

**Enterprise in Nanotechnology**  
***Starting a High Technology Business***

Case Studies

for the

MSc Nanoscale Science and Technology

run by

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# 1. Introduction

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**T**raditionally, there was always something “not quite right” about an academic involved in business. That time is now firmly in the past. The name of the game is *spin-out* and there are not many universities now without a technology transfer or innovations unit.

## UK vs MIT

In 2001, the Financial Times conducted a survey of 100 UK universities: 59 replies revealed that, in the past 3 years, 396 companies had been created by university spin-out or investment in an external start-up. The estimated value of these companies was £143m. 10 universities had not spun out any companies and 39 had not invested in any external start-up companies. Two-thirds had made no money at all or less than £1m. Only 6 had a combined portfolio of over £10m.

Just before these 6 vice-chancellors start to cheer and spray each other with champagne, contrast the UK situation with just one American university.

**The spin-out companies of MIT, by the year 1997, had generated total global sales of \$232bn.**

**The university has spun out over 4000 companies.**

**In 1999 it received sponsorship from industry worth \$62m.**

**MIT signs more than 100 patents a year.**

So we have some way to go in this country to cross the cultural canyon which seems to separate us from the United States. However, attitudes are changing, progress is being made.

It is not normal for the knowledge and skills required to start up and run a successful business to be acquired by someone following a typical career in scientific research.

*How to write a business plan.*

*How to seek finance for a company.*

*How to plan the marketing of a product.*

These are matters of fundamental importance to a new business venture with which the aspiring businessperson-scientist must become acquainted. One often hears it said in business education circles that, above all, the essence of the job is to teach students **the right questions to ask** and **where to go to get the answers**. So, the aim of these case studies is to introduce students to the key processes involved in starting up a business by emphasising the important questions that must be answered.

*Dr Brian P. Clark  
May 2002*

## 2. The Workshops.

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### 2.1 Introduction

Each case study involves a new start-up company based upon some nanotechnological innovation. There are three workshop exercises involved.

1. The Early Stage
2. Marketing
3. Pulling It All Together

### 2.2 Learning Outcomes

After completing the workshop sessions each group will be able to provide a rough sketch of the answer to each of the following questions related to the business ventures described in their case notes.

1. **What is the product?**
2. **Who will buy the product and what is the estimated market value?**
3. **Who are the competitors and why will people prefer to buy your product?**
4. **How much will the product cost?**
5. **How will the product be made and how much will this cost?**
6. **How will the company be managed?**
7. **When will the company start making a profit?**
8. **What finance does the company need to succeed, what are the most likely sources of this funding, and when will investors see a return on their money?**
9. **How will the company develop over the mid- to long-term?**

These are essentially the questions that need to be answered in order to put together a business plan, the *sine qua non* of any attempt to create a successful enterprise.

In order to provide a focus for the workshop activities, each group will nominate one of its members to present the group's findings in the form of a 2-minute *elevator pitch*. Brief notes on the art of the elevator pitch are given later.

## 3. Workshop - The Early Stage

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### 3.1 Learning Outcomes

At the end of this workshop you should have been able to do the following.

**1. Familiarise yourself with the material in the case study to which your group has been assigned.**

Read the case study pages of the appropriate colour, have a look at the Lloyds TSB start-up guide. Sections 7 and 8 below on Rapid Product Development and Low-Cost Microchip Prototypes, respectively, might be useful to you later on.

**2. As a little warm-up exercise, give your new company a suitable name. A dividend will be awarded to the most inventive offering.**

It is assumed that you will be forming a limited company as opposed to a partnership, sole tradership or public limited company. The Lloyds TSB guidance pack has some further information on types of businesses where the other options might be suitable.

**3. Estimate the start-up costs (excluding product costs and salaries at this point) and monthly overheads for running an office with, for insurance purposes, at least one employee.**

You can get guidance on the what to include here from the Lloyds TSB guide.

Often a spin out company will benefit from an offer for an initial period of free office accommodation and other facilities from the parent university, but let's look at the full whack for the purposes of the exercise.

Will there be a web site?

The cool new Hewlett-Packard colour printer may cost only £120, but it costs £80 a time to replace the ink cartridges.

What are phone bills likely to be?

### 3.2 Notes

#### 3.2.1 Forming a Company

One needs at least two people to form a company: there has to be a company secretary and one or more company directors. If there is only one director then he or she cannot also be company secretary.

A limited company must also have a registered office and it is the directors' duty to ensure that this remains attended.

Don't try to create the company yourself - you will end up chewing unnecessarily over your *Memorandum of Association*, and wondering whether or not you need a Commissioner of Oaths, and

becoming a little uncomfortable about the possibility of acting *ultra vires*. The easiest way of creating a company is to use the services of an accountant or a solicitor: company formation agents buy an off-the-shelf company which has already been created by a company specialising in this process. The off-the-shelf company's details are then changed to your requirements.

**This process will take two to three weeks and cost around £120.**

### 3.2.2 Insurance Requirements

If the company employs any staff then there must be an employer's liability insurance policy worth a minimum of £2 million to cover any injury or illness suffered by staff as a result of being employed by the company. The certificate for this policy must be displayed in the workplace.

Obviously one should shop around the registered insurance brokers to find the best deal, but employer's liability for a small firm should cost about **£300 per year**.

If you have office equipment like computers & peripherals, fax and other office machinery, then it would be wise to spend **another £500 or so per year** to insure these against fire and theft.

### 3.2.3 Accountancy

In order to save some money, you might be tempted to forego the services of a professional accountant. This is not recommended. In the rosy early days this might seem like a reasonable risk, but 2 months after your yearly accounts are due at Companies House, when the fines are mounting up (£100 per month to a maximum of £1000), and you can't find some bank statements, and you're not quite sure what the required format is, and . . . Employ an accountant. Including an auditing service, **a reasonable sum to budget is £3000.**

### 3.2.4 Legal Services

Perhaps in the very early stages you might not need a solicitor, but if you are employing any staff then it is wise to get a solicitor to draw up the contract of employment.

## 4. Workshop - Marketing

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At the end of this workshop you should have been able to do the following.

1. **Devise a strapline and a mission statement for your company - a contribution to the consumable budget for the most impressive.**

A strapline is the one phrase or sentence which goes beneath your company name to sum up the company's business. For example, the strapline of Cyrano Sciences, the electronic nose company is: *We digitize smell!*

In the university sector mission statements are regarded as a bit naff by many staff. They are, however, quite important to commercial operations and you will find on the home pages of most high tech companies a couple of sentences which summarise the mission or "the vision thing". Also, it is annoying to have to dig deep into a company's web site to find out what it does. Here is a classic mission statement from Zyvex.

*"Zyvex's mission is to be the industry leader in adaptable, affordable, molecularly precise manufacturing. While our ultimate goal is to produce a molecular assembler capable of creating a variety of materials using precise atomic and molecular placement, the path to building an assembler will afford us the opportunity to produce an array of MEMS-, subMEMS-, and nanoscale devices for a variety of industries."*

From Nantero,

*"Nantero, Inc. is building a high density nonvolatile random access memory chip, which can replace DRAM (dynamic RAM), SRAM (static RAM), flash memory, and ultimately hard disk storage--in other words a universal memory chip suitable for countless existing and new applications in the field of electronics. The target markets in aggregate exceed \$100B in revenue per year. Nantero's product is called NRAM™ (Nanotube-based/ Nonvolatile RAM), developed using proprietary concepts and methods derived from leading-edge research in nanotechnology."*

2. **Identify your main competitors and analyse strengths and weaknesses of your company and your most powerful competitor.**

One conventional way of doing this is to use SWOT analysis. (**SWOT** = **S**trengths, **W**eaknesses, **O**pportunities, **T**hreats.) Section 9 gives some advice on a SWOT analysis.

Each member of the group should also attempt a For/Who/The/Unlike/OurProduct statement.

**For** (target customer)

**Who** (statement of the need or opportunity)

**The** (product name) is a (product category)

**That** (statement of key benefit i.e. compelling reason to buy)

**Unlike** (primary competitive alternative)

**Our product** (statement of primary differentiation)

3. **Name your product.** Remember - Name it and frame it!

4. **Sketch out a marketing plan for your company.**
5. **Discuss possible ways for the company to develop in the mid-term and identify what seems to be the best alternative.**

There are 3 classic ways for a company to develop:

- a. expand the market for an existing product;
- b. find a new market for an existing product;
- c. develop a new product.

## **5. Workshop - Pulling It All Together**

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At the end of this workshop you should have been able to do the following.

1. **Work out what staffing will be required, the management structure and an estimate of the salary requirements (bear in mind possible payments to directors)**
2. **Produce a rough cost for the Phase 1 process in your case study.**
3. **Assuming a successful Phase 1, draw up an estimated profit and loss statement for the first 3 years and calculate when the break-even point will occur. To do this you will have to estimate manufacturing costs and sales volumes, and set a price for your product.**
4. **Identify possible financial exit points.**
5. **Summarise your group's conclusions in the form of an elevator pitch.**

## 6. The Elevator Pitch

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### *The Bonzai Business Plan*

The elevator pitch may appear to be a bit of a gimmick, but it is a useful exercise, a good way to concentrate your thoughts about an enterprise. It is also useful as an aid to writing the *executive summary* of your business plan. The executive summary is one page, at most two pages, appearing at the start of your plan. The following excerpt from David E. Gumpert's book, "How to Really Create a Successful Business Plan" (ISBN: 1880394235, 1996) gives his definition:

*Certainly the most significant part of any business plan is its executive summary. What is an executive summary? Probably the best way to begin defining it is to explain what it isn't.*

*The executive summary is not an abstract of the business plan.*

*The executive summary is not an introduction to the business plan.*

*The executive summary is not a preface.*

*The executive summary is not a random collection of highlights.*

*Rather, the executive summary is the business plan in miniature. The executive summary should stand alone, almost as a kind of business plan within the business plan. It should be logical, clear, interesting - and exciting. A reader should be able to read through it in four or five minutes and understand what makes your business tick. After reading your executive summary, a reader should be prompted to say, "So that's what those people are up to."*

The elevator pitch is essentially your executive summary. The origin of the term refers to the scenario in which suddenly and unexpectedly you find yourself together in an elevator (*lift* - UK) with someone who is a potential investor.

You have to grasp this opportunity with both entrepreneurial hands. You have the period of the elevator ride to pitch (*throw* - UK) your ideas across with sufficient clarity, conciseness and enthusiasm that your captive audience becomes interested enough to want to have a look at your business plan.

An "elevator ride" is obviously not a standard unit of time: one sees definitions ranging from 30 seconds to 5 minutes (slow elevator, big building). Our elevator ride will take 120 seconds. During this time you should be able to answer the following questions quite comfortably.

**What is the big idea?**

**What market does the project address?**

**Why does your new product have an advantage in this marketplace?**

**What is the competition?**

**How will the company be managed?**

**What is the total amount of money needed to carry out the business plan?**

**How will you raise these funds?**

**What is the size of the first phase funding?**

**When and how will investors get a return?**

The elevator pitch is not an exercise in talking fast - if anything, slow down your delivery to emphasis your facts. It is surprising how much can be conveyed in such a short time.

One tip is not to disparage the competition. This can easily come across as being a bit petty. Emphasise the benefits of *your* product to the buyer.

The Centre for Mathematical Sciences at Cambridge has blackboards installed in the lifts so that interesting discussions need not be interrupted on a trip to the tea-room and back. We will go one step further than Cambridge and fit our lift with an overhead projector: acetates and coloured pens are provided if you have a diagram or some bullet points which might help the pitch.

The assessment will be based on the quality of the case made for the business idea.

## 7. SWOT Analysis

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As stated before, SWOT analysis consists of analysing the strengths, weaknesses, opportunities and threats of a business. The idea is that this type of analysis can provide a clear basis for your business decisions, including marketing.

Under **strengths** and **weaknesses** you might consider such factors as:

- the state of your balance sheet and credit rating
- position in the market
- reputation and brand recognition
- quality control
- customer base
- product range
- research and development activity
- Intellectual Property Rights
- management strength
- skill base
- administrative system
- production capacity
- location

**Opportunities** may arise from:

- a downturn in the fortunes of a competitor
- the opening up of new market areas
- new distribution channels
- new trends in society
- legislative or regulatory change

**Threats** may emerge from such things as:

- new competitors
- new or stronger products from existing competitors
- customer loss
- unreliable suppliers
- loss of key personnel

Once you have analysed your company under the SWOT headings comes the difficult part.

**You must build and capitalise on your strengths.**

**You must act to counteract the effects of your weaknesses.**

**You must make the most of your opportunities.**

**You must try to reduce or eliminate your threats.**

To get the best out of a SWOT analysis by a team of people, start the process by allowing some time for each individual to compile his or her own SWOT analysis, then compare results.

This chapter was based on the following document available from the website of the Chartered Institute of Marketing ([www.cim.co.uk](http://www.cim.co.uk)): Directors Briefing ST1, *SWOT Analysis*, by David Patten (author of *Successful Marketing for the Small Business*, Kogan Page, £12.99), Jim McGlauchlin (Optima) and David Kent (Business Link Leeds).

## 8. Rapid Prototyping

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### 8.1 Introduction

One of the commonest Phase 1 tasks is to build a prototype of the device one hopes to commercialise. Due to some amazing advances in the field known as **rapid prototyping (RP)**, this process is one heck of a lot faster and cheaper than 15 years ago when RP started to develop.

There are several technologies in use, but they share the common feature of being 3D manufacturing processes which operate on the principle of material addition rather than the conventional material removal process. A sculptor is involved in material removal, for example: he or she starts with a block of material and creates the end product by piece wise removal of small elements.

All rapid prototyping procedures start with the formation of a 3D model of the product using computer-aided design (CAD) software. The software then slices up the CAD model into a series of thin layers. Each layer is described in an industry standard format *stl* (stereolithography) file. The stl files are then downloaded to an RP machine which then builds the object up slice by slice using one of a range of technologies.

Using RP, a product developer can have a new device warm in the hand just **hours** after creating it on the computer monitor.

### 8.2 The Technologies

There are 5 main processes available in the UK.

#### 8.2.1 Stereo-lithography (SLA)

Material: epoxy or acrylate resins. Parts are built onto a platen in a tank of photosensitive polymer resin. A laser traces the outline of the first slice, so solidifying the resin. The platen then moves down a layer and the process repeats.

#### 8.2.2 Laminated Object Manufacture (LOM)

Material: laminated paper. Paper coated with heat-sensitive adhesive is activated by passing through heated rollers. A laser mounted on a 2D plotter cuts the cross-section then the next layer is added.

#### 8.2.3 Fused Deposition Modelling (FDM)

Materials: ABS (Acrylonitrile Butadiene Styrene) , MABS (Methyl Methacrylate ABS), Wax, Elastomers. Entails extrusion of thermoplastics just above their melting points. A heated head element controls the shape of each cross-section.

#### 8.2.4 Selective Laser Sintering (SLS)

Materials: nylon, polycarbonate, rapidsteel. Uses fusible powder which is heated to just under its fusing temperature. A laser beam then provides sufficient energy to fuse the particles and in this way a solid 2D tranche is made.

### 8.2.5 Ink Jet Modelling (IJM)

Material: thermoplastic. A liquid-to-solid inkjet printer. A flatbed milling system is used to ensure a uniform height level of each layer.

## 8.3 The Savings

A typical RP project would take a few weeks for the CAD (~£10K); a day to produce the stl files (~£1.2K); a few days to produce an LOM model (~£3.2K); 6 weeks for casting (~£2.1K).

**Total time - 6 weeks; total cost - £16K.**

Using conventional methods this would be something like the following.

**Total time - 27 weeks; total cost - £115K.**

## 8.4 Where?

There are over 40 centres in the UK which will carry out RP work, many of them in the universities: Cardiff, Coventry, Leeds, Liverpool, Northumbria, Nottingham, Oxford, Queens, Teesside, for example.

The above information was taken from:

GETTING STARTED IN RAPID PROTOTYPING

M. Sarwar, S. Hogarth, P.M. Hackney

Center for Rapid Product Development

School of Engineering

University of Northumbria at Newcastle

<http://www.unn.ac.uk/~meph1/faim.htm>.

## 9. Low-Cost Microchip Prototypes

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Applied Microengineering Ltd (AML) of Abingdon have come up with a novel way of helping companies develop microsystem versions of a prototype device. They call it the *multi-product wafer* (MPW). AML carries out the design work for a company, then creates a mask for chip creation containing etches for different products. In this way, a company can buy **20 sample chips for around £5000** due to the cost of the etching mask being shared between a number of companies.

AML are specialists in thin film deposition (PVD & CVD) and patterning, and sensor design and interfacing.

Normally one would pay something of the order of **£50 000 for design production of a etching mask for a chip.**

## 10. Intellectual Property Rights

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### 10.1 UK Patent Office

The UK Patent Office operates a superb site with detailed information on all aspects of Intellectual Property Rights (IPR) at [www.patent.gov.uk](http://www.patent.gov.uk).

They also supply excellent printed introductions to the different kinds of intellectual property. The UK Patent Office guide to patents is included in your workshop pack.

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