 1981 p 731-747.
7. Nakayama, Y., et al. In vivo measurement of anodic polarization of orthopedic implant alloys: comparative study of in vivo and in vitro experiments, *Biomaterials*, v 10 Aug 1989 p 420-424.
8. Okazaki, Y., et al. Corrosion resistance and corrosion fatigue strength of new titanium alloys for medical implants without V and Al, *Mat Sci and Eng: Struct Mat: Properties, Microstructure and Processing*, v 213 1996 p 138.
9. Reuling, N., et al. Release and detection of dental corrosion products in vivo: development of an experimental model in rabbits, *J Biomed Mater Res*, v 24 Aug 1990 p 979-991.
10. Rondelli, G., Corrosion resistance tests on NiTi shape memory alloy, *Biomaterials*, v 17 1996, p 2003-2008.
11. Sivakumar, M., et al. Investigation of failures in stainless steel orthopedic implant devices: pit induced stress corrosion cracking, *J Mat Sci Letters*, v 11 Aug 1992 p 1039.
12. Wever, D.J., et al. Cytotoxic, allergic, and genotoxic activity of a nickel-titanium alloy, *Biomaterials*, v 18 Aug 1997 p 1115-1120.
13. Wisbey, A., et al. Effect of surface treatment on the dissolution of titanium-based implant materials, *Biomaterials*, v 12 Jul 1991 p 470-473.
14. Yang, J., et al. Detection of antibodies against corrosion products in patients after Co-Cr total joint replacements, *J Biomed Mater Res*, v 28 Nov 1994 p 1249-1258.

APPENDIX F.

FLYER

CORROSION

DETECTION AND MITIGATION IN SERVICE WATER AND FIRE PROTECTION SYSTEMS

MARCH 17-19, 1999

Seaport Hotel and Conference Center, Boston, Massachusetts

presented by **ALTRAN CORPORATION**



451 D Street
Boston, MA 02210

Boston • Charlotte • San Francisco • Toronto

As plants age, the importance of understanding and controlling **corrosion** becomes more acute and is a fundamental element in the development of plant optimization and reliability strategies. Causes of potential failures, degradation, contamination, reduced availability and efficiency must be identified and avoided. Now, **Altran Corporation**, a leading consultant to power utilities and industry, has assembled an outstanding team of experts from industry and academia to discuss corrosion issues in two crucial plant systems: **service water and fire protection**.

Workshop Content

The workshop will focus on the practical aspects of corrosion detection, recognition, prevention and mitigation. The aim is to provide practical and useful information which can be applied immediately to solve existing

problems in service water and fire protection systems. The workshop will include hands-on laboratory sessions during which course participants will have the opportunity to learn more about the field of corrosion as related to service water and fire protection systems.

Laboratory Workshop Topics

- SEM/EDS
- Metallography and microscopy
- DC polarization/EIS
- Microbiology and biofouling
- Exposure testing, coatings, and materials selection
- Failure analysis

Who Should Attend

This workshop offers an opportunity for representatives from a variety of industries to interact and share experience:

- **Managers and project leaders** responsible for decisions regarding **design and materials selection** in any given industrial application.
- **Materials engineering professionals** who wish to familiarize themselves with practical aspects of **corrosion prevention and mitigation**.
- **Representatives of government agencies** familiar with the **regulatory issues** concerning materials in industrial applications.
- **Managers and engineers** responsible for **operation of industrial systems** that are susceptible to corrosion.

Workshop Fee:

The workshop fee of \$1200 includes all workshop materials, lunches, and hosted events.

Location:

The workshop will be held at the **Seaport Hotel at the World Trade Center**, One Seaport Lane, Boston, Massachusetts, 02210. The Seaport Hotel is located in the city's bustling new Seaport District, just minutes from the heart of Boston.



Corrosion Workshop when making reservations. Note that the special group rate will be guaranteed only until February 17, 1999.

Seaport Hotel Reservations:
1-888-WTC-HOTEL

Travel:

The Seaport Hotel is located ten minutes from **Boston Logan Airport** via taxi through the Ted Williams Tunnel. In addition, the hotel provides free shuttle bus service to and from **Boston South Station, Faneuil Hall**, and other downtown locations.

Meals:

Lunch each day, reception on Wednesday evening, dinner on Thursday evening and refreshments during breaks are included with the registration fee.

Hotel Accommodations:

A special group rate has been negotiated with the Seaport Hotel. *Please mention the Altran*

Registration and Payment:

Registration will be limited on a first-come, first-serve basis to facilitate personal interaction with the course presenters. Three or more registrations from the same company will re-

ceive a 10% discount on each registration. Payment to be submitted no later than four weeks before the scheduled workshop date, accompanied by the registration form. Company checks, company purchase orders, money orders, and personal checks in US dollars will be accepted. Altran Corporation does not accept credit cards. Paid registrations canceled in writing at least 14 days in advance of the workshop, will receive a full refund.



For additional information or to pay by company purchase order contact our Workshop Coordinator at:



617/204-1000



617/204-1020



workshops@altran.com

<http://www.altran.com>

Look for future Altran Corporation workshops on **Waterhammer, Failure Analysis, and Biofouling**

REGISTRATION FORM

Please detach form and remit with payment in enclosed postage free reply envelope, or send to:
Corrosion Workshop, **Altran Corporation**, 451 D Street Boston, MA 02210

SEM 99-01: Corrosion—Detection and Mitigation in Service Water and Fire Protection Systems
March 17-19, 1999, Seaport Hotel and Conference Center, Boston, Massachusetts

Name: _____

Title: _____

Company: _____

Address: _____

City: _____ State/ZIP: _____

Tel: _____ Fax: _____ E-Mail: _____

Method of Payment: Personal or company check Money order Company purchase order

Course Syllabus and Schedule

DAY 1: March 17, 1999

8:00AM Registration and Welcome
Tom Esselman, President, Altran Corporation
Introduction to Corrosion
Ronald M. Latanision
Coffee
Overview of Service Water and Fire Protection Systems
Edward Dubost
Mechanisms of Corrosion
Florinda G. Ballinger

12:00PM Lunch

1:30PM Detection and Recognition of Corrosion - Case Studies
Ockert J. Van Der Schijff
Coffee
Biological Fouling
Marc W. Mittelman

5:00PM Hosted reception

DAY 2: March 18, 1999

8:30AM MIC - Recognition and Control
Ralph Mitchell
Coffee
Selected Case Studies From the Field
"Ask the Experts"

12:00PM Lunch

1:30PM Laboratory Workshop
SEM/EDS
Metallography and microscopy
DC polarization/EIS
Microbiology and biofouling
Exposure testing, coatings, and materials selection
Failure analysis

7:00PM Hosted Dinner

DAY 3: March 19, 1999

8:30AM Coatings for Corrosion Prevention
Dick Martin
Coffee
Panel Discussion: "Current Regulatory and Operational Issues Related to Service Water and Fire Protection Systems"

12:00PM Lunch

1:30PM Continuation of Laboratory Workshop
All presenters will be available for discussions.

Course Materials:

Registration fee includes a complete set of printed and bound lecture notes, as well as a copy of the 50-page pocket guide, "Corrosion", part of the Altran Field Guide Series.

Principal Presenters and Speakers



Ronald G. Ballinger, Sc.D.

Associate Professor of Nuclear Engineering and Materials Science and Engineering, Massachusetts Institute of Technology; Principal, Altran Corporation

Professor Ballinger is a member of the H.H. Uhlig Corrosion Laboratory in the Department of Materials Science and Engineering at MIT. He is an internationally-recognized expert in a number of material-related areas:

environmental effects on material behavior, physical metallurgical and electrochemical aspects of environmentally assisted cracking in aqueous systems, experimental fatigue and fracture mechanics, and degradation of materials properties and their effects on component life. Professor Ballinger has authored or co-authored more than 30 scientific publications and is a member of several professional societies including the National Association of Corrosion Engineers, American Society for Metals, Electrochemical Society, and the American Society for Testing and Materials.



Ralph Mitchell, Ph.D.

Gordon McKay Professor of Applied Biology, Harvard University; Principal, Altran Corporation

Professor Mitchell is the Gordon McKay Professor of Applied Biology at Harvard. He is an expert on problems relating to the activities of microorganisms on surfaces, with an emphasis on biodeterioration of materials. He has published extensively on microbially-induced corrosion.

In addition to corrosion, his laboratory is working on problems related to fouling of surfaces, failure of polymeric coatings resulting from microbial activity, and degradation of concrete by bacteria. Professor Mitchell has published more than 150 papers in scientific journals. His four books include *Environmental Microbiology* (Wiley, 1992). He was the founder and former Editor-in-Chief of the international journal, *Microbial Ecology*.



Richard L. "Dick" Martin

Project Engineer, Altran Corporation

Mr. Martin is a protective coatings and linings specialist with 18 years experience in protective coating selection and application, condition assessment, failure analysis, and testing. His expertise includes review and assessment of coatings programs, preparation of specifications and application procedures, development of testing programs, and performance of on-site coatings examinations. Mr. Martin is a member of several technical societies including Society for Protective Coatings (SSPC), National Association of Corrosion Engineers (NACE), and American Society for Testing and Materials (ASTM). He has authored or co-authored 11 technical papers on protective coatings and linings.



Marc W. Mittelman, Ph.D.

Director of Biofouling Mitigation, Altran Corporation

Dr. Mittelman is a specialist in the fields of industrial and environmental microbiology. Before joining Altran Corporation, Dr. Mittelman was an Associate Professor in the Faculty of Medicine, University of Toronto where he still holds an appointment, and Director of the Centre for Infection and Biomaterials Research. In addition to managing clinical research in this field, he developed an industrial microbiology research program focusing on biological fouling. Dr. Mittelman's own research activities have focused on microbial adhesion to engineered materials. At Altran Corporation, he is responsible for failure analysis evaluations, process development, contract research, as well as related technical consulting activities. Dr. Mittelman has published over 50 papers and holds two patents. He is the co-author of two texts, both dealing with biological contamination and deterioration.



Ronald M. Latanision, Ph.D.

Professor of Materials Science and Engineering, Massachusetts Institute of Technology; Director of the H. H. Uhlig Corrosion Laboratory in the Department of Materials Science and Engineering at MIT; Principal, Altran Corporation

Dr. Latanision has been a member of the faculty of the Materials Science and Engineering Department of MIT since

1974. He has taught graduate courses in corrosion, electrochemical processing of materials, and solid state surface science. He also serves as the director of the MIT Summer Course, *Corrosion: the Environmental Degradation of Materials* and has produced a twenty-lecture videotape series entitled *Corrosion Engineering*. Professor Latanision is a member of the National Academy of Engineering and a Fellow of ASM International.

Professor Latanision has presented nearly 200 technical lectures at various national and international meetings or as an invited colloquium speaker. He is co-Editor of *Advances in the Mechanics and Physics of Surfaces* (with T. E. Fischer) and is a member of the Editorial Advisory Board of *Progress in Surface Science*.



Ockert J. Van Der Schijff, PE(SA), Ph.D.

Senior Engineering Consultant, Altran Corporation

Dr. Van Der Schijff is a metallurgist with over sixteen years of experience in the field of metallurgical and chemical engineering research and consulting. He specializes in aqueous corrosion of materials in industrial applications and failure analysis in utility, manufacturing and chemical processing environments. He served as an Associate Professor in the Department of Metallurgical Engineering at the Potchefstroom University in South Africa, teaching courses in corrosion and wear, materials and corrosion for chemical engineers, and pyrometallurgy, heat transfer processes, materials science, and thermodynamics for metallurgical engineering students. As a Senior Engineering Consultant at Altran Corporation, Dr. Van Der Schijff is responsible for broad analytical analysis, failure analysis, contract research, business development, and project management in the materials science disciplines. He has more than 20 papers and conference presentations to his credit. In addition he has published more than 70 technical reports dealing with various aspects of materials and corrosion.

At Altran...

OUR PRIMARY OBJECTIVE is to be responsive to client needs by providing excellence and innovation in problem resolution.

Altran Corporation

<http://www.altran.com/>

Corporate Headquarters:

BOSTON
451 D Street • Boston, MA 02210 • 617/204-1000

Offices:

CHARLOTTE
13801 Reese Boulevard West • Huntersville, NC 28078 • 704/875-8100

SAN FRANCISCO
150 Spear Street • San Francisco, CA 94105 • 415/543-6111

TORONTO
260 Thornlea Court • Waterloo, Ont. N2T 2M7 • 519/725-5783

altran

altranna@altran.com

altrannc@altran.com

altransf@altran.com

altranca@altran.com

APPENDIX G.

RATE SCHEDULES

ALTRAN CORPORATION
Materials Engineering Division

Standard Power Utility Terms and Conditions for 2000

<u>Classification</u>	<u>Hourly Rate</u>
Officer/Principal	\$138.00
Engineering Manager/Senior Engineering Consultant	115.00
Engineering Supervisor	106.00
Technical Consultant	102.00
Senior Project Engineer	102.00
Project Manager/Project Engineer	92.00
Senior Engineer/Senior Scientist	87.00
Technical Supervisor/Lead Engineer/Scientist	75.00
Engineer/Senior Technical Assistant/Senior Designer	68.50
Laboratory Technician/Assistant Engineer/Technical Assistant	56.00
Machinist	42.50
Administrative Assistant/Receptionist	42.50

The above rates are inclusive of salary, overhead expenses, fees, benefits, vacation allowance, sick leave, holiday pay, taxes, and insurance. These rates include travel time not to exceed eight hours per day. Overtime will be billed at the straight time rate without premium. These rates will remain in effect through December 31, 2000.

All direct charges such as travel, subsistence, telephone, direct materials, equipment, outside services, etc., will be billed at cost. Mileage will be billed at \$0.35 per mile. Service bureau computer charges (which include computer usage, surcharges for use of proprietary programmes, reproduction charges, file storage and other applicable use charges) may be billed at cost plus 20%.

General laboratory usage and mechanical testing will be billed at \$50/hour. This rate will include normal laboratory consumables such as mounting material, machining tools, polishing material, and chemicals. Specialised supplies such as test fixtures, unusual measurement equipment, unusual sectioning tools, and film will be billed at cost. Analytical services, such as scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), wavelength dispersive spectroscopy (WDS), infrared spectrometry, gas chromatography, X-ray diffraction, mass spectrometry, and differential scanning calorimetry will be billed at \$150/hr.

Unless otherwise agreed upon in writing, any samples submitted to Altran Corporation for analysis will be stored for one year from the date of receipt whereafter any or all will be discarded.

ALTRAN CORPORATION
Materials Engineering Division

Standard Industrial Terms and Conditions for 2000

<u>Classification</u>	<u>Hourly Rate</u>
Officer/Principal	\$162.00
Engineering Manager/Senior Engineering Consultant	131.00
Engineering Supervisor	118.00
Technical Consultant	115.00
Senior Project Engineer	108.00
Project Manager/Project Engineer	98.00
Senior Engineer/Senior Scientist	92.00
Technical Supervisor/Lead Engineer/Scientist	80.00
Engineer/Senior Technical Assistant	74.00
Laboratory Technician/Assistant Engineer/Technical Assistant	59.00
Machinist	47.00
Administrative Assistant/Receptionist	47.00

The above rates are inclusive of salary, overhead expenses, fees, benefits, vacation allowance, sick leave, holiday pay, taxes, and insurance. These rates include travel time not to exceed eight hours per day. Overtime will be billed at the straight time rate without premium. These rates will remain in effect through December 31, 2000.

All direct charges such as travel, subsistence, telephone, direct materials, equipment, outside services, etc., will be billed at cost. Mileage will be billed at \$0.35 per mile. Service bureau computer charges (which include computer usage, surcharges for use of proprietary programmes, reproduction charges, file storage and other applicable use charges) may be billed at cost plus 20%.

General laboratory usage and mechanical testing will be billed at \$72/hour. This rate will include normal laboratory consumables such as mounting material, machining tools, polishing material, and chemicals. Specialised supplies such as test fixtures, unusual measurement equipment, unusual sectioning tools, and film will be billed at cost. Analytical services, such as scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), wavelength dispersive spectroscopy (WDS), infrared spectrometry, gas chromatography, X-ray diffraction, mass spectrometry, and differential scanning calorimetry will be billed at \$160/hr.

Unless otherwise agreed upon in writing, any samples submitted to Altran Corporation for analysis will be stored for one year from the date of receipt whereafter any or all will be discarded.

ALTRAN CORPORATION
Materials Engineering Division

Standard Litigation Terms and Conditions for 2000

<u>Classification</u>	<u>Hourly Rate</u>
Senior Consultant 1 (Variable Rate)	\$300.00-\$400.00
Senior Consultant 2	250.00
Senior Consultant 3	200.00
Senior Scientist	150.00
Project Manager	125.00
Engineering Support	95.00
Administrative Support	55.00

The above rates are inclusive of salary, overhead expenses, fees, benefits, vacation allowance, sick leave, holiday pay, taxes, and insurance. These rates include travel time not to exceed eight hours per day. Overtime will be billed at the straight time rate without premium. These rates will remain in effect through December 31, 2000.

All direct charges such as travel, subsistence, telephone, direct materials, equipment, outside services, etc., will be billed at cost. Mileage will be billed at \$0.35 per mile. Service bureau computer charges (which include computer usage, surcharges for use of proprietary programmes, reproduction charges, file storage and other applicable use charges) may be billed at cost plus 20%.

General laboratory usage and mechanical testing will be billed at \$80/hour. This rate will include normal laboratory consumables such as mounting material, machining tools, polishing material, and chemicals. Specialised supplies such as test fixtures, unusual measurement equipment, unusual sectioning tools, and film will be billed at cost. Analytical services, such as scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), wavelength dispersive spectroscopy (WDS), infrared spectrometry, gas chromatography, X-ray diffraction, mass spectrometry, and differential scanning calorimetry will be billed at \$225/hr.

Unless otherwise provided through advance written agreement, Altran Corporation does not provide services on a contingency basis nor will delays due to third party billing be considered acceptable. The terms for payment are net 30 days from the date of invoice. Invoicing will be monthly for charges incurred through in the previous month. This agreement is drawn between the primary client and Altran Corporation and is exclusive of any arrangements made between the Altran Corporation client law firm and its client. Unless other arrangements are made under written agreement, an estimate will be provided for the effort to be undertaken. An up-front retainer of 15% of the estimated cost of the support effort will be required before any work is undertaken, unless other arrangements are made in advance.

Storage of bulky physical evidence will be charged at \$150 per month, beginning at such time as the evidence is no longer directly required for analysis or examination.

The above terms are considered in force until such time as the litigation matter for which support is being contracted is resolved. Failure to make payment according to this agreement will result in the following actions:

- a monthly interest rate will be assessed in the amount of 1.5% of the outstanding balance, beginning 60 days after date of invoice
- all activities by Altran Corporation will be stopped following 60 days of non-payment of the amount due
- failure to make timely payments will be considered for legal action and the cost of such action will be charged to the client firm

The above terms have been reviewed and accepted on this day, the

_____ day of _____, 2000, by
_____, representing the firm of
_____, in the matter of
_____ vs. _____

For Altran Corporation:

APPENDIX H.

COMPENSATION FORECAST

Projected Compensation Schedule by Month - 2000

Position	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Year Total
Vice President	\$7,917	\$7,917	\$7,917	\$7,917	\$7,917	\$7,917	\$7,917	\$7,917	\$7,917	\$7,917	\$7,917	\$7,917	\$95,004
Retainer: Associate 1	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 2	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 3	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 4	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Engineering Manager	\$6,667	\$6,667	\$6,667	\$6,667	\$6,667	\$6,667	\$6,667	\$6,667	\$6,667	\$6,667	\$6,667	\$6,667	\$80,004
Laboratory Administrator	\$0	\$0	\$0	\$0	\$0	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$37,919
Senior Engineer	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$5,417	\$65,004
Lead Engineer	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$50,004
Lead Engineer	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$4,167	\$4,167	\$4,167	\$4,167	\$4,167	\$20,835
Engineer	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$45,000
Engineer	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$3,750	\$45,000
Scientist	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$40,500
Scientist	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$3,375	\$40,500
Technical Supervisor	\$3,167	\$3,167	\$3,167	\$3,167	\$3,167	\$3,167	\$3,167	\$3,167	\$3,167	\$3,167	\$3,167	\$3,167	\$38,004
Technician	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$30,000
Technician	\$0	\$0	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	\$25,000
Administrative Assistant	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$24,000
Total Direct Salaries	\$62,085	\$62,085	\$64,585	\$64,585	\$64,585	\$70,002	\$70,002	\$74,169	\$74,169	\$74,169	\$74,169	\$74,169	\$828,774
Fringe Benefits (12%)	\$7,450	\$7,450	\$7,750	\$7,750	\$7,750	\$8,400	\$8,400	\$8,900	\$8,900	\$8,900	\$8,900	\$8,900	\$99,453
Total Compensation	\$69,535	\$69,535	\$72,335	\$72,335	\$72,335	\$78,402	\$78,402	\$83,069	\$83,069	\$83,069	\$83,069	\$83,069	\$928,227

Projected Compensation Schedule by Month - 2001

Position	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	Year Total
Vice President	\$8,075	\$8,075	\$8,075	\$8,075	\$8,075	\$8,075	\$8,075	\$8,075	\$8,075	\$8,075	\$8,075	\$8,075	\$96,900
Retainer: Associate 1	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 2	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 3	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 4	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Engineering Manager	\$6,800	\$6,800	\$6,800	\$6,800	\$6,800	\$6,800	\$6,800	\$6,800	\$6,800	\$6,800	\$6,800	\$6,800	\$81,600
Laboratory Administrator	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$66,300
Senior Engineer	\$0	\$0	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$55,250
Senior Engineer	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$5,525	\$66,300
Lead Engineer	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$51,000
Lead Engineer	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$4,250	\$51,000
Engineer	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$45,900
Engineer	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$3,825	\$45,900
Scientist	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$41,304
Scientist	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$3,442	\$41,304
Technical Supervisor	\$3,230	\$3,230	\$3,230	\$3,230	\$3,230	\$3,230	\$3,230	\$3,230	\$3,230	\$3,230	\$3,230	\$3,230	\$38,760
Technician	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$30,600
Technician	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$2,550	\$30,600
Administrative Assistant	\$2,040	\$2,040	\$2,040	\$2,040	\$2,040	\$2,040	\$2,040	\$2,040	\$2,040	\$2,040	\$2,040	\$2,040	\$24,480
Receptionist	\$0	\$0	\$0	\$0	\$0	\$1,850	\$1,850	\$1,850	\$1,850	\$1,850	\$1,850	\$1,850	\$12,950
Total Direct Salaries	\$75,329	\$75,329	\$80,854	\$80,854	\$80,854	\$82,704	\$82,704	\$82,704	\$82,704	\$82,704	\$82,704	\$82,704	\$972,148
Fringe Benefits (12%)	\$9,039.48	\$9,039.48	\$9,702.48	\$9,702.48	\$9,702.48	\$9,924.48	\$9,924.48	\$9,924.48	\$9,924.48	\$9,924.48	\$9,924.48	\$9,924.48	\$116,658
Total Compensation	\$84,368	\$84,368	\$90,556	\$90,556	\$90,556	\$92,628	\$92,628	\$92,628	\$92,628	\$92,628	\$92,628	\$92,628	\$1,088,806

Projected Compensation Schedule by Month - 2002

Position	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Year Total
Vice President	\$8,237	\$8,237	\$8,237	\$8,237	\$8,237	\$8,237	\$8,237	\$8,237	\$8,237	\$8,237	\$8,237	\$8,237	\$98,844
Retainer: Associate 1	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 2	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 3	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Retainer: Associate 4	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$48,000
Engineering Manager	\$6,936	\$6,936	\$6,936	\$6,936	\$6,936	\$6,936	\$6,936	\$6,936	\$6,936	\$6,936	\$6,936	\$6,936	\$83,232
Laboratory Administrator	\$5,635	\$5,635	\$5,635	\$5,635	\$5,635	\$5,635	\$5,635	\$5,635	\$5,635	\$5,635	\$5,635	\$5,635	\$67,620
Senior Engineer	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$67,632
Senior Engineer	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$5,636	\$67,632
Lead Engineer	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$52,020
Lead Engineer	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$4,335	\$52,020
Engineer	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$46,812
Engineer	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$46,812
Engineer	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$46,812
Engineer	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$3,901	\$46,812
Scientist	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$42,132
Scientist	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$3,511	\$42,132
Technical Supervisor	\$3,295	\$3,295	\$3,295	\$3,295	\$3,295	\$3,295	\$3,295	\$3,295	\$3,295	\$3,295	\$3,295	\$3,295	\$39,540
Technician	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$31,320
Technician	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$31,320
Technician	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$2,610	\$31,320
Administrative Assistant	\$2,081	\$2,081	\$2,081	\$2,081	\$2,081	\$2,081	\$2,081	\$2,081	\$2,081	\$2,081	\$2,081	\$2,081	\$24,972
Receptionist	\$1,900	\$1,900	\$1,900	\$1,900	\$1,900	\$1,900	\$1,900	\$1,900	\$1,900	\$1,900	\$1,900	\$1,900	\$22,800
Total Direct Salaries	\$94,482	\$94,482	\$94,482	\$94,482	\$94,482	\$94,482	\$94,482	\$94,482	\$94,482	\$94,482	\$94,482	\$94,482	\$1,133,784
Fringe Benefits (12%)	\$11,338	\$11,338	\$11,338	\$11,338	\$11,338	\$11,338	\$11,338	\$11,338	\$11,338	\$11,338	\$11,338	\$11,338	\$136,054
Total Compensation	\$105,820	\$105,820	\$105,820	\$105,820	\$105,820	\$105,820	\$105,820	\$105,820	\$105,820	\$105,820	\$105,820	\$105,820	\$1,269,838

APPENDIX I.

REVENUE FORECAST

Projected Revenue by Month - 2000

Position	Util	Rate	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Year Total
Business Days in Month			20	19	23	20	22	22	20	24	20	22	20	20	252
Vice President	80%	\$156	\$24,320	\$23,104	\$27,968	\$24,320	\$26,752	\$26,752	\$24,320	\$29,184	\$24,320	\$26,752	\$24,320	\$24,320	\$306,432
Associate 1	25%	\$156	\$6,240	\$5,928	\$7,176	\$6,240	\$6,864	\$6,864	\$6,240	\$7,488	\$6,240	\$6,864	\$6,240	\$6,240	\$78,624
Associate 2	25%	\$156	\$6,240	\$5,928	\$7,176	\$6,240	\$6,864	\$6,864	\$6,240	\$7,488	\$6,240	\$6,864	\$6,240	\$6,240	\$78,624
Associate 3	25%	\$156	\$6,240	\$5,928	\$7,176	\$6,240	\$6,864	\$6,864	\$6,240	\$7,488	\$6,240	\$6,864	\$6,240	\$6,240	\$78,624
Associate 4	25%	\$156	\$6,240	\$5,928	\$7,176	\$6,240	\$6,864	\$6,864	\$6,240	\$7,488	\$6,240	\$6,864	\$6,240	\$6,240	\$78,624
Engineering Manager	60%*	\$125	\$15,264	\$14,501	\$17,554	\$19,352	\$21,287	\$21,287	\$18,808	\$22,570	\$18,808	\$20,689	\$18,808	\$18,808	\$227,735
Laboratory Administrator	50%	\$104	\$0	\$0	\$0	\$0	\$0	\$0	\$11,040	\$13,248	\$11,040	\$12,144	\$11,040	\$11,040	\$69,552
Senior Engineer	80%	\$104	\$17,664	\$16,781	\$20,314	\$17,664	\$19,430	\$19,430	\$17,664	\$21,197	\$17,664	\$19,430	\$17,664	\$17,664	\$222,566
Lead Engineer	80%	\$85	\$15,232	\$14,470	\$17,517	\$15,232	\$16,755	\$16,755	\$15,232	\$18,278	\$15,232	\$16,755	\$15,232	\$15,232	\$191,923
Lead Engineer	80%	\$85	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$15,232	\$16,755	\$15,232	\$15,232	\$15,232	\$62,451
Engineer	80%	\$72	\$13,568	\$12,890	\$15,603	\$13,568	\$14,925	\$14,925	\$13,568	\$16,282	\$13,568	\$14,925	\$13,568	\$13,568	\$170,957
Engineer	80%	\$72	\$13,568	\$12,890	\$15,603	\$13,568	\$14,925	\$14,925	\$13,568	\$16,282	\$13,568	\$14,925	\$13,568	\$13,568	\$170,957
Scientist	80%	\$85	\$15,232	\$14,470	\$17,517	\$15,232	\$16,755	\$16,755	\$15,232	\$18,278	\$15,232	\$16,755	\$15,232	\$15,232	\$191,923
Scientist	80%	\$72	\$13,568	\$12,890	\$15,603	\$13,568	\$14,925	\$14,925	\$13,568	\$16,282	\$13,568	\$14,925	\$13,568	\$13,568	\$170,957
Technical Supervisor	80%	\$68	\$13,056	\$12,403	\$15,014	\$13,056	\$14,362	\$20,557	\$13,056	\$15,667	\$13,056	\$14,362	\$13,056	\$13,056	\$170,701
Technician	80%	\$59	\$11,904	\$11,309	\$13,690	\$11,904	\$13,094	\$13,094	\$11,904	\$14,285	\$11,904	\$13,094	\$11,904	\$11,904	\$149,990
Technician	80%	\$59	\$0	\$0	\$0	\$11,904	\$13,094	\$13,094	\$11,904	\$14,285	\$11,904	\$13,094	\$11,904	\$11,904	\$113,088
Administrative Assistant	50%	\$47	\$3,760	\$3,572	\$4,324	\$3,760	\$4,136	\$4,136	\$3,760	\$4,512	\$3,760	\$4,136	\$3,760	\$3,760	\$47,376
Revenue			\$182,096	\$172,991	\$209,410	\$198,088	\$217,897	\$224,092	\$208,584	\$250,301	\$223,816	\$246,198	\$223,816	\$223,816	\$2,581,105

Laboratory time \$68
Machine time \$156

Laboratory Utilisation = 40% for engineering and technical staff only
* Until appointment of Laboratory Administrator - then 75%

Projected Revenue by Month - 2001

Position	Util	Rate	Position Days in Month												Year Total	
			Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01		
Business Days in Month			20	19	23	20	22	22	20	24	22	20	22	20	20	252
Vice President	80%	\$162	\$25,280	\$24,016	\$29,072	\$25,280	\$27,808	\$27,808	\$25,280	\$30,336	\$27,808	\$25,280	\$27,808	\$25,280	\$25,280	\$318,528
Associate 1	25%	\$162	\$6,480	\$6,156	\$7,452	\$6,480	\$7,128	\$7,128	\$6,480	\$7,776	\$7,128	\$6,480	\$7,128	\$6,480	\$6,480	\$81,648
Associate 2	25%	\$162	\$6,480	\$6,156	\$7,452	\$6,480	\$7,128	\$7,128	\$6,480	\$7,776	\$7,128	\$6,480	\$7,128	\$6,480	\$6,480	\$81,648
Associate 3	25%	\$162	\$6,480	\$6,156	\$7,452	\$6,480	\$7,128	\$7,128	\$6,480	\$7,776	\$7,128	\$6,480	\$7,128	\$6,480	\$6,480	\$81,648
Associate 4	25%	\$162	\$6,480	\$6,156	\$7,452	\$6,480	\$7,128	\$7,128	\$6,480	\$7,776	\$7,128	\$6,480	\$7,128	\$6,480	\$6,480	\$81,648
Engineering Manager	75%	\$130	\$19,576	\$18,597	\$22,512	\$19,576	\$21,534	\$21,534	\$19,576	\$23,491	\$21,534	\$19,576	\$21,534	\$19,576	\$19,576	\$246,658
Laboratory Administrator	50%	\$108	\$11,480	\$10,906	\$13,202	\$11,480	\$12,628	\$12,628	\$11,480	\$13,776	\$12,628	\$11,480	\$12,628	\$11,480	\$11,480	\$144,648
Senior Engineer	80%	\$108	\$0	\$0	\$0	\$18,368	\$20,205	\$20,205	\$18,368	\$22,042	\$20,205	\$18,368	\$20,205	\$18,368	\$18,368	\$174,496
Semior Engineer	80%	\$108	\$18,368	\$17,450	\$21,123	\$18,368	\$18,368	\$20,205	\$18,368	\$22,042	\$20,205	\$18,368	\$20,205	\$18,368	\$18,368	\$231,437
Lead Engineer	80%	\$88	\$15,808	\$15,018	\$18,179	\$15,808	\$17,389	\$17,389	\$15,808	\$18,970	\$17,389	\$15,808	\$17,389	\$15,808	\$15,808	\$199,181
Lead Engineer	80%	\$88	\$15,808	\$15,018	\$18,179	\$15,808	\$17,389	\$17,389	\$15,808	\$18,970	\$17,389	\$15,808	\$17,389	\$15,808	\$15,808	\$199,181
Engineer	80%	\$75	\$14,144	\$13,437	\$16,266	\$14,144	\$15,558	\$15,558	\$14,144	\$16,973	\$15,558	\$14,144	\$15,558	\$14,144	\$14,144	\$178,214
Engineer	80%	\$75	\$14,144	\$13,437	\$16,266	\$14,144	\$15,558	\$15,558	\$14,144	\$16,973	\$15,558	\$14,144	\$15,558	\$14,144	\$14,144	\$178,214
Scientist	80%	\$88	\$15,808	\$15,018	\$18,179	\$15,808	\$17,389	\$17,389	\$15,808	\$18,970	\$17,389	\$15,808	\$17,389	\$15,808	\$15,808	\$199,181
Scientist	80%	\$88	\$15,808	\$15,018	\$18,179	\$15,808	\$17,389	\$17,389	\$15,808	\$18,970	\$17,389	\$15,808	\$17,389	\$15,808	\$15,808	\$199,181
Technical Supervisor	80%	\$71	\$13,632	\$12,950	\$15,677	\$13,632	\$14,995	\$21,402	\$13,632	\$16,358	\$14,995	\$13,632	\$14,995	\$13,632	\$13,632	\$178,170
Technician	80%	\$61	\$12,352	\$11,734	\$14,205	\$12,352	\$13,587	\$13,587	\$12,352	\$14,822	\$13,587	\$12,352	\$13,587	\$12,352	\$12,352	\$155,635
Technician	80%	\$61	\$12,352	\$11,734	\$14,205	\$12,352	\$13,587	\$13,587	\$12,352	\$14,822	\$13,587	\$12,352	\$13,587	\$12,352	\$12,352	\$155,635
Administrative Assistant	50%	\$49	\$3,920	\$3,724	\$4,508	\$3,920	\$4,312	\$4,312	\$3,920	\$4,704	\$4,312	\$3,920	\$4,312	\$3,920	\$3,920	\$49,392
Receptionist	25%	\$49	\$0	\$0	\$0	\$0	\$0	\$0	\$1,960	\$2,352	\$2,156	\$1,960	\$2,156	\$1,960	\$1,960	\$12,348
Revenue			\$232,736	\$221,099	\$267,646	\$251,104	\$276,214	\$282,621	\$253,064	\$303,677	\$278,370	\$253,064	\$278,370	\$253,064	\$253,064	\$3,125,724

Laboratory Utilisation = 40% for engineering and technical staff only

Laboratory time \$71
Machine time \$162

Projected Revenue by Month - 2002

Position	Util	Rate	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Year Total
Business Days in Month			22	19	22	20	22	21	21	23	20	23	20	20	253
Vice President	80%	\$168	\$28,794	\$24,867	\$28,794	\$26,176	\$28,794	\$27,485	\$27,485	\$30,102	\$26,176	\$30,102	\$26,176	\$26,176	\$331,126
Associate 1	25%	\$168	\$7,392	\$6,384	\$7,392	\$6,720	\$7,392	\$7,056	\$7,056	\$7,728	\$6,720	\$7,728	\$6,720	\$6,720	\$85,008
Associate 2	25%	\$168	\$7,392	\$6,384	\$7,392	\$6,720	\$7,392	\$7,056	\$7,056	\$7,728	\$6,720	\$7,728	\$6,720	\$6,720	\$85,008
Associate 3	25%	\$168	\$7,392	\$6,384	\$7,392	\$6,720	\$7,392	\$7,056	\$7,056	\$7,728	\$6,720	\$7,728	\$6,720	\$6,720	\$85,008
Associate 4	25%	\$168	\$7,392	\$6,384	\$7,392	\$6,720	\$7,392	\$7,056	\$7,056	\$7,728	\$6,720	\$7,728	\$6,720	\$6,720	\$85,008
Engineering Manager	75%	\$135	\$22,317	\$19,274	\$22,317	\$20,288	\$22,317	\$21,302	\$21,302	\$23,331	\$20,288	\$23,331	\$20,288	\$20,288	\$256,643
Laboratory Administrator	50%	\$112	\$13,068	\$11,286	\$13,068	\$11,880	\$13,068	\$12,474	\$12,474	\$13,662	\$11,880	\$13,662	\$11,880	\$11,880	\$150,282
Senior Engineer	80%	\$112	\$20,909	\$18,058	\$20,909	\$19,008	\$20,909	\$19,958	\$19,958	\$21,859	\$19,008	\$21,859	\$19,008	\$19,008	\$240,451
Senior Engineer	80%	\$112	\$20,909	\$18,058	\$20,909	\$19,008	\$20,909	\$19,958	\$19,958	\$21,859	\$19,008	\$21,859	\$19,008	\$19,008	\$240,451
Lead Engineer	80%	\$91	\$17,952	\$15,504	\$17,952	\$16,320	\$17,952	\$17,136	\$17,136	\$18,768	\$16,320	\$18,768	\$16,320	\$16,320	\$206,448
Lead Engineer	80%	\$91	\$17,952	\$15,504	\$17,952	\$16,320	\$17,952	\$17,136	\$17,136	\$18,768	\$16,320	\$18,768	\$16,320	\$16,320	\$206,448
Engineer	80%	\$78	\$16,122	\$13,923	\$16,122	\$14,656	\$16,122	\$15,389	\$15,389	\$16,854	\$14,656	\$16,854	\$14,656	\$14,656	\$185,398
Engineer	80%	\$78	\$16,122	\$13,923	\$16,122	\$14,656	\$16,122	\$15,389	\$15,389	\$16,854	\$14,656	\$16,854	\$14,656	\$14,656	\$185,398
Engineer	80%	\$78	\$16,122	\$13,923	\$16,122	\$14,656	\$16,122	\$15,389	\$15,389	\$16,854	\$14,656	\$16,854	\$14,656	\$14,656	\$185,398
Engineer	80%	\$78	\$0	\$0	\$0	\$14,656	\$16,122	\$15,389	\$15,389	\$16,854	\$14,656	\$16,854	\$14,656	\$14,656	\$139,232
Scientist	80%	\$91	\$17,952	\$15,504	\$17,952	\$16,320	\$17,952	\$17,136	\$17,136	\$18,768	\$16,320	\$18,768	\$16,320	\$16,320	\$206,448
Scientist	80%	\$78	\$16,122	\$13,923	\$16,122	\$14,656	\$16,122	\$15,389	\$15,389	\$16,854	\$14,656	\$16,854	\$14,656	\$14,656	\$185,398
Technical Supervisor	80%	\$73	\$15,418	\$13,315	\$15,418	\$14,016	\$15,418	\$21,101	\$14,717	\$16,118	\$14,016	\$16,118	\$14,016	\$14,016	\$183,686
Technician	80%	\$63	\$14,010	\$12,099	\$14,010	\$12,736	\$14,010	\$13,373	\$13,373	\$14,646	\$12,736	\$14,646	\$12,736	\$12,736	\$161,110
Technician	80%	\$63	\$14,010	\$12,099	\$14,010	\$12,736	\$14,010	\$13,373	\$13,373	\$14,646	\$12,736	\$14,646	\$12,736	\$12,736	\$161,110
Technician	80%	\$63	\$14,010	\$12,099	\$14,010	\$12,736	\$14,010	\$13,373	\$13,373	\$14,646	\$12,736	\$14,646	\$12,736	\$12,736	\$161,110
Administrative Assistant	50%	\$51	\$4,488	\$3,876	\$4,488	\$4,080	\$4,488	\$4,284	\$4,284	\$4,692	\$4,080	\$4,692	\$4,080	\$4,080	\$51,612
Receptionist	25%	\$51	\$4,488	\$3,876	\$4,488	\$4,080	\$4,488	\$4,284	\$4,284	\$4,692	\$4,080	\$4,692	\$4,080	\$4,080	\$51,612
Revenue			\$320,329	\$276,648	\$320,329	\$305,864	\$336,450	\$327,541	\$321,157	\$351,744	\$305,864	\$351,744	\$305,864	\$305,864	\$3,829,397

Laboratory time \$73
Machine time \$168

Laboratory Utilisation = 40% for engineering and technical staff only