INTELLIGENT HAP SOLUTIONS INC.
BUSINESS PLAN:
HAPTIC TECHNOLOGY FOR EDUCATIONAL APPLICATIONS

by

Ali AbdulHussein
M.A.Sc., Electrical Engineering, UBC, 2008
B.A.Sc., Electronics Engineering, SFU, 2006

PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF BUSINESS ADMINISTRATION

In the MOT MBA Program
of the
Faculty
of
Business Administration

SIMON FRASER UNIVERSITY

Summer 2011

Approval

Name: **Ali AbdulHussein**

Degree: **Master of Business Administration**

Title of Project: **Intelligent Hap Solutions Inc. Business Plan: Haptic Technology for Educational Applications**

Supervisory Committee:

_____

Adjunct Professor, Ian Hand
Senior Supervisor

_____

Associate Professor, Elicia Maine
Second Reader

Date Approved: _____

Abstract

Haptic technology has been utilized since 1952 in various industries. This technology is based on providing feedback, mainly force feedback, to users performing various tasks. For instance, in the video gaming industry, where haptic technology has been utilized widely, a player can feel the reaction of his actions when playing the game. They can feel how hard it is to kick a soccer ball or turn a racing car.

This business plan, developed for Intelligent Hap Solutions Inc., a start-up company, investigates the application of haptic technology in the education industry. A product, HapChem is proposed, which will enable chemistry students, both in high school and university, to build compounds and form reactions using a robotic arm with haptic technology. Using HapChem, students can feel the weight, and other properties of compounds as well as the reaction characteristics.

The business will require initial private capital investment from both the founders and from angel investors. The venture is projected to break-even with 4 years and produce a stage appropriate risk-adjusted return on investment for its investors.

Keywords: haptic, rate of return, chemistry, angel, feedback, sport, ROI.

1: Executive Summary

1.1 Business Opportunity

In this venture, we attempt to take advantage of a business opportunity that seems promising. Over the last decade, there has been increased commercial interested in Haptic technology. Haptic devices provide feedback to the user with the sense of touch by applying forces, vibration and motion. This technology has found applications in several industries. The most prominent one is tele-operation and medical/surgical training. Today, medical students can perform a full surgery on a virtual body using a Haptic robot arm. This arm provides the student with a sense of feedback. For instance, if they are suturing an organ, they can feel the stiffness of that organ and apply force accordingly.

1.2 Mission

Intelligent Hap Solutions is developing Haptic technology products for the educational market. Our HapChem product enables chemistry students and chemists to design chemical compound/structures with a Haptic feedback interface and control system. We believe that HapChem will allow Chemistry students to learn faster and more effectively.

1.3 Product Offering

We are offering software (HapChem) and a Haptic robot arm (HapArm) to control the design process. Both components will be designed and implemented by our engineers and project managers. We will sell the product for $4,000 or $3,000 if bought in bundles of 10.

1.4 Our Team

Our team is composed of four founders. David Zhouming, Ali AbdulHussein and Shi Wen all have an engineering background and combined business experience of more than 10 years. Ali is an MBA degree candidate who has been involved in several start-ups before. The fourth founder is Dr. Shahram Payandeh who is a professor at the School of Engineering Science, Simon Fraser University. He holds several patents in the field of Haptic robotics and related technologies.

1.5 Financial Requirements

With $50,000 of founder seed contribution, and an expected $100,000 of angel capital during second year of operation, we expect to breakeven during Q2 of 2014 and deliver a Return on Investment (ROE) of 600% to angel investors in 2016, if a competitor or other entity acquires the venture. This equates to an annualized ROE of 43%. Figure 1 shows the projected cash flow for period 2011-2016. Figure 2 shows the annual net income projected for the same period.

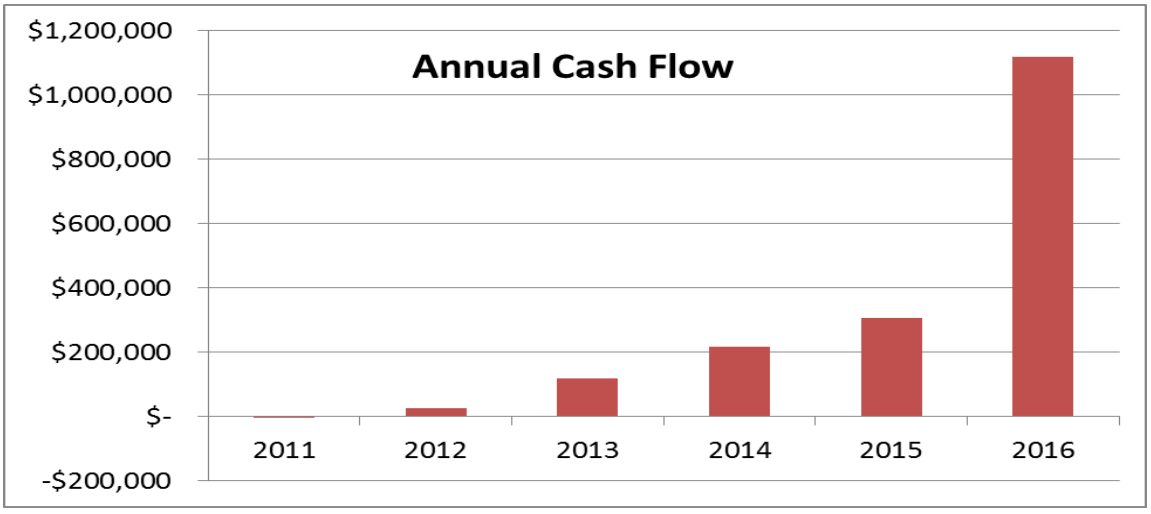

Figure 1: Annual cash flow projections

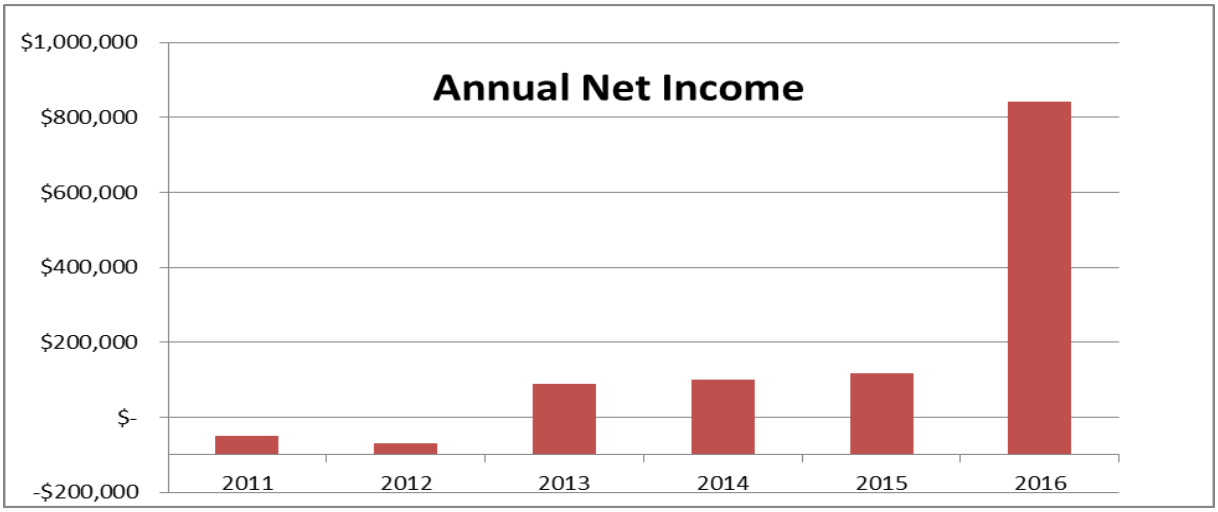

Figure 2: Annual net income

Dedication

This thesis is dedicated to my parents Samar Ibrahim & AbdulSalam Hamze for their perseverance over the years, as they have given me the opportunity to study at this reputable university, SFU, in this great region of the world to pursue my MBA studies.

Acknowledgements

I wish to express my sincere thanks to my supervisor, Prof. Ian Hand. This thesis and work would have not been accomplished without his expertise and advice. I am particularly grateful to him for giving me the opportunity to explore and excel in developing a business plan through his finance course and the summer applied project.

A special thanks to my mother and father who supported me throughout my stay at Simon Fraser University.

Table of Contents

List of Figures

List of Tables

Glossary

3D	Refers to the geometric space we live in with three dimensions: length, width and depth (height).
ASIC	Application-specific Integrated Circuit: is an electronic circuit that implements a specific application such as data processing or filtering.
Embedded Systems	A system design to execute one or more functions such as monitoring or controlling a set of sensors or motors. Embedded systems are often enclosed within a bigger system such a dishwasher or car.
Firmware	A software that implemented functions on an embedded systems. Firmware are typically implemented with C or C++ languages.
GUI	Graphical User Interface: an interface that allows users to interface with an electronic or mechanical device with simple movements, or commands.
HapArm	The hardware component of our haptic technology solution. This is the 'robot' arm that the user uses to control the HapChem and execute tasks.
HapChem	The software component of our haptic technology solution.
Haptic	Feedback technology that allows a system component to deliver feedback from action in the form of force or vibration. This technology is most common in gaming.
PCB	Printed Circuit Board: is a board where electronic components are mounted to form a circuit.
ROE	A key financial ratio. Return on Equity: measures the return on share ownership in a company. It is calculated by dividing net income after tax by shareholder equity.
Tele-operation	Performing operations remotely, and usually over a network.
USB	Universal Serial Bus: industry standard for communication between electronics devices.

2: Product Description

Our product is composes of two main components: the Haptic arm (HapArm) and the graphical user interface application (HapChem) as in Figure 3 below. The system together is targeting chemistry students in later high school grades and early university classes. The solution gives the user the ability to design, build, manipulate and form chemical compounds and molecules.

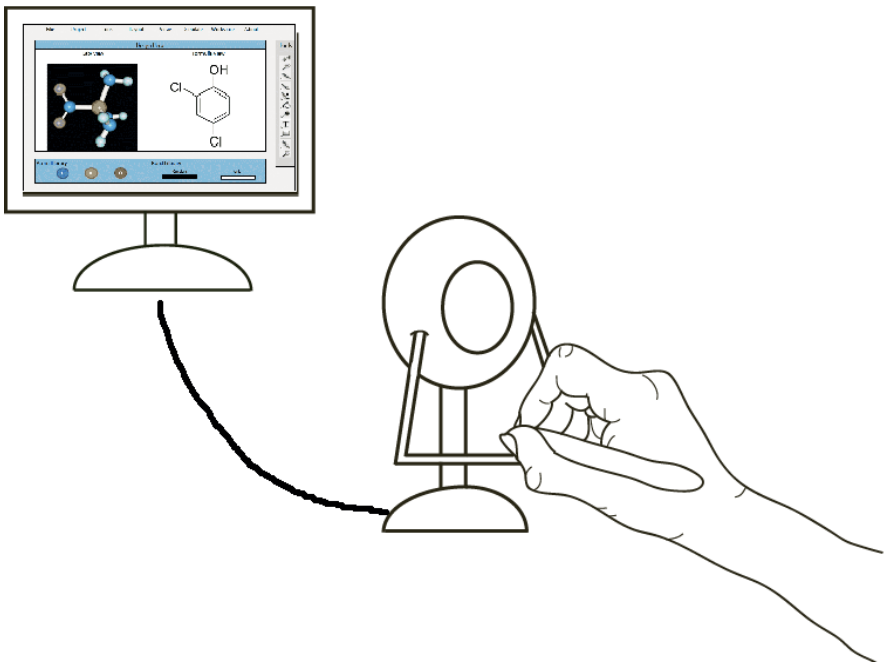

Figure 3: A diagram of our proposed solution

2.1 HapChem Specifications

Figure 4 demonstrates a snapshot of our proposed software solution (HapChem). The software will have the following features:

- Lab view: shows the 3D view of the chemical structure
- Formulae view: shows the chemical formulae for the chemical compound

- Tools: a set of basic tools to allow user to build, move, select, rotate and modify structures
- Atom and bond library: provides several atom molecules to be used to build chemical compounds
- Menus: several standard menus to help complete the design and manipulation process.

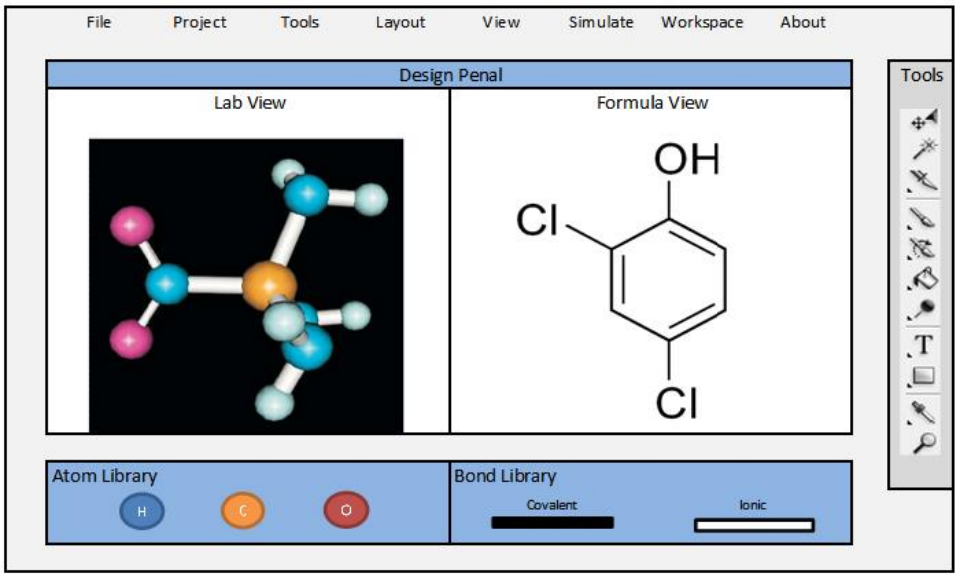

Figure 4: Snapshot of our proposed software GUI application

HapTrian will enable the users to see the following visual properties of the design process:

- Atom shape and size
- Electronic distribution of atoms
- Compound and molecular view of atoms and structure both in formulate and 3D view
- Bonding properties between atoms
- View ruler to allow realistic distance measurement

Such properties make the design process realistic and will help students understand the realistic and practical aspects of chemical structures. Our software will be initially suited to work on Windows XP/Visa/7 platforms. Future builds will allow Mac computers to use our application. The software can be easily installed on any PC and can interface to the HapArm via a provided 6’ long USB 2.0 cable.

2.2 Hardware Specifications

The above-described HapChem application allows users to design and manipulate chemical structures. The following two peripherals are used to control the design process:

1. Standard PC mouse: used to select tools and structures
2. Our HapArm: this is a robotic arm which allows the user to feel the design process. With its Haptic capabilities and degrees of freedom, the user can feel the following force feedbacks are rendered based on characteristics of chemical components:
    - **Relative atomic weight** the user can feel the relative weight of each atom with respect to another while grabbing and moving the atoms. For instance, the user can feel that the Iron atom is a lot heavier than the hydrogen atom.
    - **Electronic Resistance/Attraction between atoms:** the user can feel the attraction and repulsion force between atoms due to electron distribution. For instance, HapArm will resist bringing two strongly negatively charged atoms in close proximity.
    - **Bonding strength:** after forming a chemical bond, the user can sense the strength between the different types of chemical bonds and, hence, intuitively learn about bonding and also compound stability.

3: The Market and Competitive Analysis

The key strength of our solution is the integration of a Haptic arm with a chemistry educational application. Therefore, to understand the market for our product, we first describe the overall market for Haptic devices and then for our selected market niche, Education.

3.1 Market Segmentation

The market for Haptic devices can be segmented into several segments as follows:

3.1.1 Tele-operators and Simulators

Haptic devices find wide application in the teleoperation and simulation industry. Typically, such devices contain two main modules. The control computer system and the remote operator arm. The user controls the remote arm to complete specific tasks via the control computer. The control computer displays live images of the operation and Haptic feedback force to simulate real-time progress of the operation. Such devices find applications in medical teleoperation and training. Training with simulators can be helpful to student doctors as well as trainee pilots. An example of such devices is Delta 6 by Force Dimension as shown in Figure 5.

Figure 5: Delta 6 device by Force Dimension

Source: (Force Dimension, 2010)

3.1.2 Computer and Video Games

Haptic devices are often used in gaming. Such devices are desirable by video game lovers as it enables to receive realistic feedback from games, especially sport games. The Novint arm by Novint Technologies, as shown in Figure 6 is an example of this application.

Figure 6: Novint robot arm by Novint Technologies, Inc.

Source: (Novint Technologies, 2011)

3.1.3 Mobile Consumer Technologies

Haptic devices also find application in mobile devices. The most common of which is the vibrator technologies embedded in most cell phones today that provide users with feedback.

3.2 Target Market Selection

The target for our HapChem solution is academic institutions, namely universities and high schools. We think that students will welcome and enjoy the use of such an application since it makes learning easier, more realistic and more entertaining.

To verify the viability of our market segment choice and customer interest, we have conducted several interviews and surveys. Note that we note the number of interviewees interviewed conducted to date may not be sufficient to eliminate the variability of individual responses, therefore we plan to complete 18-20 additional interviews in the coming 4-6 weeks.

3.2.1 Interviews with Students:

We conducted interviews directly with two high school and two university students to ask them questions about our proposed HapChem products and the student's experiences with conventional Chemistry learning methods and their Chem lab experience. The questions and responses are presented in Appendix B and C of this report. The summary of results from the interviews is as follows:

- The lab component is relatively important in all chemistry courses, both for high school and university studies.
- Students generally find labs interesting as they see the more practical aspect of the theory they are studying.
- The way labs are currently presented in schools covered by survey, and generally most schools, is through the use of projectors, slides and conventional tools. No particular technology has been utilized yet to, for instance, determine the way chemical reaction and behaviour when they are in proximity to each other (as our solution intend to offer)
- When presented with photos and software snapshots of what our solution can offer, students were interested and excited to learn more about the software features and the HapArm capabilities.

3.2.2 Interview with a Professor

Eventually, it will be the professors who will have to be convinced to adopt HapChem in their classes and labs, and therefore, and to make sure we totally understand our market and clients, we decided to conduct interviews with a professor teaching chemistry course at university level. We plan to conduct additional interviews with professors and teachers to inform and refine our development product process. The results of our findings are as follows:

- Although not very familiar with the concepts and technology of haptic force, when explained and given examples of video games, the Professor found the technology appealing.
- The professor found the software solution exciting and can certainly enhance learning experience, however, he insisted that professors and anybody who uses this technology should receive sufficient training. It is certainly not as easy as using an overhead projector but it is not that difficult either.
- Students will find the experience of learning molecular reactions and behaviour very interesting with this technology, as it seems practical and realistic.
- The professor could not give any indication of how easy it would be to convince his department to purchase such a device at the suggested price.
- The professor is convinced of the value of bringing 3D technologies into class presentations.

3.3 Our Target Market Definition

3.3.1 Market Demographics

End users of our applications will be chemistry students. For high schools, those students would be taking Chemistry 11 and 12. For universities, it would be students taking beginner and intermediate chemistry courses. HapChem allows for basic chemical/molecular design and modelling and is not suitable for advanced chemical design and simulations.

3.3.2 Market Size

Since most high schools and universities offer chemistry classes, the potential size of our market is the size of the schools and universities in our target area. Table 1 outlines total number of high schools and universities.

Area	High Schools	University & College Campuses
BC	>190	>10
Canada	>3,000	>100
North America	>30,000	>4,000

Table 1: Potential market size

3.4 Competitive Analysis

Within the area of our focus, that is the use of Haptic devices for educational training, there are several companies that have similar devices which can be competitive. In Table 2, we summarize devices manufactured by competitors. In the "Disadvantage" column, we outline the main disadvantages for each of the devices. Note that by disadvantage here we only mean what features/specifications, which are irrelevant to the use of such device for educational training systems. For instance, the Delta 6 system by Force Dimension is a great system, but is however specifically designed and priced for medical applications, and hence is features that are not required.

Device/Maker	Price	Disadvantage
Novint Falcont by Novint Technologies Inc.	$200	• Small workspace • Strong friction due to the mechanical design • Limited level of force feedback (less realistic feedback feeling) • This device is specifically designed for gaming
Phantom Omni by SensAble Technologies Inc.	$3,500	• The interface for a second Omni device • High resolution • This device is designed for medical training purposes
Delta 6 by Force Dimension	$63,000	• High resolution • High level of force feedback • 6 degree of freedom force feedback • Mainly used for medical applications
Virtuose 6D35-45 by Haption		• High (strong) force feedback • 6 degree of freedom force feedback • High resolution

Table 2: Competitor device comparison

As noted before, our system has two main components, the hardware (HapArm) and the Software (HapChem). Therefore, we needed to conduct a competitive analysis and market survey of competitive software applications used for similar applications, i.e. educational purposes for chemistry students. Table 3 summarize the most competitive software applications to HapChem. All prices quoted are for educational licenses. All these applications do not have interface to a Haptic arm that can allow for realistic modelling of molecules. *Our device is therefore different since it includes a Haptic arm that is specifically designed for this application.*

Device/Maker	Price	Main Features
Crystal Designer By Crystal Structure Design AS, Norway	Single user license: US $299 Department license: US$ 599	Built in crystal structure data Bond display options Molecules Rotation/bonding
CrystalMaker by CrystalMaker Software Ltd.	Single user license: US $ 350 20 licenses: US $1599	Building/displaying/manipulating animating molecular structures.
MoluCAD by New River Kinematics	Free for academic use	Molecular modelling and visualization

Table 3: Competitor software comparison

4: Marketing Strategy and Pricing

This section outlines our marketing strategy for our product. We assessed the alternative market channels and then defined the requirements and budget for HapChem marketing activities.

4.1 Overall Marketing Strategy

Our target market is academic institutions: high schools and universities. In both targets, it is the teacher, professors or lab technician that has to be convinced first before making an order to purchase to the appropriate department in the institution or school. Therefore, to market our solution effectively, we have to mix as much as possible with Chemistry teachers and professors.

4.2 Marketing Channels

We plan to market our product through the following activities:

4.2.1 Academic Conferences and Exhibitions

Attending conference and exhibitions is effective because it will connect us face-to-face with university faculty. Specific to chemistry, there are few annual conferences that we can attend as shown in the following table:

Conference	Location	Date
International Conference on Bioinorganic Chemistry	TBA	June, 2012
Canadian Chemistry Conference and Exhibition	Calgary, Canada	May, 2012
World Congress of Biomedical Laboratory Science	Berlin, Germany	Aug, 2012

Table 4: Conferences for marketing

These conferences typically include multiple presentation sessions where graduate students and professors form chemistry and biochemistry background present the latest of their research findings. We believe that by attending such events we can achieve the following:

- Network with the biochemistry academic circle, which is our prime target
- Hand out brochures and present a workshop about our proposed solution
- Survey professors to see their needs to make presentations more effective in their classes.

For this conference, we will need the following material:

- Prototype to demonstrate to visitors with full brochures and manuals
- Large poster depicting the use and applications of our solution
- Survey to be handed out to visitors to ask them about their view and need in using high-technology tools in class to present their material. The questions to be asked in this survey are attached in Appendix A.

4.2.2 University Workshops

We plan to attend and setup booths in universities. We plan to present workshops to students and faculty during the semester start orientation. We plan to setup the following:

University	Date	Event
Simon Fraser University, Faculty of Science - Chemistry	Sept, 2012	Year Start Orientation
University of British Columbia – Faculty of Science	Sept, 2012	Year Start Orientation
Seattle University – College of Science and Engineering	Oct, 2012	Faculty booth
University of Washington Tacoma -	Oct, 2012	Faculty booth

Table 5: Universities to visit for marketing

After we have completed our first working during the Trial/Customer feedback phase in Figure 8, we plan to attend and present workshops at the above four universities. The goals are:

- Make students aware of the existence of such technology and solution
- Be in touch with faculty and researchers
- Distribute solution brochures and material

4.2.3 High School Marketing

We plan to visit high schools to demonstrate our application and interact with teachers and students. The visits will be in local Vancouver high schools during the period Sept.-Dec. 2012. When necessary, and once we have achieved a certain level of exposure, and interest, we may target high schools outside Vancouver, particularly the US to achieve additional sales targets.

4.2.4 Brochures and Marketing Material

The above activities will require materials, people, and preparation. Material needed includes brochures, manuals and posters. As for staff, it will be two of our team that will present during these workshops and presentations.

4.2.5 Marketing with our Website

We plan to have a website ready by end of Dec 2011. The website will have the following services and pages:

- Information about our company and management team
- Information about our product which includes:
    - A high-definition video showing a demonstration of how our product works
    - Specifications for both hardware and software
- Information for partners and resellers interested in stocking and selling our solution
- Online order forms for direct buyers

4.3 Marketing Budget

Based on the suggested marketing activities in the previous section, Table 6 outlines the frequency and cost for each marketing activity. We make the following assumptions to come up with our marketing budget:

- We will be attending 3 conferences annually, each of which will cost around $2,500.
- Plan to present 4 workshops a year in 4 universities. We budget $1,500 for each.
- Visiting local high schools will mainly involve our team travelling to such schools in the lower mainland to present our application. Each will cost around $1,000 for each of the 6 high schools we plan to cover.
- A website will also be leveraged to present our solution online.

Marketing Activities	Frequency	Cost
Academic Conferences	3 conferences annually	**Cost per event** ○ Registration: $500 ○ Booth: $500 ○ Preparation/material: $500 ○ Travel expenses: $1,000
University Workshops	4 workshops in local universities	**Cost per event** ○ Booth: $500 ○ Preparation/material: $500 ○ Travel expenses: $500
High School Events	Schools events to all local schools. About 6 high schools	○ Booth: $500 per event ○ Preparation/material: $500
Website Development	Contract to local design freelancer	○ Website: $10,000 ○ Hosting: $70/year

Table 6: Marketing activities

Given the above events, costs and frequency, Table 7 below outlines the expenses for our intended marketing activities for the first 6 years. Note that in 2011 we will only be attending few workshops and conferences since the aim is to build relationship with potential clients. At this stage, we do not have a finished product to demonstrate yet. However, in 2012, once we have trial units, we will attend a lot more conferences and present in more workshops. Later during 2014-2016 we will ramp down the marketing activities as we expect to have our branded well established within the academic environment, and a word of mouth as well as our web site could be sufficient to secure future sales.

Marketing Activity	2011	2012	2013	2014	2015	2016
Academic Conferences	$2,500	$7,500	$7,500	$2,500	$2,500	$2,500
University Workshops	$1,500	$6,000	$6,000	$1,500	$1,500	$1,500
Website Hosting	$70	$70	$70	$70	$70	$70
Trial Units		10 trial units ($15,000)				
Total Marketing Cost	$5,000	$30,000	$15,000	$5,000	$5,000	$5,000

Table 7: Annual marketing budget

5: Operations

Our system is composed of two main components: HapArm and HapChem. Figure 7 shows the subcomponents of our system. The HapChem Software component is composed of:

- **3-dimensional View:** which displays a 3D view of the constructed chemical compound;
- **Formula View:** a view displaying the chemical formulate of a compound;
- **Tool Library:** tools available to user to manipulate chemical atoms and compounds, and;
- **Element Library**: chemical atoms, compound and bonds available for users.

The HapArm Hardware is composed of the following elements:

- **Control Module:** mechanisms, algorithms and code implemented in hardware ASIC; (Application Specific Integrated Circuit) to convert HapArm controller movements by the user into HapChem software control commands;
- **Feedback Module:** mechanisms, algorithms and code implemented in ASIC hardware to convert feedback from HapChem into sensory feedback in hardware that the user can feel, respond to and interact with, and;
- **USB Interface:** delivers signals between HapChem and HapArm.

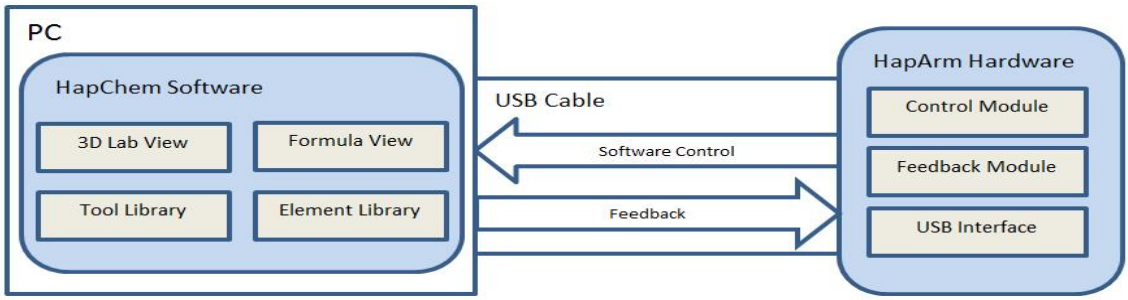

Figure 7: System subcomponents

5.1 Design and Development

The development of our device will proceeds in three phases:

1. **Prototype development:** to develop a proof of concept and fully working prototype. This phase has already started and will complete by December 2011.
2. **Trial Production:** to produce 10 units of a fully working finished product. These units will be given to potential clients for trial. This phase will occur during the year 2012.
3. **Mass Production:** after a customer trial, we modify the original design and introduce adjustment based on customer feedback. We will then produce the first 500 finished units for clients. We expected to scale-up production at the start of 2013.

5.1.1 Phase I: Prototype Development

In this phase, we produce both the proof of concept and the prototype units for our internal testing and satisfaction. This phase is broken up into four tasks:

1. **Hardware (HapArm) design and development:** this includes the design and development of the HapArm hardware. This includes the mechanical, electronic and electrical design.
2. **Software (HapChem) design and development:** this includes the design and development of the software interface (GUI) HapChem
3. **Hardware-software integration:** in this stage, we integrate the HapArm with the HapChem to present the full solution for users.
4. **System testing**: a full process of testing of the entire system together to assure high quality and performance.

To execute the prototype development phase, we will need the following software and hardware material:

- One Novint device to be used in the process of testing and verifying the HapChem software functionality. We will need this in the beginning as our hardware HapArm is not ready to be used as a test device.
- Visual Studio and OpenGL for software development (free)
- OrCAD software for PCB circuit design (free)
- A variety of electronic and mechanical parts to be used to build the HapArm
- 100 hours of a mechanic labour work to complete the mechanical design of the HapArm
- Electrical equipment for development and testing

Other than the mechanic shop, we will be able to build everything ourselves using our engineering resources. The (one-time) cost of the above requirements, to build the first full prototype as outlined in Table 8 below.

Item	Cost
Electrical/Mechanical Bill of Material	
Microcontroller Development Kit	$75
Motors/Encoders	$260
Other Electronic Components	$100
USB Cable	$10
Other Mechanical Parts (joints/links/pulleys)	$1,000
Total prototype part cost, with contingency (~25%)	**$2,000**
Test and Development Equipment	
Electrical Breadboard, Soldering station Oscilloscope, Function generator Power Supply, Multi-meter, Electrical Tools (wire strippers, cutters), Novint Test Arm. **Total equipment cost with contingency (~25%)**	**$5,000**
Outsourced Labour Cost	
Mechanic labour **Total labour cost with contingency (~25%)**	100 hours @ $80/hr. **$10,000**

Table 8: Material and labour required for prototype development

5.1.2 Phase II: Trial Production

In this phase, we intend to build 25 units, fully working. These units can potential clients as trial package or can be used for marketing and demonstration purposes. This package can help further market our product and provide us with feedback of what clients need in this application.

Added to the already purchase equipment and material in the prototype phase, we plan to acquire the following material/equipment:

- Purchase Visual Studio - $800 for professional license
- Contract senior software architect to help verify design and development for our HapChem application - $5,000
- Senior system engineer to verify hardware designs - 50 hours: $5,000

Once we acquire the above resources, the cost for building a prototype HapArm device (at volume of 25) is shown in Table 9 below.

Item	Cost
PCB for Electronic Circuit Board	$200
Electronic Parts/Components	$50
Motors/Encoders	$240
USB Cable	$10
Mechanic Manufacturing (including package)	$400
Other Mechanical Parts (joints/links/pulleys)	$300
Total Cost per Trial Unit	$1,200

Table 9: Unit cost for a working trial system

5.1.3 Phase III: Mass Production

Once a trial product is complete, around 20 to 30 of them will be given to potential clients for trial use free of charge. Clients will be asked to provide feedback for both the HapArm and HapChem. Once we receive the feedback, a one-time cost of $5,000 is needed to contract software/system/mechanical engineers to modify the design to be ready for the final phase of mass production. Due to higher volume (hundreds), we expect the cost per unit to be reduced to around the $1,000 mark.

5.2 Schedule for Design and Development

The master schedule for both our product development and business development phases is shown in Figure 8. The three aforementioned development phases commenced in Jan 2011 and will end at the end of 2013. In the mass production phases there will be enough units built to covers the sales forecast during the period 2014-2015. The master schedule also shows marketing efforts based on the data provided in Table 7. Sales, distribution and financing efforts are addressed in later sections.

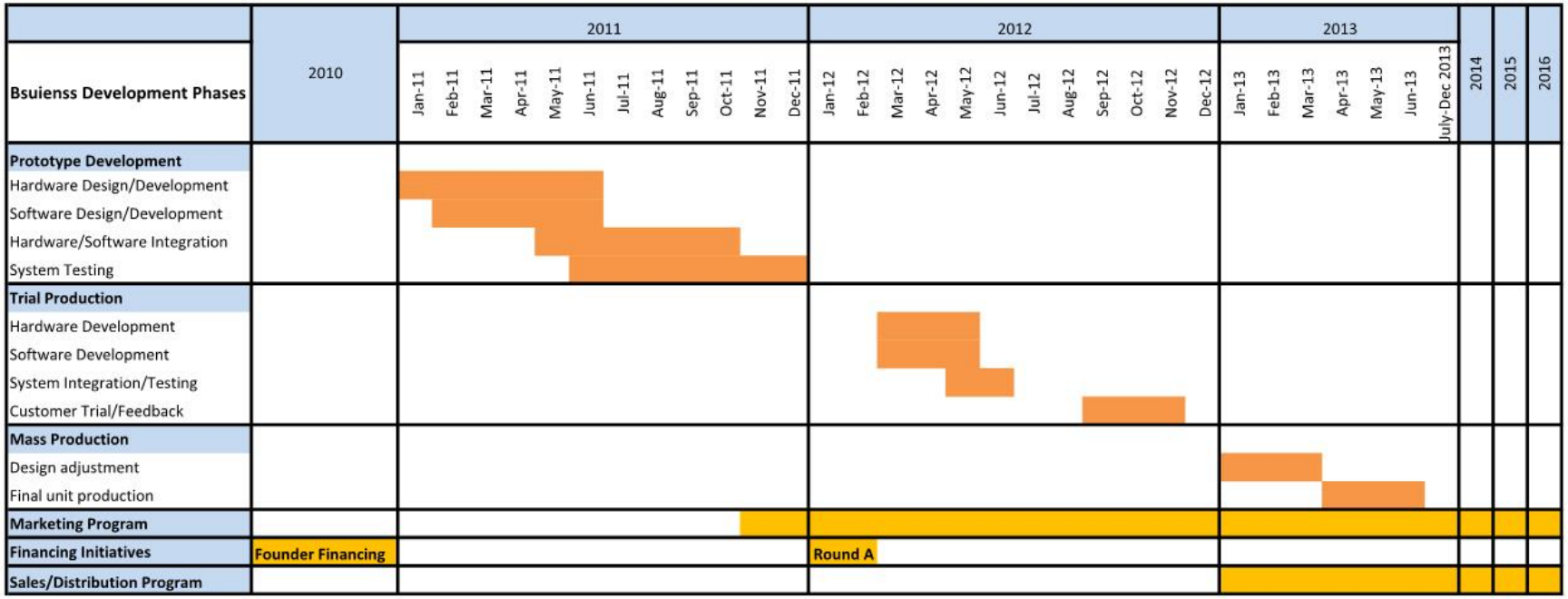

Figure 8: Intelligent Hap Solutions Inc. master business and development schedule of financing

5.3 Future Upgrades

During the year 2015, our team will spend research efforts to investigate future upgrade efforts. The following future upgrades will be investigated as part of our R&D efforts:

- **HapChem features:** upgrades to the software more design and simulation capabilities
- **HapArm:** the use of higher quality electronic components to achieve higher fidelity force feedback; faster run time performance supporting HapChem features
- **3D graphics:** to allow user to experience 3D view of our HapChem environment via a 3D glasses. This allows for a realistic feeling of depth fading and perspective. An example of the proposed 3D glasses is shown in Figure 9.

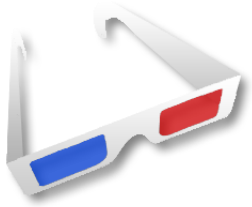

Figure 9: Proposed 3D glasses to enhance user experience

Source: (Google Image Search, 2011)

5.4 Customer Support and Warranty

The expected lifetime of the product is 10 years. During this period, the device will not need any maintenance. All software bug fixes will be available free of charge to clients. We also provide a limited 1-year, parts and labour warranty.

Customer support will available to all clients via a toll free telephone number during business hours. The website will also contain a section where clients can submit questions, bugs and concerns and answered to Frequently Asked Questions will be provided.

6: Sales and Distribution

In this section, we discuss our proposed price for the product and sales forecast. We also our sources of revenue and sales channels.

6.1 Product Price

As noted in the operational plan, our unit cost for the full HapArm and HapChem system will be around $1,000 per unit. However, looking at competitor haptic arm manufactures and their prices, we propose the following pricing:

- The HapArm to be sold in two different packages: a single HapArm system for $4,000 mainly targeting high school clients. A 10-HapArm package for $30,000 mainly targeting university departmental purchases.
- We will provide a one-year parts and labour warranty for all sold items.
- We can provide technical support for all clients.
- Software bug fixes to be download from website free of charge.

6.2 Sales Forecasts

With a market size given in Table 10 and the absence of any firm in this market, we predict a sales forecast as outlined in Table 11. We are assuming to market to the local Canadian market within the first few years then expand our market to include the United States.

Area	High Schools	University/College Campuses
BC	>190	>10
Canada	>3,000	>100
North America	>30,000	>4,000

Table 10: Potential market size

Source: (Wikipedia, List of Schools by Country, 2011)

Client	2013	2014	2015	2016
High Schools	20	70	150	250
University & Colleges	20	70	150	250
Total Sold	40	140	300	300

Table 11: Sales forecast

6.3 Recurring Subscription Revenues

As indicated above, the clients will purchase the hardware and software. One year of software upgrades (from the website) will be available free of charge, however, for later years, we will offer optional upgrade packages to client for annual subscription of $200/year. Software upgrade package includes:

- More compounds introduced.
- More characteristics of compounds to configure, such as radioactivity, bond strengths, etc.
- Software interface with more response force feedback capability (even with the same hardware).
- More user-friendly GUI. This is because will have received more customer feedback so we can modify items to better suit our customer needs.

With the sales forecast in Table 11, our revenue from subscription is given in the table below. These numbers are based on our assumption that 50% of existing clients will want to subscribe for software upgrades.

Client	2013	2014	2015	2016
Total Subscribers	-	20	90	240
Subscription Revenue (Based on annual subscription price of $200/year)		$4,000	$18,000	$48,000

Table 12: Annual subscription revenues

We believe that customers will be convinced to subscribe to our annual upgrade package because they will have already received upgrades during their first year free after purchase and know of the quality of services and features offered in upgrades.

6.4 Sales Channels

We will give clients the opportunity to place purchase orders for both the product, and the upgrades via our website. The product can then be shipped with a software CD. The client is responsible for shipping and handling fees.

After the year 2016, and as sales ramps up and we start targeting global markets, we plan to employ agents to sell our products on shelf with a commission.

7: Company Organization and Resources

7.1 Company Structure

We will form a limited liability corporation registered in BC: Intelligent Hap Solutions Inc. Incorporation will provide the company with several benefits:

- Straight-forward eventual transfer of ownership
- Continuity of the business in case of death of shareholder(s)
- Tax advantages in carrying of losses
- Assistance provided by government subsidies, including grants
- Ability to grant different class of ownership (employee stock plans)

7.2 Company Current Status

Currently, Intelligent Hap Solutions Inc. focuses on all resources and logistics required to deliver the prototype by end of 2011 and a fully functional product by end of 2012. An office space will be secured at the beginning of 2012, and then the focus will be on hiring and product development. Our immediate plans are:

- Hire technical developers as soon as funding requirements are met.
- Continue working on refining prototype mechanical and electrical design.
- Execute marketing plan as outlined in the marketing section.

7.3 Management Team

In this section, we provide details about our existing staff, employees and advisors, as well as future planned additions. We also include some figures about our start-up capital and expenses.

7.3.1 Key Personnel

The following are our current team members, and are the three founders of the company. At later stages of our business operation, we will invite more members, mainly on the advising board.

1. **Ali AbdulHussein, Business Development Manager: is** an MBA candidate from the Business School at Simon Fraser University. Ali completed his M.A.Sc. in electrical and computer engineering from the Department of Computer and Electrical Engineering at the University British Columbia (UBC) in 2008. He also holds a B.A.Sc. in Electronics Engineering from SFU. Ali has worked for several high-tech companies such as Mercedes Benz, Germany, Sierra Wireless, Richmond, Canada, and Silvertip Telematics Inc. of Vancouver, Canada. Ali also possesses management experience through his project management work at Team Engineering Inc. in Vancouver, Canada. In this business, Ali will play a key role to develop the business and commercialize the Company's technology. His main duties include marketing, business development, client relationship and financial management.
2. **Zhouming (David) Tang, Engineering Development:** a recent graduate of the School of Engineering Science at Simon Fraser University with a M.A.Sc. in electronics engineering with focus in Robotics and Control Engineering. David also holds a Bachelor of Applied Science in Electronics Engineering from the Department of Electronics

Systems in the University of Regina, 2007. David has played a key role in developing the first prototype of the device. David's main role in this operation will be to develop the embedded software to implement the proposed applications of the device.

3. **Wen (Steven) Shi, Project Management:** A recent graduate of the School of Engineering Science at Simon Fraser University with a M.A.Sc. in electronics engineering with focus in Robotics and Control Engineering. Shi's strengths are mainly in software application development. Shi's main role is the graphic user interface (GUI) development of our solution.

7.3.2 Advisors

Currently, Intelligent Hap Solutions has one advisor who is also the fourth founder of the company:

- **Dr. Shahram Payandeh, Advisor:** a professor at the School of Engineering Science at SFU. Dr. Payandeh's current research interests are in the general area of mechanics, modeling and control of robotic (physical/virtual) mechanisms. Dr. Shahram will oversee the development of our project closely. He has vast experience and familiarity with this project and the overall industry in general.

7.3.3 Board of Directors

Currently, the board of directors consists of Ali AbdulHussein and Dr. Payaendeh. The future voting shareholders will select 1 additional director.

7.3.4 Employees

Additional to their management roles, the three key founders will execute the company's development and business plans. Ali AbdulHussein will be mainly involved to carry out the

business development plans and marketing activities. Shi and David will be primarily involved with the technical aspect of product development until further additions are completed.

7.3.5 Planned Additions

Intelligent Hap Solutions is planning to hire several co-op and full-time engineers, architects and potentially sales people once funding requirements are met.

7.4 Company and Human Resources

7.4.1 Start-up and Operating Expenses

Intelligent Hap Solutions will need to secure the following resources to start and operate its business:

Item	Expense
Office/Workshop Space **An office based in a less expensive rental area such as, for example, South Surrey, to complete product assembly development**	$1,500/month
Insurance	$150/month
Utility/Hydro/Internet expenses	$300/month
Book-keeping and Accounting Fees and Misc. Expenses including Business License Fee.	$1,000/year
Office Supplies, Furniture and equipment	$200/year Plus one time start-up cost of $2,000

Table 13: Office expenses

7.4.2 Salaries and Human Resources

During the period 2011-2013, the four founders of the company expect to receive no salary or benefits. However, after 2013, and as sales start to ramp up, we intend to place all four founders on payroll.

Also, during the period 2014-2016, we plan to hire two external engineers (co-op and experienced) at an annual budget of $100,000. The hired employees will assist the founders in the following three activities:

- Offer clients technical support with both hardware and software
- Implement customer features and fix bugs based on customer feedback
- Assemble and prepare goods to be sold to clients.

Additionally, in the period 2014-2016, we plan to hire one sales person to help sales efforts for our product line. The following table outlines our human resources cost for the six-year period. The contractor fees are based on figures given in the operational plan previously.

	2011	2012	2013	2014	2015	2016
Founder Salary (Four FTE)				$120,000	$280,000	$400,000
Contractor Fees	$10,000	$10,000	$5,000			
Full-time Engineer salary (Two FTE)				$100,000	$100,000	$100,000
Sales person (One FTE)				$60,000	$60,000	$60,000
Total	$10,000	$10,000	$5,000	$280,000	$440,000	$560,000

Table 14: Human resource expenses

7.5 Intellectual Property

The mechanical design of our HapArm will not require patent protection; however the HapChem software will be protected by Copyright.

8: Financial Projections

This section lists our financial assumptions. Based on these assumptions, we provide our projected financial statements and ratios. We also highlight our expected and sources of capital investment.

8.1 Assumptions

We utilized the following assumptions in our financial projections. The assumptions were considered in the financial statements in the next sections:

1. Corporate income tax: 21% on net profit[1]
2. Opening inventory expense is the $17,000 (material, contractor labour, equipment) needed to build the first prototype[2]
3. Founders will contribute a total of $50,000 which is the sum of BCIC scholarship amount plus some seed money.[3]
4. Relatively stable exchange rates (US and CAD dollars are close to parity)
5. No changes in technology that would deem our software and products obsolete
6. Dividends are projected to be paid to all founders and investors starting from the year 2015[4]
7. A discount rate of 35% has been utilized
8. IRAP/NSERC maybe be used to fund eligible R&D salaries, but these are not accounted for in the financial statements since they are no assured.

[1] Income Statement: income tax expense line
[2] Income Statement: expenses line
[3] Cash Flow Statement: bootstrap investment line
[4] Cash Flow Statement: dividend payment line

9. The Scientific Research and Experimental Development Program (SR&ED) will be used to claim refunds and/or tax credits for our R&D expenditures for work done in Canada.

8.2 Financial Statements

Income, cash flow and balance sheet statements are shown in the next three tables. Quarterly projections are shown for the break-even year, 2014.

Income Statement									
Revenue	**2011**	**2012**	**2013**	**2014Q1**	**2014Q2**	**2014Q3**	**2014Q4**	**2015**	**2016**
Units sold to high schools			80,000	70,000	70,000	70,000	70,000	600,000	1,000,000
Units sold to univeristies in single packages			80,000	35,000	35,000	35,000	35,000	300,000	500,000
Units sold to univeristies in departmental packages				26,250	26,250	26,250	26,250	225,000	375,000
Revenue from upgrade subscription				571	571	571	571	18,000	48,000
(less returns within the 1-year warranty)				4,000	4,000	4,000	4,000	320,000	40,000
Net Revenue	**-**	**-**	**160,000**	**127,821**	**127,821**	**127,821**	**127,821**	**823,000**	**1,883,000**
Cost of Goods Sold									
Cost of Goods Sold			20,000	25,000	25,000	25,000	25,000	200,000	300,000
Production Payroll	10,000	10,000	5,000	25,000	25,000	25,000	25,000	100,000	100,000
Gross Profit (Loss)	**(10,000)**	**(10,000)**	**135,000**	**77,821**	**77,821**	**77,821**	**77,821**	**523,000**	**1,483,000**
Expenses									
Marketing	5,000	30,000	15,000	1,250	1,250	1,250	1,250	5,000	5,000
Software		800							
Legal and Accounting fees	1,000	1,000	1,000	250	250	250	250	1,000	1,000
Insurance	1,800	1,800	1,800	450	450	450	450	1,800	1,800
Office supplies, Furniture and equipment	7,000	200	200	50	50	50	50	200	200
Rent	18,000	18,000	18,000	4,500	4,500	4,500	4,500	18,000	18,000
Management/Sales/Overhead Payroll				45,000	45,000	45,000	45,000	340,000	460,000
Travel	3,000	5,000	5,000	500	500	500	500	2,000	2,000
Utilities	3,600	3,600	3,600	900	900	900	900	3,600	3,600
Web hosting and domains	70	70	70	70	-	-	-	70	70
Total Operating Expenses	39,470	60,470	44,670	52,970	52,900	52,900	52,900	371,670	491,670
Operating Income (Loss)	**(49,470)**	**(70,470)**	**90,330**	**24,851**	**24,921**	**24,921**	**24,921**	**151,330**	**991,330**
Non-operating revenues, expenses, gains, losses	-								
(Less interest expense)	-								
Income Before Taxes	(49,470)	(70,470)	90,330	24,851	24,921	24,921	24,921	151,330	991,330
(Less income tax expense)	-	-	-	-				33,200	148,700
Income From Continuing Operations	**(49,470)**	**(70,470)**	**90,330**	**24,851**	**24,921**	**24,921**	**24,921**	**118,130**	**842,631**
Net Income	**(49,470)**	**(70,470)**	**90,330**	**24,851**	**24,921**	**24,921**	**24,921**	**118,130**	**842,631**

Table 15: Income statement

Cash Flow Statement

Cash from Operations	2011	2012	2013	2014Q1	2014Q2	2014Q3	2014Q4	2015	2016
Cash Sales	0	0	160,000	127,821	127,821	127,821	127,821	823,000	1,883,000
Total Cash flow on Hand	**0**	**0**	**160,000**	**127,821**	**127,821**	**127,821**	**127,821**	**823,000**	**1,883,000**
Less Expenses Paid:									
Inventory Costs	2,000	0	20,000	25,000	25,000	25,000	25,000	200,000	300,000
Production Wages	10,000	10,000	5,000	25,000	25,000	25,000	25,000	100,000	100,000
Marketing	5,000	30,000	15,000	1,250	1,250	1,250	1,250	5,000	5,000
Software	0	800	0	0	0	0	0	0	0
Legal and Accounting fees	1,000	1,000	1,000	250	250	250	250	1,000	1,000
Insurance	1,800	1,800	1,800	450	450	450	450	1,800	1,800
Office supplies	7,000	200	200	50	50	50	50	200	200
Rent	18,000	18,000	18,000	4,500	4,500	4,500	4,500	18,000	18,000
Management/Overhead Payroll	0	0	0	45,000	45,000	45,000	45,000	340,000	460,000
Travel	3,000	5,000	5,000	500	500	500	500	2,000	2,000
Utilities	3,600	3,600	3,600	900	900	900	900	3,600	3,600
Web hosting and domains	70	70	70	70	0	0	0	70	70
Taxes	0	0	0	0	0	0	0	33,200	148,700
Total Cash Expenditures	**51,470**	**70,470**	**69,670**	**102,970**	**102,900**	**102,900**	**102,900**	**704,870**	**1,040,370**
Capital Purchase	0	0	0	0				0	0
Sale of Fixed Assets	0	0	0	0				0	0
Change in Cash from Assets	**0**	**0**	**0**	**0**				**0**	**0**
Financing									
Investor stock	0	100,000	0	0	0	0	0	0	0
Bootstrap investment	50,000	0	0	0	0	0	0	0	0
Dividend Payment	0	0	0					30,000	30,000
Change in Cash from Financing	50,000	100,000	0	0	0	0	0	-30,000	-30,000
	0	0							
Increase (decrease) in Cash	**-1,470**	**29,530**	**90,330**	**24,851**	**24,921**	**24,921**	**24,921**	**88,130**	**812,631**
Cash at Beginning of Period		**-1,470**	**28,060**	**118,390**	**143,241**	**168,163**	**193,084**	**218,006**	**306,135**
Cash at End of Period	**-1,470**	**28,060**	**118,390**	**143,241**	**168,163**	**193,084**	**218,006**	**306,135**	**1,118,766**

Table 16: Cash flow projections

Balance Sheet						
Assets:	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Cash	- 1,470	28,060	118,390	218,006	306,135	1,118,766
Inventory	2,000	2,000	2,000	2,000	2,000	2,000
Total Current Assets	530	30,060	120,390	220,006	308,135	1,120,766
Fixed Assets:						
Furniture and Fixtures						
Office Furniture and equipment						
Total Fixed Assets	-	-	-	-	-	-
Total Assets	530	30,060	120,390	220,006	308,135	1,120,766
Liablities						
Current Liabilities						
Bank Loans						
Dividend payable					- 30,000	- 30,000
Total Current Liabilities	-	-	-	-	- 30,000	- 30,000
Long-Term Liabilities						
Dividend payable						
Total Long Term Liablities	-	-	-	-	-	-
Total Liabilities	-	-	-	-	- 30,000	- 30,000
Owner's Equity						
Share Capital	50,000	150,000	150,000	150,000	150,000	150,000
Retained Earnings(Deficit)	*- 49,470*	*- 70,470*	*90,330*	*99,616*	*118,130*	*842,631*
Accumulated RE	- 49,470	- 119,940	- 29,610	70,006	188,135	1,000,766
Total Shareholder's Equity	530	30,060	120,390	220,006	338,135	1,150,766
Total Liabilities and Equity	530	30,060	120,390	220,006	308,135	1,120,766

Table 17: Balance sheet

8.3 Financial Ratios

Table 18 also shows two relevant financial ratios. Notice the dip in profit margin in 2015. This is primarily due to increase in founder salary, although sales and net income are ramping up. Also, notice the sustainable growth in ROE, which reflects the company's efficiency and profitability.

Ratios	2013	2014	2015	2016
Profit Margin	56%	20%	14%	45%
Gross Profit Margin	84 %	61 %	64 %	79 %
Return on Equity (ROE)	90%	101%	117%	842%

Table 18: Financial ratios

8.4 Break Even Analysis

Reviewing our income statement, it appears that a break-even point occurs at the second quarter (Q2) of 2014. This is the point when revenues cover all fixed and variable costs.

8.5 Capital Requirements

Due to limited access to debt financing, our primary source of funding will be equity funding. The following sources of capital are expected to be secured:

- **Founders:** at the start of the company, a total of $50,000 will be committed from three (Zhouming, Ali, Wen) of the 4 founders in this venture. Accordingly, each one of these three will hold 30% of the company and Dr. Payandeh (Advisor) will hold 10%.

- **Angel:** at end of year one, the company will have a net present value (NPV) of around $500,000 based on future cash following during 2012-2016 and a discount rate of 35%. We expect to raise $100,000 of investment in return to 20% of the company. All company shareholders will sell shares to provide the required shares. Table 19 outlines the characteristics of our expected angel investor or investors.

Characteristic	What We Expect	Typical Canadian Angel
Investment Size	$100,000	Average of $100,000 with most investors preferring under $175,000
Investment Horizon	6X in 5 years	10X in 5-8 years
Cash-Out Method	Acquisition	Public Offering or Acquisition
Stage of Development	Concept (Seed) Stage	Concept Stage
Proportion of Ownership	20%	Smaller stakes than VC
Management Role	Advisory	Advisory
Sector	Hardware, software	78% of Angel investment is in Computer Software

Table 19: Expected angel investment characteristics

Additionally, the capitalization table for our venture is provided in the following table.

Capitalization Table for Intelligent Hap Solutions Inc.

List of Shareholders		Founders Round				1st Private Funding Round				Tot Sh
Name	Positions / Category	Date	Paid-in Capital	Shares		Date	Paid-in Capital	Shares		
				#	%			#	%	
Ali AbdulHussin	Founder	01/09/2011	$ 15,000	3,000,000	30.0%					
David Zouming	Founder	01/09/2011	$ 15,000	3,000,000	30.0%					
Wen Shi	Founder	01/09/2011	$ 15,000	3,000,000	30.0%					
Shahram Payandeh	Founder	01/09/2011	$ 5,000	1,000,000	10.0%					
	Angel Investor(s)					01/12/2012	$ 100,000	2,000,000	20.0%	
		TOTAL	$ 50,000	10,000,000	100.0%	Total	$ 100,000	2,000,000	20.0%	1
		$/Share	$ 0.005			$/Share	$ 0.05			Paid-in
						Pre Money Value*	$ -			Avg. $
						Post-Money Value	$ 100,000			Post Mo
		Total Shares O/S		10,000,000				2,000,000		1

*Note: Pre-money Values as Negotiated

	# of
Founders	
Investors	
Total	

.

Capitalization Table for Intelligent Hap Solutions Inc.

List of Shareholders		Founders Round				1st Private Funding Round				Total # of Shares	% of Company
Name	Positions / Category	Date	Paid-in Capital	Shares		Date	Paid-in Capital	Shares			
				#	%			#	%		
Ali AbdulHussin	Founder	01/09/2011	$ 15,000	3,000,000	30.0%					3,000,000	25.0%
David Zouming	Founder	01/09/2011	$ 15,000	3,000,000	30.0%					3,000,000	25.0%
Wen Shi	Founder	01/09/2011	$ 15,000	3,000,000	30.0%					3,000,000	25.0%
Shahram Payandeh	Founder	01/09/2011	$ 5,000	1,000,000	10.0%					1,000,000	8.3%
	Angel Investor(s)					01/12/2012	$ 100,000	2,000,000	20.0%	2,000,000	16.7%
										-	0.0%
										-	0.0%
										-	0.0%
										-	0.0%
										-	0.0%
		TOTAL	$ 50,000	10,000,000	100.0%	Total	$ 100,000	2,000,000	20.0%	12,000,000	100.0%
		$/Share	$ 0.005			$/Share	$ 0.05			Paid-in Capital	$ 150,000
						Pre Money Value*	$ -			Avg. $ per Share	$ 0.01
						Post-Money Value	$ 100,000			Post Money Value	$ 600,000
		Total Shares O/S		10,000,000				2,000,000		12,000,000	100.0%

*Note: Pre-money Values as Negotiated

	# of Shares	Ownership % (Fully Diluted)
Founders	10,000,000	83.3%
Investors	2,000,000	16.7%
Total	12,000,000	100.0%

Table 20: Capitalization table

8.6 Venture Valuation and Company Exit

Based on sales growth at a rate of 10% (typically for this industry and market size), we expect that the company NPV be around $3,000,000 at end of 2016 as given in Table 21. This calculated was based on 35% discount rate, and taking into account 5 years of cash flows.

When acquired, it is estimated that investors will cash out their 20% ownership interest for approximately $600,000. This amounts to an annualized rate of return of 43% or 600% over 5 years.

We expect that one of the competitors outlined (Novint Technologies Inc., SensAble Technologies Inc. or Haption) will consider acquiring our technology. We think that one of these companies will be interested in entering the academic market segment by offering affordable technology like ours. They already have the infrastructure and human resource to develop our technology at reasonable costs, and therefore, they might find it reasonable to acquire our market and start building the product, with perhaps more features, yet keeping the cost low.

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Free Cash Flow to the Firm	-$1,470	$28,060	$118,390	$219,720	$307,593	$1,120,223
NPV	$382,229	$517,480	$960,455	$1,497,134	$2,152,211	$2,983,773

Table 21: Annual cash flow and NPV calculations

9: Risk Analysis

Our company, like any other new venture, faces several predictable and non-predictable risks. To better understand, assess and mitigate risks, we divide our risks into two categories: External and Internal. External are the risks or threats, which are mainly outside our control such the global economy, investment climate and competition. Internal risks have to do more with our company and employees such as product development risk, operation and personnel commitment.

In the following sections, we outline and assess the main external and internal risks and our plan to mitigate these.

9.1 External Risks

9.1.1 Unstable global economy

Intelligent Hap Solutions offers an innovative technology that is somehow considered luxurious to acquire. We are selling a device to universities and schools that may be utilized to enhance the learning experience. It is not a necessity to have our solution to complete basic chemistry and organic classes. Therefore, should the economy takes a hit, or even a slight downtown, and the school and universities decide to cut budgets, we will certainly have a harder time making sales. This risk applies to North America, where we plan to target first, as well as other international markets.

Additionally, since a large portion of our sales are going to be in the United States, our revenues will be affected by currency exchanges fluctuations.

9.1.2 Insufficient Capital

We are expecting angel investment of $100,000 and founder investment of $50,000. As for founder investment, although we all committed to make these contributions, they have not been made yet. Therefore, there is always a risk of not being able to secure these funds.

As for angel investment, we are expecting the amount to be raised at the beginning of 2012, after we have a fully presentable prototype. If we fail to complete a prototype, there is the risk of not being able to convince an angel to investment. Investors may also choose not to participate for other reasons.

If we failed to raise the required capital, operations will slow and halt eventually.

9.1.3 Competition and Intellectual Property

As it stands, we are applying an existing hardware design to software to introduce a novel solution. Most of our novelty is in the integration of software and hardware as well as the idea itself. Therefore, there is always a risk that one of our competitors manages to enhance their hardware before we do, and files for a patent.

If that happens, our sales and ability to raise capital will be negatively impacted. To mitigate this risk, we should always focus on research around the area of hardware design and development to keep our superiority.

9.2 Internal Risks

9.2.1 Development and operational risks

Our team possesses professional experience and sufficient education to execute all business and development tasks to the best we can. We are also keen on hiring experienced co-op and senior engineers, and sales people. However, if we failed to hire the sufficient capacity, there is always a risk of falling behind schedules and staying within budget.

In addition, some of the hardware and software designs could be relatively more challenging than we anticipated which increases the risk of not delivering on time. We reduce such risks, we plan to review our design and plans with experience seniors engineering, architects and successful entrepreneurs for verification.

9.2.2 Death or injury of key personnel

Should any of directors or key personnel become unavailable for one reason or another, the development and business process will certainly experience delays and may incur extra costs to replace these personnel.

To reduce this risk, we will train all personnel and staff to adequately document and share their findings, knowledge, codes, data with within the company databases and archives, as well as share such data with other employees and staff. This will allow us to find alternative capacities smoother.

10: Conclusion

In this business plan, we presented a business plan for HapChem, a product being developed by Intelligent Hap Solutions Inc. HapChem is an educational application that enables high school and university students to have a better and more realistic experience while studying chemistry. The solution consists of a hardware robotic arm, or haptic controller, with the HapChem software application. The arm is used to control the software application.

The value of our solution is in its cutting-edge haptic technology that allows for user sensory feedback sense when manipulating chemistry atoms and molecules, enhancing user experience and aiding learning. To build and launch HapChem, we aim to raise $150,000 from founders and angel investors and generate an investor return of up to 600% within 5 years from the launch of Intelligent Hap Solutions Inc.

For additional information, please contact Ali AbudulHussein at aabdulhu@sfu.ca.

Appendices

Appendix A: Workshop Survey Questions

Target: workshops and academic conferences participators.

Purpose: to understand students' need in chemistry classes and gauge the effectiveness of existing technologies used to demonstrate chemistry-related material in class and lab.

Questions:

- Why are you attending this event?
- Do you teach or assist in teaching classes with chemistry material?
- What kind of material do you present in these cases?
- Do you have a lab component in these classes?
- What tools do you have available to facilitate the teaching process?
- Do you expect your students to use other tools (than those provided in the lab/class) to learn?
- Do you know about the haptic technology and its application?
- What do you think about introducing high-tech devices based on haptic technology in a chemistry class or lab to help students understand material easier?
- Do you think students will be interested and excited about using a video-game-like joystick to control chemical compounds?

Appendix B: Interview with High School Students

Student Information:

Interviewee Background	**Two Grade 12 students taking Grade 12 Biology and Chemistry classes**
Identities	Anonymous
School	RC Palmer Secondary School Richmond, BC, Canada

Interview Settings:

- Students volunteered 30 minutes of their time to participate in the interview.
- The two interviews were conducted separately and the results below were combined.
- The interviews were conducted by Ali Abdul Hussein.
- Students agreed to share the results of the interview and answers, providing that their identity remained anonymous.

Interview Questions:

Question	Response
Are you interested in taking more chemistry/biology classes in your post-secondary school?	"One student wants to major in Engineering, and the other in Kinesiology and thought they need to take more chemistry courses in their first/second year."
How did you like your experience in grade 12 chemistry/biology classes?	"The courses were not as easy as we thought. I initially thought they would involve more math since I am stronger in math. However, as the year progressed, the contents shifted toward more

	analytical, and concepts."
How was the teacher's performance in presenting the material?	"Teachers were good. However, we thought the lab component was not prepared for and introduced well during the classes."
What tools were used to present and demonstrate class concepts?	"Mainly the overhead projector for slides. Sometimes the teacher uses blackboard for drawings."
What tools were used to help complete lab instructions and reports?	"Custom reaction and equation editor software was provided by the school for our use to complete the reports."
Was there any software used to facilitate the understanding of chemical reactions and chemical compounds visually?	"No."
Have you used haptic devices before?	"Yes in gaming mainly for sports video games."
What do you think about the use of haptic device (like a mouse) in software to help understand chemical reactions more closely and realistically?	"We never thought of this, but it can be a good day. I cannot imagine how you can apply haptic force feedback there but I think if you manage to make us feel the reaction strength between molecules, we will have more understanding of how compounds actually form and behave."

Appendix C: Interview with University Students

Student Information:

Interviewee Backgrounds	• **One student pursuing a Bachelor of Science at Department of Molecular Biology and Biochemistry, Simon Fraser University. Second Year of studies.** • **One student pursuing Chemical Engineering at the University of British Columbia. Fourth year of studies.**
Identities	Anonymous
School	Simon Fraser University (SFU) The University of British Columbia (UBC)

Interview Settings:

- Students did not mind to volunteer 60 minutes of their time to conduct the interview.
- The two interviews were done separately but the results below were combined for clarity.
- Ali Abdul Hussein conducted the interviews.
- Students did not mind sharing the results of the interview and answers, as long as their identity remains anonymous.
- The interviews were conducted on campus at coffee shops.

Interview Questions:

Question	Response
Are you taking chemistry or biology courses during the course	"Yes, to fulfil the requirement of our degrees. We have to take at least 3 chemistry courses within

of your undergraduate studies?	the first 2 years of our studies."
What tools were used to present and demonstrate class concepts?	"Often the professors utilized blackboard for drawings. Handouts and online readings were also used. Additionally, some Online assignments were completed but most of these were of multiple-choice style. Mainly the overhead projector for slides."
Is there a lab component for your courses?	"Yes. All chemistry courses had about 20% of their workload focused on lab and experiments. This includes lab attendance, lab completion and lab group and individual reports. Some courses also had lab quizzes where we were supposed to complete certain chemistry theoretical or experimentation problem."
What tools were used to help complete lab instructions/reports?	"Custom reaction and equation editor software was provided by school for our use to complete the reports."
Was there any software used to facilitate the understanding of chemical reactions and chemical compounds <u>visually</u>?	"No."
Have you used haptic devices before?	"Yes. "
What do you think about the use of haptic device (like a mouse) in software to help understand chemical reactions more closely and realistically?	"It is a neat idea. Although we love chemistry in general, we typically find class material boring and the current lab setup is not very practical. We think by introducing such technology to lab, which most of us heard about, students will be more interested in learning reactions and

	compounds' behaviour."
If we brought a prototype, would you be interested in trying it and provide us with feedback?	"Yes sure. We are happy to be first users of this cool technology."

Bibliography

MAKO Surgical Corp products and specifications. Retrieved from http://www.makosurgical.com/site/

Number of schools in Canada. Retrieved from http://www.statcan.gc.ca/start-debut-eng.html

Delta 6 device by Force Dimension products and specifications. Retrieved from http://www.forcedimension.com/delta6-overview

Novint robot arm by Novint Technologies, Inc. *products and specifications*. Retrieved from http://www.novint.com/index.php?option=com_content&view=article&id=39&Itemid=54

Phantom Omni by SensAble Technologies Inc. *products and specifications*. Retrieved from http://www.sensable.com/haptic-phantom-omni.htm

Virtuose 6D35-45 by Haption products and specifications. Retrieved from http://www.haption.com/site/eng/html/materiel.php?item=1

Crystal Structure Design AS products and specifications. Retrieved from http://www.crystaldesigner.no/

CrystalMaker Software Ltd. products and specifications. Retrieved from http://www.crystalmaker.com/

New River Kinematics products and specifications. Retrieved from http://www.kinematics.com/

Adept Technology, Inc. products and specifications. Retrieved from http://www.adept.com/

MPB Technologies Inc. products and specifications. Retrieved from http://www.mpb-technologies.ca/

3D glasses of the future. Retrieved from http://www.google.ca/images?hl=en&xhr=t&q=3d+glasses&cp=6&um=1&ie=UTF-8&source=og&sa=N&tab=wi&biw=1600&bih=707