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# The International Consortium for Outsourcing and Networking - Global Mind

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# The International Consortium for Outsourcing and Networking - Global Mind

A Major Qualifying Project Submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

In Partial Fulfillment of the Requirements for the

Degree of Bachelor of Science

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# Abstract

The International Consortium for Outsourcing and Networking (ICON) - Global Mind is a virtual, for-profit entity that aims to connect worldwide industrial customers with researchers at universities and R&D facilities via an online web portal. Our focus for this Major Qualifying Project (MQP) was to discover what values ICON could provide potential partners, and identify problems relevant to the infancy stages of the business. Based on this research, we delivered a set of actionable recommendations for ICON's market entry.

# Authorship

Sections of this paper were drafted individually; however, the final report has been revised and edited through a combined effort.

Marco Castro took lead for the Introduction, Research and Development Literature Review, Industrial Engineering Analysis, and Consulting Report.

Michael Cevallos took lead for the Consortia Literature Review, Industrial Engineering Research, and Methodology,

Takayoshi Tsutsui took lead for the Abstract, Introduction, Marketing and Virtual Businesses Literature Review, Management Engineering Research, Conclusion, and Proofreading/Revisions.

Michael Cevallos

Marco Castro

Takayoshi Tsutsui

# Acknowledgements

Our team would like to thank our advisors, Professor Frank Hoy, Professor Mark Rice, and Professor Amy Zeng, for their advice and guidance throughout the MQP process, as well as our project sponsor, Dr. Sergei Krivoshlykov, and Professor Germano Iannacchione for the project opportunity. We would also like to thank the various, undisclosed participants for providing their valuable time, knowledge, and input about various subject material.

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# Chapter 1: Introduction

The introduction chapter provides background on the International Consortium for Outsourcing and Networking (ICON), and states the problems our Major Qualifying Project (MQP) team is designed to solve throughout the project.

## 1.1 Background

The International Consortium for Outsourcing and Networking is an emerging business concept that aims to bring together academia, private industry, and government partners together to establish a “global network of expertise and facilities”, in order to solve many industry Research and Development (R&D) problems, especially focusing on cutting-edge technology and anticipating future technologies. Worldwide industry and government partners would be able to outsource some R&D projects to academic or other approved research parties, for potentially quicker development time and cost savings. Researchers would generate new concepts and perform experimental proof-of-feasibility studies for prototypes. ICON would be led by an Innovation Steering Board—a board of directors including representatives of industrial partners—to maintain a good relationship with its partners and provide itself with continuous feedback.

While the company will have a headquarters located in Massachusetts, ICON would primarily operate virtually through a Web portal, cutting much of the overhead costs required for large operating facilities. A virtual platform would allow the company to more easily connect

with industry and academic partners all over the world. Meetings would be conducted online (and documented/recorded), and would be a place for candid, open discussion and brainstorming sessions. Legal contracts and Non-Disclosure Agreements (NDAs) would be signed by all affiliated parties to protect Intellectual Property (IP), and to ensure quality of work. ICON would generate most of its revenue via contract fees, membership fees, as well as from the commercialization of developed technologies. Any profits made would be "distributed fairly" to researchers and creators of the ideas.

## 1.2 Problem Statement

ICON's main purpose is to help industrial customers anticipate and develop future emerging technologies, while bypassing expensive, time-consuming processes dealing with governments and grants. Based on our initial meeting with Dr. Sergei Krivoshlykov, the founder of ICON, our MQP team identified some initial challenges for ICON to overcome. As for any startup business, these challenges include attaining credibility, securing the first customers, and developing a sustainable financial model.

## 1.3 Goals

Our team's primary focus for this MQP project was to answer the question: "What are the key success factors that will determine whether ICON GM's business model can achieve financial sustainability?" which focused on identifying values for potential customers, and what initial problems and concerns would need to be overcome. In order to answer this question, the

team compiled a literature review and conducted interviews with other similar consortia or businesses, as well as industry personnel in an effort to answer sub-questions and focus areas such as:

- What direct and indirect analogues already exist on the market, and what are their essential differences?
- What value propositions will lead to success?
- How can ICON establish credibility with potential industrial customers?
- What are the most important steps to assess feasibility?
- What would be the composition of the ICON team and organizational structure?
- What is the most efficient marketing strategy for ICON?
- What are some specific wish-list items, immediate needs, and future needs for ICON's industrial customers?
- Is a global, virtual network business model feasible and sustainable?
- How can ICON identify and approach its initial customers?
- Would early adopters assist and collaborate in development of the financial model (including how to finance the pre-tax cash flow development)?
- What would be the overall business strategy/model?
- What goals do potential industry partners have in terms of R&D, and how are they achieving them?

- What are some gaps in R&D activities that ICON could fulfill, that other consortia may not?

The team also applied knowledge gained from Worcester Polytechnic Institute's Industrial Engineering and Management Engineering degree programs, which are demonstrated in Chapters 2.5 and 2.6. Based upon our findings, the team drafted a consulting report to assess potential courses of action and to provide specific recommendations for ICON to be able to function as a virtual, for-profit company.

# Chapter 2: Literature Review

The literature review chapter investigates various research that ties in with our main question, and examines works that may help lead ICON to success. This chapter also incorporates knowledge gained from our respective majors to demonstrate our understanding and application of material.

## 2.1 Marketing

In order to achieve success, ICON will need to consider how it will market itself as a valuable service to potential customers. While we believe that most of its initial marketing techniques will be through a "push" method of face-to-face interactions and direct engagement, our team has researched important marketing concepts and tools that will be critical for long-term success.

## 2.11 Value

Providing exceptional value—the customer's perceived benefits less the customer's perceived costs—is primarily the biggest driver of success (Lai, 1995). As a business, ICON will need to first understand consumer value needs, create and communicate an appropriate value proposition, and finally deliver it (McKinsey, 2000). When establishing the value proposition, it is important to understand the three layers of the product (or service, in this case) being provided: the core product (benefit), the actual product (physical product), and the augmented product (added value) (Armstrong & Kotler, 2017). For example, the core product may be the benefit of being able to easily find matching university-industry partnerships via ICON, while the web portal and database act as the actual product, and the knowledge, research outcomes, and relationships established as a consequence of ICON would be the augmented product. While there are similar consortia that focus on R&D fields, ICON's virtual platform may be a unique core competency that attracts businesses and universities, which can minimize costs and time; however, based on our interviews with various companies, it seems that one distinct value derived from other consortia is the face-to-face networking through big events and annual meetings (Appendix B). With an online platform, this value dimension may be diminished or lost altogether. While ICON intends to conduct business from an online platform, connecting businesses with universities, ANTEOS may want to eventually consider hosting networking events to add further value to ICON. Our comprehensive findings from various interviews, which give insight to potential customer needs, can be found in Appendix B. With a clear value

proposition, ICON will be able to establish a better mission and objective, and implement effective marketing strategies.

## 2.12 Visibility

Visibility and branding are key to establishing a good reputation and recognition for potential customers. ICON - Global Mind can increase visibility by using trademarks such as a logo or slogan, well-developed websites, and mainstream and social media coverage (Williams & Williams, 2017). Increasing brand recognition will help ICON be perceived as legitimate, and increase consumer trust for those who may not be familiar with the company, personnel, or its partners. Trademarks should be memorable (visually appealing and easy to say, spell, or read), have a positive meaning, make good use of colors, and be fitting for the target consumer. Other methods of increasing visibility include indexing the websites on popular search engines such as Google, and using paid ads or increasing organic ranking using keywords. Further details on increasing organic ranking for Google can be found on IEEE's tutorial paper, *How to Use Search Engine Optimization Techniques to Increase Website Visibility*. While we believe initial consumers will be engaged via direct contact and word-of-mouth, it is still important to leave opportunities for any potential customers searching to fulfill needs that ICON may provide.

## 2.13 Strategic Marketing Planning

Another important tool is the use of Strategic Marketing Planning, which includes internal and external situation analyses, using various concepts such as the Marketing Mix, PESTEL and SWOT analysis, Ansoff Matrix, 5C model, STP, and Perceptual Maps, among

others. More in-depth details about Strategic Marketing Planning can be found in works such as *The Marketing Plan Handbook* by Alexander Chernev, and *Marketing Plan Handbook* by Marian Burk Wood. Success of these marketing tactics can be measured by analyzing controls such as return on investment (ROI), customer satisfaction, and customer loyalty (Chernev, 2011). Many instances of marketing failure stem from the lack of benefit over existing products or services, poor matching and miscommunication between the provided product and consumer needs and perceptions, over-estimation of the market size, poor positioning strategies, and/or poor pricing, product quality, promotion, or distribution. After segmenting and targeting the appropriate market and consumers, ICON will also require a positioning strategy to differentiate itself from other R&D consortia in the eyes of the consumers.

## 2.14 Pricing

ICON will also need to determine pricing strategies based on its pricing objectives. A pricing objective is the fundamental goal that determines product or service pricing, and includes objectives such as profit, market share attainment, competitive effect, and customer satisfaction (Rao, 2009). We do not believe ICON should focus much on attempting to take the market share or "surpassing" competitors (other R&D consortia), as companies often involve themselves in more than one consortium, and may frequently change membership status depending on economic situations (Appendix B). Several different pricing methods may be effective for ICON to implement, including subscription-based fees or a one-time membership payment, along with a percentage cut of any contracts signed by industry-university partnerships. In general, we

believe that a customer-centric, value-based pricing method should be chosen, as the sizes, and consequently the available capital for businesses will vary, as will the personnel, facilities, and available equipment of universities (Rao, 2009). To each customer, the perceived value may differ based on needs and capabilities. With a value-based pricing method, prices will be justified for the benefits customers receive, though a deep understanding of both the customers and competitors will be necessary. Costs can be calculated by using the sum of fixed and variable costs, which will most likely include legal fees, IT and website maintenance fees, and overhead costs, among others. Further information about pricing strategies, including psychological pricing, cost-based markup pricing, competitive pricing, and new product pricing, can be found in *Empirical Generalizations from Reference Price Research* by Kalynaram and Winer, as well as in the *Handbook of Pricing Research in Marketing* by Rao. Chapters 2.54 and 4.8 present deeper analysis on some pricing strategies.

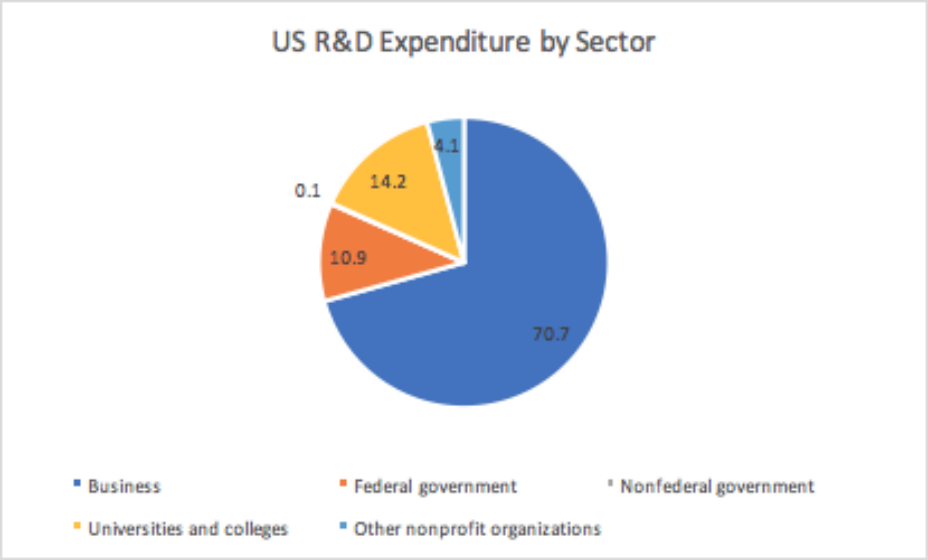
## 2.2 Research and Development

Research and Development (R&D) encompasses a wide range of activities, from research yielding fundamental knowledge in the social sciences, to research addressing national defense needs, and such critical societal issues as global climate change or general-purpose technologies. The global R&D forecast is a combination of the industrial, government, and academic investment by country. The number of technological trends, including cloud computing and biopharmaceuticals, ensures that technology will continue to drive new advances as well as demand for constant innovation.

The United States continues to be the country with the largest investments in R&D, a title it has held for the past 50 years (OECD, 2017). R&D investments as a whole have been growing annually; however, developing countries in economic turmoil are seeing stagnating R&D investment rates.

The U.S. economy continues to outpace many other Western economies with strong programs in place for ensuring continued, albeit slow, growth. This constant growth could not be understood without the increase in industrial investment R&D, specifically, due to the support of academic institutions, federal government research organizations, and strong industrial organizations (IRI, 2016). Technological trends, which include automation, robotics, cloud computing, and biopharmaceuticals, ensure that technology will continue to drive new advances for the following years and decades to come.

## FIGURE 1: U.S R&D EXPENDITURE BY SECTOR



## 2.21 Current Trends in Industry

Innovation provides an important source of firm competitive advantages and success. Therefore, companies invest considerable resources in programs designed to increase their innovation. Technical innovation and innovation of an organization can be defined as the successful implementation of new products and processes, as well as the significant and successful technological changes of products and processes (OECD & Smits, 2002).

According to Doz, Olk, and Smith, an R&D consortium is a 'legal entity established by two or more organizations that pool resources and share decision making for cooperative research and development activities' (Doz, Olk, & Smith, 2000). Nevertheless, the level of decision-making and goals set varies case to case, as many consortia partners' agendas differ.

Companies form research and development consortia for different reasons. Among the reasons cited are market pressures, international competition, the increased pace of new product development, cutbacks in corporate research and development budgets, and shared concerns about meeting new regulatory or safety requirements (Chernev, 2011). According to a survey conducted in 1993 by the Economist magazine, the three reasons most commonly cited were to gain access to a market, to exploit complimentary technologies, and to reduce the time taken for innovation.

Government-sponsored or government-supported R&D consortia have been common in Japan since the 1960s, and now number more than 200 (Nishimura, 2010). In the United States, however, the formation of industry specific R&D consortia was hindered by antitrust laws that

penalized cooperation among competitors until Congress passed the National Cooperative Research Act (NCRA) of 1984 (Scott, 2006).

Unlike Europe and Japan where government initiatives have both created and fully funded large multi-firm research consortia as part of industrial policy (such as VLSI in Japan and ESPRIT in Europe), the United States government has taken a less active role with only two primary programs that promote and sponsor collaborative R&D in the United States. One facet is the U.S. government's partial funding of R&D through limited federal matching and grants via agencies such as the National Science Foundation (Bianco, 2007). Secondly, the U.S. government offers reduced antitrust liability to joint ventures pursuant to the National Cooperative Research Act and the National Cooperative Research and Product Act (NCRPA). The previously mentioned Acts were passed by Congress in response to the concerns that U.S. firms were losing their industrial competitiveness due to the country's avoidance of cost-saving consortia because of anti-trust enforcement.

Under the NCRPA, firms within an industry may form consortia to conduct "precompetitive" research. Precompetitive research is research that is considered generic to the development of multiple products of basic value to all participants (Corey, 1997) . As a result, they all are able to compete more effectively in the global marketplace.

Research and development consortia have been successful in spurring innovation. SEMATECH, a Texas-based consortium of major semiconductor manufacturers founded in 1987, has had success in helping its member companies regain dominant market shares in the

international semiconductor equipment and silicon-chip markets (Bianco, 2007). Another consortium, the U.S. Council for Automotive Research (USCAR), was formed to accelerate technological innovation among the major automobile manufacturers.

## 2.3 Virtual Businesses

Virtual businesses offering products and services are common in today's information age. According to *Outsourcing Business to Cloud Computing Services: Opportunities and Challenges*, by Hamid R Motahari-Nezhad, Bryan Stephenson, and Sharad Singhal of Hewlett Packard Labs, "today there are very few businesses that do not have a Web presence, and there are many small and medium businesses (SMBs) such as retail shops that solely offer their services and products online." Through our research, we have found that virtual and global industries and systems are beneficial due to their flexibility, responsiveness, and efficiency (Chesbrough & Teece, 1996). Shortcomings, however, include the difficulty of coordination, conflicting interests, and lack of control. To overcome these potential problems, ICON will need to create strategic alliances, but be willing to change relationships depending on the situation. As a business model, a decentralized, global approach seems to be fitting for the service, as innovations will be autonomous, and can be created independently from other innovations. Further explanations about the importance of virtual alliances and organizational structuring can be found in the Harvard Business Review article, *When is Virtual Virtuous? Organizing for Innovation*, by Henry W. Chesbrough and David J. Teece.

## 2.31 Website

For a virtual business, a website is a critical first step for success. Based on a study conducted by the Department of Marketing and Business Management of the University of Zaragoza, Spain, accessibility, speed, navigability, and content are deemed some of the most important factors of an effective website (Hernandez, Jimenez, & Martin, 2009). Further information determined by the study, *Key website factors in e-business strategy*, may be found in the *International Journal of Information Management*. In its current state, ICON's website, "http://www.icongmind.xyz", provides good fundamental content on the company's value proposition, general business model, and contact information for interested customers; however, the website lacks elements of credibility and security from the perspective of the customers, and lacks a portal or database linked to the website, which could be used for more fluid data collection and clientele matching. The website's (and consequently, ICON's) credibility can be increased by focusing on security, privacy, and usability (Chen, Hsu, & Lin, 2009). More information, such as about the use of encryption and privacy statements to quell potential customer fears, and user interface, as well as website capability and content, can be found in *Website attributes that increase consumer purchase intention: A conjoint analysis*. We caution that the use of a ".xyz" domain is still relatively new, and so may raise security concerns and limit accessibility for particular servers, an example being Worcester Polytechnic Institute's. Similar to the trademarks referenced in the Marketing section, colors and design, as well as user interface should be engaging and memorable (Cyr, Head, & Larios, 2009). Due to the nature of

service provided, we believe that a mobile site is not quite necessary, though fundamental content should be easy to access through a mobile device.

## 2.32 Communities

Through our interviews, we have found that one value businesses participating in consortia particularly expect or enjoy is the ability to network with other businesses who face similar R&D problems. While the utilization of online meeting spaces such as Skype, Zoom, or Adobe Connect are good tools for connecting a handful of organizations, virtual meetings still lack the same essence as face-to-face meetings. As discussed briefly in the Marketing section, one solution to appease this problem would be host an annual or bi-annual physical networking event near ICON's headquarters. In the long-term however, this may cause logistical problems and unnecessary expenses, as ICON intends to be a global business and thus organizing a formal networking event— bringing together many global partners and customers—would be a substantial time-consuming task in of itself. Another alternative is to establish an online community early on, which, if successful, can be an effective business model for continuous networking. As John Hagel writes, virtual communities can be used for business-to-business applications (customers) and revolve around certain types of industries to create a "shared focus to aggregate customers together who have similar concerns and requirements" (Hagel, 1999). These communities may also help to solidify relationships with and between customers and allow discussion of important issues in R&D and uncover potential projects or ideas. There is a variety of options available for online communities, including social media groups and forum

pages. If the target is purely for interaction and networking (allowing customers to establish casual relationships), a social media group may be sufficient. If the goal is instead to create a professional discussion platform, a forum-type of community may be preferable.

## 2.33 IT

Information Technology (IT) will also be critical in creating a dynamic structure for retaining industry and university partners via the web portal. *Allocating Decision Rights and Accountability: Elements of Effective IT Governance*, by the Harvard Business School Publishing Corporation, states, "Firms with above-average IT governance effectiveness had 20 percent higher profits as measured by three-year industry-adjusted return on assets." The excerpt describes five allocations of key decisions for effective use of IT: IT Principles, Enterprise Architecture, IT Infrastructure, Business Needs and Project Deliverables, and IT Investments and Prioritization. More information about IT infrastructure such as Cloud services, are available in *Outsourcing Business to Cloud Computing Services: Opportunities and Challenges.* Other studies, such as of *Organizational Virtualness* by Pascal Sieber and Joachim Griese, go into considerable detail about various ways to manage virtual networks, which may be useful to understand long-term, but not quite for this phase of the project. While *IT Governance and Its Mechanisms*, by Steven De Haes and Wim Van Grembergen, states that an IT steering board should be implemented, we believe that due to the virtual and global nature of the business, ICON's overall steering board should be the vehicle to partially oversee IT-related matters on a regular basis, with several specific personnel who are knowledgeable about IT participating. We

believe that in this initial phase, it will be crucial to establish a viable, centralized IT infrastructure that will be transferable or adoptable for any future offices or global headquarters, which may be handled by a third party consultant. *IT Operations Management Is Undergoing Transformation* by Donna Scott of Gartner, depicts five levels of IT Process Maturity (Chaotic, Reactive, Proactive Service, and Value), which will be a helpful resource to understand the importance of IT in the long-term.

## 2.4 Consortia

Technological innovation and application is a prerequisite for any company to survive in today's fast paced, global economy. Yet, the resources required to begin and maintain such cutting-edge research in a multitude of increasingly complex fields are out of reach for all, but the largest organizations (Governments, Global Multi Corporations, etc.). To foster innovation and growth among companies, consortia have developed, allowing companies to pool their unique resources to solve technical problems for mutual benefit.

To gain a better understanding of how to best develop ICON, we must first go over what a consortium is and how one operates. A consortium is an organization that brings together multiple entities such as universities, governments, and industries, pooling resources and knowledge to tackle a variety of technical or non-technical research problems (Roud & Vlasova, 2017). These relationships may be very complicated, with a variety of different contracts and agreements in place to proportionally distribute benefits. The most obvious and apparent benefit of this model is that research can be conducted quicker and more efficiently due to the

combination of resources. While this is true, the very nature of the work often implies that the process may not work so smoothly. The relationships that are built between competing or completely different entities such as universities and corporations can be, and usually are, very strenuous, especially between different types of organizations (Appendix B). The competing interests and priorities that exist among these organizations ensure that contract and patent negotiations are either hindered or halted before research can commence (Appendix B: Interview B).

For this subchapter, two distinct types of consortia were examined. The first is what can be classified as government-university-industry partnerships. The second type of consortia researched are smaller, more application focused, and are mainly comprised of industries.

## 2.41 Government Consortia

Since the beginning of the 20th Century, governments have played increasingly larger and leading roles in the development and growth of new technological and scientific advances (Vitaliy & Vlasoya, 2017). This has been accomplished through institutions such as GUIRR (Government University Industry Research Roundtable). GUIRR stands as a nonpartisan organization whose mission goal, as stated on its home page is "To convene senior-most representatives from government, universities, and industry to define and explore critical issues related to the national and global science and technology agenda that are of shared interest". Large government consortia such as GUIRR are less focused on any single industry or business.

Though its customers may also be its members, its priority is on “national and global science and technology”. These type of consortia have several benefits and drawbacks.

One of the greatest benefits of this type of government-sponsored consortia is the great amount of influence and resources that they have at their disposal. A 2010 study found that the presence of government consortia has had a “positive impact on the research productivity of participating firms” in Japanese robotics industries (Lechevalier, Ikeda, & Nishimura, 2010). This paper compared the quality and quantity of patents produced, and found a positive correlation between patents and government-sponsored R&D consortia. Similarly, Research of German and French institutions has found that, “Cooperating with public research increases product innovation” in their respective countries (Robin & Schubert, 2013). It is, however, important to note that in both cases, the increase in productivity in both firms was due to increased resources. The process of innovation by which this innovation takes place is the same. These large government consortia function because of their ability to bring a large variety and amount of industries and experts together; however, as effective as they can be, they do have several limitations.

The effectiveness of government consortia can vary dramatically depending on factors such as the located country and government, as well as the specific industrial field. For example, the main goal GUIRR has had the most difficult time achieving in recent years is translating the increase in research conducted into marketable services and products. While universities focus on research and breakthroughs, if the new knowledge cannot be leveraged into marketable

services and products, then industry will consider it as a failure. This is where government consortia fall short in comparison to industry consortia. What GUIRR has had success in, is in allowing a wide range of private, government, and university professionals forge personal relationships to discuss a wide range of topics that are of current importance.

## 2.42 Industry Consortia

As opposed to government consortia, private industry consortia have several traits that distinguish them from larger national institutions. One of these traits is that industrial consortia tend to target one specific market or field. Examples include specializing in fields such as recycling, organics processing, or drying. The reason for this specific targeting is that many of the technical and procedural problems affect the entire industry, providing an easier opportunity for industry consortia to find specific research projects for a small group of researchers to work on together (Vlasova, 2017). The number of project centers vary, but a single consortium will usually have anywhere from 15-30 members, involved in different research projects. The research conducted in these centers are not time sensitive or highly critical, but may contain results that have the potential to benefit many of its members (Roud & Vlasova, 2017).

Another difference that was noted based on our interviews is that members in industry consortia tend to have high turnover rates. Once a specific project center has completed its research, which typically lasts anywhere from one to five years, members will leave the consortium if a new project does not fit the company's needs. When this occurs, new and previous members are contacted to see if they have any interest in joining (Appendix B)

The benefit of this consortium model is that it has a high chance of providing members value, as they join project centers which aim to solve the specific problems the companies are currently facing. These are highly specific and targeted research problems which all members wish to solve. This is in stark contrast to mixed research of academia (universities) and industry in which the final goals may not always align (Appendix B).

In our interviews, we have also observed the limitations that research consortia have. They depend largely on professional trust and personal connections to begin and continually organize, which is vital, as all research being conducted in these consortia is of great value to the member companies. Research consortia also are only effective in tackling broad industry problems, as any form of competitive and proprietary research is not conducted through consortia, as the value of competitive advantage is too high. If cutting-edge research, critical to a company's success, were to leak or be stolen, then the potential risks and loss in revenue could be tremendous. This greatly limits the number of research opportunities available for consortia.

## 2.5 Industrial Engineering

Industrial Engineering (IE) is the application of science, mathematics, and engineering methods to improve upon and predict industrial methods and goals. These include areas such as statistical analysis, planning, operations management and design. These analytical methods are uniquely suited for the analysis of business models and their long-term feasibility. It is for this reason that the tools and methods used when analyzing the feasibility of ICON - Global Mind as a consortium consist mainly of industrial engineering tools.

Several IE tools were used to examine and analyze the feasibility of ICON as a business, such as the use of EMV, SWOT, PESTEL analyses, and cash flow diagrams. Each of these served a distinct purpose when analyzing ICON and the market in which it will exist. The information that was required to run these analytical tools was acquired through a variety of sources. This includes interviews with people familiar working with consortia's and businesses involved with R&D, and the online research of organizations similar to that of ICON - Global Mind.

## 2.51 SWOT

The purpose of the SWOT analysis is to find and identify any possible strengths, weaknesses, opportunities, and threats that a product or service has in a given environment. Identifying these four aspects of a business allow proper planning of unique business opportunities, and mitigation of any potential threats.

The Strengths of a business can be defined by several different questions. These include, "What does the company do well? ", "What are some unique skills?", "What does the company do better than its competitors?" and "What unique, low cost resources do you have that other do not?" to name a few (Gregory, 2016). The answers to these questions help identify the business USP, or unique selling proposition. Identifying the USP of a business is important as it informs decisions makers where to best invest resources and time.

The Weaknesses in a SWOT analysis are attributes or traits of the business or individual that can impede growth and progress. This can include any resources that are lacking, which

parts of the business are not profitable with, and areas that may require more experience and education (Martin, 2009). It is important to clarify which weakness are present early, so that steps can be made to improve them before they hinder the business.

Opportunities consist of any possible niches that are not currently being filled. This does not only mean finding new potential customers, but also finding new services that can be offered to existing clientele. This can be accomplished by incorporating new technologies, seeking new markets, and understanding the increasingly growing and shifting demands of the business' current market (Berry, 2017).

The final aspect of a SWOT analysis are the Threats. These are any changes that occur externally, which can pose a danger to the current business model. This can include new competition and viable alternatives, a change in regulations and trade barriers, or a shift in customer demand (Berry, 2017).

## 2.52 PESTEL

A PESTEL analysis is used to monitor and evaluate external factors that could negatively or positively affect an organization. It evaluates six different factors: political, economic, social, technological, environmental and legal. Identifying and analyzing these six factor pressures is necessary to then evaluate any possible strengths and weaknesses as seen in the SWOT analysis.

Political factors, the first in the PESTEL analysis, refers to any way the government can intervene in the economy. This includes, but is not limited to, political stability, foreign trade

policy, and tax policy (Professional Academy, 2018). These are all factors that play a great role in determining how well an organization can conduct business.

Economic factors include a wide variety of variables, which can greatly affect an organization's ability to conduct business. These include current economic growth, inflation rates, exchange rates, and interest rates. Depending on the type of business, several factors will have a greater impact. For business to consumer companies, the amount of disposable income greatly affects the bottom line (Professional Academy, 2018). Similarly, markets that deal with loans, such as the banking and housing industries, are more impacted by interest rates.

Social factors comprise of data such as age distribution, expected population growth, cultural values, and social norms. In one's own country, these factors may be intuitive and cultural norms easy to grasp, but can play an even greater role when attempting to drive into new international markets. It is important to understand who comprises the new markets, and what values influence market decisions.

The fourth external factor is the technological landscape. The introduction and application of new technologies and processes can greatly influence the way goods and services are produced, marketed, and sold. It has the potential to drive down costs and open new markets, while also making previous goods and services obsolete.

Of all the factors on the list, environmental is the most recent. It not only refers to how raw materials will be sourced, but any pollution and the total carbon footprint that is made as a well. There is also a growing demand by consumers for more sustainable and ethically produced

goods, and hence, some environmental factors may be classified as social or political factors as well.

Legal factors include any laws and regulations that a company or organization must adhere to, in order to be compliant within a certain country. This includes any workers and consumer rights, health and safety regulations, and product safety standards.

## 2.53 Influence Diagram

Influence diagrams are a visual representation of decision situations. They summarize the key information that is required to make a decision. This information includes the decisions that need to be made, the objective or sub-objectives, and chance variables that will influence the final objective (Lumina, 2014). Our influence diagram related to ICON may be found in chapter 4.6.

## 2.54 Cash Flow Budget Analysis

The projected cash flow of a business is one of the most important tools available when calculating the viability of the business. This is because a cash flow analysis lists all inflows and outflows of cash that the company or project is expected to produce. Not only does the cash flow budget specify the amount and where the money is entering and leaving, but it also states how much is available in any given time period. It is important to note however, that a cash flow budget does not show profitability—only liquidity. Although the two are closely related, they have several key differences.

The first is that profitability is calculated with income and expenditures; however, cash flows use inflows and outflows. Inflows and outflows differ from income and expenses in two ways. The first is that cash flows factor in timing of payment. The inflow is not calculated for when the item is purchased, but for when the payment is received. In many cases, they are the same, but may differ drastically when making loans and early orders. The second is that many items cannot be classified as either expenditures or revenue. These include items such as loans and the payment of accumulated interest. The advantages of using a cash flow budget is that as long as a variety of variables are adequately estimated, an estimation can be made for if and when an organization will begin generating revenue, and what expenditures will most impact the organization.

## 2.55 Cluster Analysis

The cluster analysis is an exploratory analysis that attempts to identify structures within the data. More specifically, it aims to identify homogenous groups of cases if the grouping is not previously known. For this project, the cluster analysis was used to identify dominant modes of collaboration, including outsourcing R&D, specialization and separation of R&D activities, and more integrated “learning” approaches. Additionally, the analysis helped group consortia participants, and whether or not the consortium maintained in-house R&D facilities. The results suggest that many consortia organize to avoid spillovers, and as a result, do not achieve cross-pollination of expertise the National Cooperative Act was designed to promote.

## 2.6 Management Engineering

Many aspects of the Management Engineering component overlap with the Industrial Engineering component. To differentiate, the Management Engineering section includes some concepts related to the Mechanical Engineering field to satisfy the concentration requirement—specifically, Lean analysis and information regarding photonics and optoelectronic nanomaterials.

### 2.61 Lean Analysis

Lean analysis and management, as well as related Six Sigma principles, stem from the desire to drastically improve quality (meeting and/or exceeding customer expectations, and reducing variation) through a systematic change in the process and its prioritization of the people who are a part of the organization and processes (Clark, Silvester, & Knowles, 2013). While lean principles are most frequently used for manufacturing capabilities, it will be advantageous for ICON to understand the fundamental philosophy and principles in order to provide high-quality services and eventually, products in the R&D phase. By correctly establishing an efficient lean process, ICON's R&D project teams will be able to implement "faster product development with fewer engineering hours, improved manufacturability of products, higher quality products, fewer production start-up problems, and faster time to market" (Karlsson & Ahlstrom, 1996). To achieve this, *The Difficult Path to Lean Product Development* describes that there must be a smooth integration of cross-functional team members, with each member being competent

engineers, and must be able to work closely with management (leadership) and clients (customers).

Successful lean thinking includes tools and concepts such as total quality, takt time, line balancing, one-piece flow, value stream mapping, and many others, which can be found in *A business process change framework for examining lean manufacturing; a case study*, by Jaideep Motwani. The research also underlines the importance of company culture, learning capacity, IT capability, worker-management relationship balancing, and overall strategic initiatives, which all come together to develop a waste-free, high-quality process for product development and manufacturing, a crucial part of any engineering and R&D process. W. Edwards Deming, considered as one of the architects of lean management and six sigma processes, stated fourteen points for quality excellence (Evans & Lindsay, 2017). The most important, he described, was the ability for the company's constituents—every employee from management to low-level workers—to truly understand and adopt the company philosophy. While ICON may only have a few workers initially, and see itself as a partner of many external organizations, the company should still strive to retain a core value of beliefs. The outlook of both leadership/management and their outlook on quality is especially important, and should consider these lean management methodologies when organizing and appointing leaders for R&D projects. While the value of ICON may be present, the service must be delivered appropriately, matching or exceeding customer needs and expectations to truly be valuable.

## 2.62 Photonics and Optoelectronic Nanomaterials

Due to the knowledge base and specialization of ICON personnel, the starting point for ICON will be to primarily focus on photonics and optoelectronic nanomaterial industries. Photonics refers to the use and relationship between optics and electronics, which have played an increasingly important role for semiconductor technology in recent years (Saleh & Teich, 1991). According to Saleh and Teich, optoelectronic nanomaterials deal with "devices and systems that are essentially electronic in nature but involve light," such as "light-emitting diodes, liquid-crystal display devices, and array photodetectors" among others. Both photonics and optoelectronic nanomaterials are becoming increasingly important fields, as they encompass technologies and instrumentation related to fiber optics, defense systems, telecommunications, solar and thermal energy, environmental monitoring, medical imaging, as well as many of the electronic devices the general public uses daily, such as phones, computers, cars, etc. (The Optical Society, 2018). As such, the fields present many opportunities for R&D, as advancement in these fields lead to more advanced electronics and technology, which have limitless market potential. Op-Tec.org highlights many more fields with a demand for Photonics and Optoelectronics. Because light plays such an integral role in both photonics and optoelectronic nanomaterials, an in-depth understanding of how light functions, in various situations and with different types of materials, is crucial for the development of instrumentation having principally new or augmented functionality. For example, electronic circuits carry electrons over a distance; however, the speed at which they can be transported becomes limited due to the quality of the material and cross sectional area of the wires, also potentially creating interference (Ozbay,

2006). For such a scenario, optical fiber is a superior technology compared to more analog methods using materials such as copper wire, as it is able to transport more data using light, also preventing much of the electromagnetic interference (Keiser, 2003). Optical fiber is only one of the many technologies in the fields of photonics and optoelectronic nanomaterials, and while many of the concepts are interdisciplinary, much of this applies to mechanical engineering knowledge about materials and high-level mathematics, including differential equations and advanced calculus. University research teams would indeed understand much of the fundamentals of various aspects of photonics and/or optoelectronic nanomaterials, and would thus be able to provide potential solutions to specific problems.

# Chapter 3: Methodology

The goal of this MQP was to develop a clear set of recommendations for our project sponsor, in regards to a future online, global consortium, ICON - Global Mind. The final recommendations were to be delivered in the form of a consulting report. To accomplish this, we created five primary objectives:

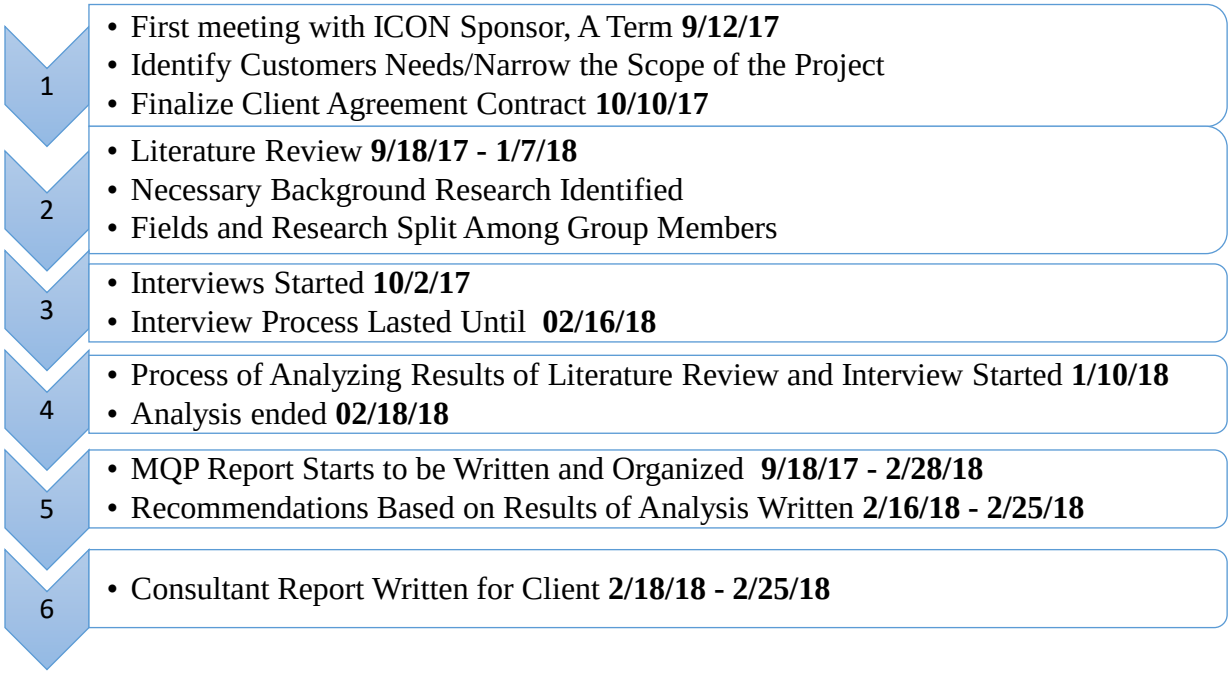
1. Identify internal (advisors') and external (sponsor's) customer needs
2. Clarify project deliverables with customers
3. Complete background research & interviews
4. Analyze the results and data
5. Report and present recommendations

In this scenario, we consider our internal customers to be our advisors, who appropriately grade the report, and our external customer to be our client, to whom we will be presenting the consulting report.

## 3.1 Project Process

The final timeline for the project goals and deliverables can be seen in the figure below. This contains the start and end date for each of the project goals and sub-goals that were necessary to complete the MQP.

### FIGURE 2: PROJECT PROCESS



## 3.2 Client Agreement Contract

For any project, it is essential to first have a firm grasp on what is required by the client(s). In this case, our team's primary clients consist of Dr. Sergei Krivoshlykov, as well as our advisors, Professors Frank Hoy, Mark Rice, Amy Zeng, and Germano Iannacchione. To gain a clear understanding of the project, objectives, and deliverables, our team initially met with the Major Qualifying Project (MQP) advisors to discuss the project requirements and to gain direction from an MQP perspective, and determined that a consulting report would be appropriate for a business project such as this. Afterwards, our team met with the primary client, Dr. Sergei Krivoshlykov, to discuss potential project deliverables for ICON's consulting report. Afterwards, a timeline of objectives was drafted to retain consistent progress, and was approved by the advisors. Our team also created a Client Agreement (review and proposal) for Dr. Krivoshlykov to revise and approve, listed in Appendix D. By having a clear understanding of the project from the initial phase through thorough communication, our team attempted to mitigate potential misunderstandings and future errors.

## 3.3 Review of Literature

For the literature review, we first decided on research areas that would be important to learn for the project. We identified six main areas: Marketing, Research and Development, Virtual Businesses, Consortia, Industrial Engineering, and Management Engineering. We divided each of these portions among members of the team. The sources were primarily articles

from formal research and industrial journals that were accessed online or through textbook publications.

## 3.4 Interviews

Interviews were an integral part of our research. To retain confidentiality, all names and organizations are undisclosed, although the transcripts may be found in Appendix B. All interviews followed a semi-structured format. We chose this format because while we knew specific questions to ask, we did not know if there was additional information we could gain from the interview and opportunities that may arise. To conduct the interviews, we specifically followed three general steps:

1. Before meeting with the interviewee, we prepared an interview outline with core questions to ask, based on information about their positions and organizations, as well as any relevant background information that was mentioned or found.
2. Whenever possible, there would be one dedicated interviewer who asked questions and led most of the conversation, along with one note taker who recorded key information and asked clarifying questions. At the end of the interview, we would ask to be put in touch with any other relevant potential contacts.
3. After the interview was finished, we went through the taken notes and compiled them into a formal write-up, to be able to draw conclusions.

For our research, we also interviewed several professionals with expertise and experience in running and working with consortia's. These experts had a variety of backgrounds

and unique perspectives to offer, allowing us to gain an in-depth understanding of the managerial and entrepreneurial processes that are required when developing and operating a consortium or participating in one, along with any challenges that need to be overcome. These insights into various challenges provided the team with a better understanding of how to potentially add value to ICON, and to satisfy needs for university and industry partners.

Interviews were also conducted with a several professionals in photonics and optics fields. They offered insight into the unique challenges and opportunities available in these industries and explained why proprietary and competitive research is so highly valued and presents a multitude of risks.

## 3.5 Analyzing and Developing Recommendations

For the final term of the project (January 10, 2018 to mid-February), we analyzed the information that we had gathered from all of our research and interviews. We then finalized a set of short and long-term recommendations, listed in Chapter 5. There were six recommendations, which were written in both the MQP, and more concisely in the consulting report. These recommendations drew heavily from the market research that was learned from both the literature review and interviews, as well as the PESTEL, SWOT, and cluster analyses.

# Chapter 4: Results

## 4.1 Adding Value through Partnerships

The use of external sources to save time and money as well as address IP issues is the most innovative and efficient way companies may handle R&D. In industries with a high degree of technical complexity, enterprises tend to build alliances with partners that have complementary skills, in order to jointly develop new technology.

Currently, 3% of the U.S. GDP is invested in R&D. Therefore, alternative forms of R&D, such as joint ventures and partnerships, are beneficial for all parties involved. Companies, especially those who aim to be in the top of the innovation ladder, must maintain a competitive edge in uncertain markets. Through inter-corporate consortia, enterprises can enter into new markets, and gain new technology while reducing R&D risks and costs.

Based on the comprehensive effects of resource integration, business strategy, and flexibility, consortia are superior to mergers and direct investments (Barason, 1990). As a response to the intense competition accompanying the process of globalization, the regrouping of technology, knowledge, and network resources can help to enhance the diversification of output value. R&D has gradually become one of the key business strategies for corporations.

## 4.2 Derived Benefits through Participation in Consortia

One of the benefits derived from joining a consortia is the learning curve effect (Fudenberg & Tirole, 1983).When the data was analyzed for any the correlation between various indicators such as willingness, it was revealed that almost all factors are positively associated (table below). The only exception to this is when there is an increase in the number of employees. The motivation perspective and individual business performance suggest that the total capital, turnover, number of R&D personnel, and increase in new output are significantly and positively correlated, suggesting that participation in R&D consortia can enhance business performance. As the data gathered suggests, 91.74% of the companies confirm the benefits of participating in R&D consortia, and are willing to participate in R&D consortia a second time (Hsu* & Lin, 2014).

### TABLE 1: CONSORTIA EFFECTIVENESS

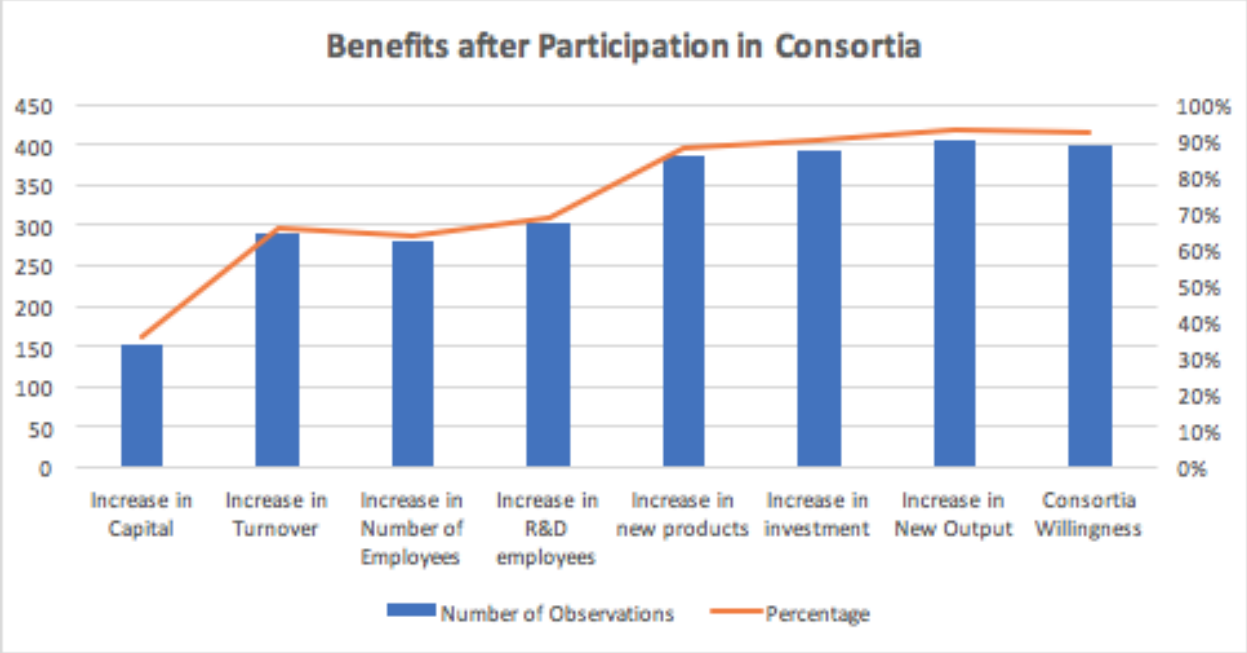
| Effectiveness | Number of Observations | Percentage |
|---|---|---|
| **Increase in Capital** | 153 | 36% |
| **Increase in Turnover** | 289 | 66% |
| **Increase in Number of Employees** | 280 | 64% |
| **Increase in R&D employees** | 303 | 69% |
| **Increase in new products** | 386 | 88% |
| **Increase in investment** | 394 | 90% |
| **Increase in New Output** | 405 | 93% |
| **Consortia Willingness** | 400 | 92% |

*Source: Journal of Economics and Management 2014

The table above represents a study from the Journal of Economics and Management about corporations that have participated in consortia, and how they were affected. The data

reflects that the majority of the critical aspects in which industry partners join for, often occur. The observations show that participating in consortia does bring benefits to partners, such as 66% increase in R&D project turnover, as well as 88% increase in new innovative products. Other factors of the data seem remarkable, one in 10 companies that were part of a consortia has had an increase in investment.

## FIGURE 3: BENEFITS AFTER PARTICIPATION IN CONSORTIA



## 4.3 Market Assessment

R&D activities do not always lead to innovation, but are necessary in order to increase the probability of innovation occurring. With innovation being the task of converting information from diverse sources into useful knowledge, collaboration between actors has been found to be an important driver for the success of R&D activities (Freeman, 1991).

R&D consortia are often not clearly understood by the public. This means that several corporations, which may actually benefit from its practices, miss the chance to find alternatives to R&D expenditures. To attract more companies it will be important to clearly portray the potential benefits, risks and expected success rates. Currently a limited amount of direct, quantifiable research has been conducted by firms and industries in regards to the potential revenue streams and positive outcomes of joining consortia.

This report intends to identify a number of these factors, such as the composition of an R&D consortia and the cooperation between actors within an R&D consortium. The National Cooperative Research and Production Act (NCRPA) is a United States federal law that reduces potential antitrust liabilities of research joint ventures (RJV) and standards development organizations (SDOs). Incepted in 1984 and replaced in 1993 by a modern version NCRA, the Act has just under 1,000 joint ventures registered.

Contrary to popular belief, barely over 35% of NCRA consortia has some relationship with any government agencies, at the same time, only around 20% of the NCRPA consortia has

a university as a member. U.S. consortia derive most of their funds from member dues, whereas Japanese consortia obtain most of their funds from the government.

Consortia have several limitations, including a high barrier of entry in terms of cost, and narrow research areas. This leads to consortia naturally being short-term endeavors, as there is no incentive to continue sharing information with potential competitors once the industry problem has been solved and the company has acquired the benefit of joining the consortium.

It is necessary then to produce a new consortium model that meets the needs of modern business. It should be online, fast, and leverage the global resources that exist to solve pressing problems in industry today.

## 4.4 SWOT Analysis

The scope of the analysis covers business activities that affect the company's ability to promote consortia; expand technical expertise; product and service development delivery; attracting venture capitalists and broadening the current customer base; identifying new and emerging markets and competitors; expanding the global base; creating alliances with other research and development companies to share expertise, knowledge, and resources; securing technology required to advance the company mission and vision; and to increase profits.

**Strengths:**

- Growth alternative to company's R&D strategy.
- Valuable input outside the company.
- Pool resources, energy, ideas, marketing and related

- Decrease time-to-market: accelerate the creation phase and bring potential new products to market faster.
- Create synergy among multiple communities
- Discover and share through consensus provided exposure to new concepts.
- Facilitate Scholarship of Teaching and Learning (SoTL) research, and more diverse population subjects.
- Eligible for government funding.
- Increased opportunity to keep up to date on new developments.

**Weaknesses**:

- Greater logistical challenges—taking more time and energy to manage
- Potential division over Intellectual Property can slow the decision making process
- External sources can be difficult to replicate once it has transitioned in-house

**Opportunities**:

- Benefit from commercialization of the proposed concepts or developed technologies
- Opportunity to increase the level and effectiveness of competitive intelligence gathering
- Loss of proprietary developments
- Potential spillover effect
- R&D Tax Incentive
- Potential access to new markets
- Technology acquisitions: opportunity to acquire entirely new technologies through purchase, acquisition, or mergers

**Threats**:

- Potential Reduction of Diversity in Technology Avenues
- Existing Competition in Product Markets
- Different organizations with different goals, ideas, and agendas on where and how to use shared R&D.
- Different locations and cultures may affect a consortia lifetime or wellbeing.
- Diverse time zones threaten communication
- Replication of innovative ideas.

## 4.41 Priorities

New business development activities address broadening the potential customer base, as well as creating new alliances that arise from the investment of both knowledge and human capital. Activities in this area include imparting or sharing of knowledge and research results, venture capital investments, innovation coupled with creativity and design, start-up as well as spin-offs and survival, and other investment opportunities that will enhance the profitability of the company.

## 4.42 Competition

The competition, consisting mainly of established consortia and research institutions, highlights ICON's specific traits that appeal to customers, as well as traits that differentiate ICON from alternative consortia. Continuous improvement of ICON will increase productivity and profitability. This will be accomplished through best practices documentation, management

development, expansion of e-business, access to capital for use and reinvestment, networking, government regulations, environmental performance, and international trade development. In industry and technology sectors, R&D is a crucial component of innovation and a key factor in developing new competitive advantages. Therefore, the ability for an R&D consortium to obtain and apply the innovative findings dictate the difference in which corporations transform knowledge and findings into innovative products, designs, or services.

## 4.43 Networking

Business activities and local economies can be identified and acted upon through a solid networking system, establishing relationships with industry leaders and experienced industry professionals in niche markets, by linking businesses with potential future clients. Networking is of great importance for R&D consortia and is one of the first steps for the ICON business model to be successful, especially as a startup with a small number of workers. Networking in industries where ICON can aim to differentiate from competitors will be crucial. Therefore, ICON's business model should focus on connecting with industry experts and potential partners to form a joint venture for outsourcing R&D. Besides facilitating the exchange of information, opportunities like joint ventures, client leads, and partnership are few examples of the endless opportunities within networking.

## 4.44 Implications

The SWOT analysis has several important implications for the future of ICON - Global Mind. The first and most important is that ICON has the potential to offer collaboration tools,

which are not commonly found on the market today. These include its online presence and global reach, combined with a low barrier of entry; however, great logistical hurdles, and complex contract negotiations implicate that ICON will have to begin small, with only a handful of clients and industry partners. It would be beneficial if these clients have had previous positive work relationships with ICON's leadership, overcoming the most difficult parts of ICON's initial hurdles—the logistics and contract negotiations—to take place more smoothly. It will also be necessary to continually monitor the research landscape to keep ICON's distinctive competence.

## 4.5 PESTEL Analysis

**Political Factors**

ICON seeks to create a global network that consists of patent sharing and virtual collaboration. Though this may work within one border due to having consistent patent sharing and trade laws, incorporating this into a multinational stage may present some problems. Countries that currently have embargoes against others for technologies would not have full accessibility. It would also be difficult to enforce any profit sharing or patent privacy laws in countries without strict enforcement of intellectually privacy laws.

As far as we have seen, no organization or political entity exists that is similar to what ICON sets out to be. The closest we have found would be entities such as GUIRR and the National Academies for the Science Engineering and Medicine. It should be stated that these are

only national organizations, and their main purpose is to increase collaboration between universities, government, and private institutions.

**Economic Factors**

Because ICON seeks to be a global platform, it would not be largely impacted by the economic growth or depression of any single country. ICON seeks to lower the barrier and costs that are required for collaboration; however, any collaboration will require a certain level of investment that can only be made in an economically favorable environment.

**Social Factors**

Globalization has increased the number of technically competent and specialized industries across the globe. Socially, it has become more common and even necessary to work with industries that are located across the globe. ICON - Global Mind hopes to leverage this shift in the future, and not only have a presence nationally, but globally as well.

**Technology**

Internet Access has become ubiquitous in all but the most rural and impoverished areas of the globe. This will make a service such as ICON easy and inexpensive to access for any potential customer. The business will depend almost entirely on the proliferation of internet access to reach customers.

**Environment**

The research market of global consortia did not directly deal with the environment; however, if accomplished, ICON - Global Mind will allow for easier communication and

collaboration of research teams across to globe. This will make studying global phenomena such as global warming easier.

**Legal**

The most difficult aspect of ICON will consist of the laws and regulations that each country has in regards to intellectual property, technology transfer, and enforcement of IP. Because each country has differing laws and standards, it will be difficult to properly create and enforce any of ICON's bylaws in regards to profit and patents.

The United States has strong IP laws; however, the cost to enforce patents and IP can be very high. In the United States, it falls on the owner of the patent to sue any persons who infringe upon intellectual property. It is for this reason that ICON will have to keep in mind two aspects for it to gain consumer trust. The first is the presence of strong comprehensive, specific, and legally binding contracts that will be available for all its customers. This will give a strong legal groundwork for its customers to use against potential infringement against their IP. The second aspect that ICON - Global Mind will need is professional trust that ensures no information will be leaked or sold to competitors.

## 4.51 Implications

The results of the PESTEL analysis imply that the current conditions, which can affect the long-term success of ICON - Global Mind are very favorable. Currently, the global economy is in a state of growth—a time when companies are most likely to invest in R&D (Statista, 2017). This, along with national and international political stability, will allow ICON's growth

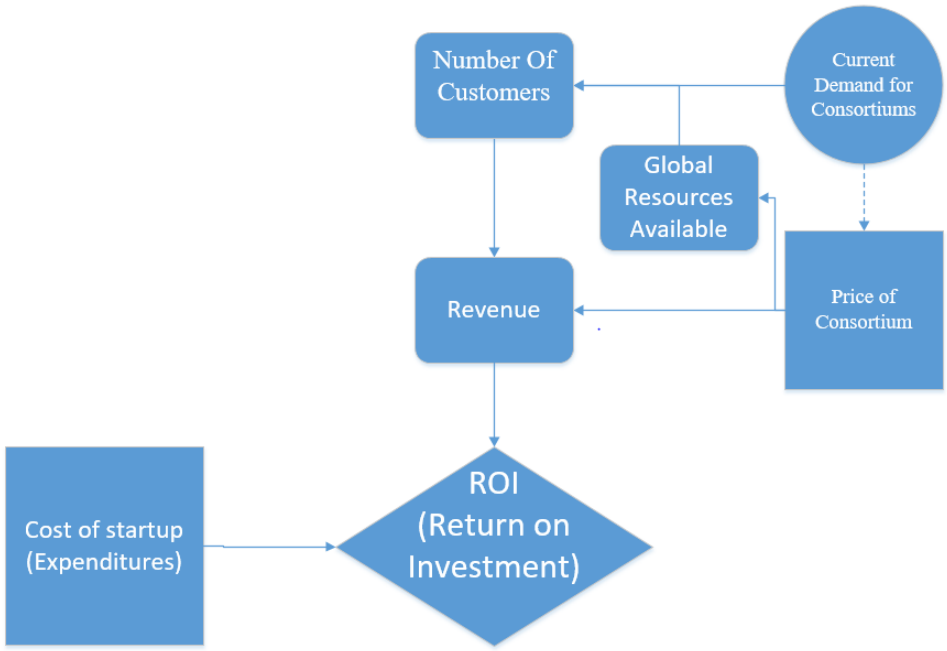
to be unhindered. The PESTEL analysis shows that the most critical part will be any legal and political barriers that can hinder growth in new markets.

## 4.6 Influence Diagram

To gain a clearer understanding of market forces and external variables that would affect the profitability of ICON, we developed a simple influence diagram. In this diagram, we observed that maximizing revenue would require modifying the price for different customers.

The diagram below shows that the number of customers ICON can attract is dependent upon three factors: the current market demand, the amount of resources ICON can offer, and the price of entry. A high entrance price of $15,000 may work well for traditional consortia, but may be too high of a barrier for individuals and small businesses who may be interested. Small entities and groups are required for a successful business, as they will become a part of the global network that ICON wishes to leverage. Successful research projects with these smaller businesses may then help to attract larger organizations who would be willing to pay higher prices, ultimately attracting further customers.

## FIGURE 4: INFLUENCE DIAGRAM




# 4.7 Cash Flow Analysis

An estimated cash flow analysis of ICON was developed based on the values for revenue and expenditure. These values have been extrapolated from both interviews and online research.

**Calculating Revenue**

To calculate revenue, we used the data that we have gathered throughout our interviews. The two largest factors that determine the revenue of any consortia are the number of paying members, and the price to join the consortia. Other elements will also affect the revenue stream, such as from conventions and other event fees that large consortia offer.

From our project sponsor, we learned that the revenue model that is currently planned on being used would rely on the Small Business Innovation Research (SBIR) model for R&D contracts. A typical SBIR contract contains $150K per six months (Phase I) and $750K for two years (Phase II). This would cover overhead and other general and administrative costs, which would be used for supporting ICON's infrastructure and operations. Typical overhead consists of 70% of direct labor, while general and administrative costs cover approximately 20% of total direct costs and overhead, and fees of 8% of total contract costs. Contracts with industrial partners in ICON will follow a similar cost scheme; however, due to its online nature, expenditures will differ.

The revenue will depend on the entry cost. For the first five years, we used $150,000 as the contract price to join. This is because ICON will be a new entity on the market and thus will need to have a price point that is competitive with the current competition. The second factor that will affect the revenue is the number of customers ICON manages to attract. We calculated this by analyzing the data and trends that were seen in the interviews with industry professionals and professors with experience in launching and running consortia (Appendix B). These figures were then applied to ICON - Global Mind. It is important to note that these numbers are highly dependent on the amount of contacts that the consortia personnel have in the industry, as well as the size of their network. Both of the numbers in this forecast can be easily edited to suit ICON's preferences and expectations.

## TABLE 2: REVENUE OVER TIME

| Year | Revenue | Price | # of new Customers |
|---|---|---|---|
| 1 | $ 450,000.00 | $ 150,000 | 3 |
| 2 | $ 600,000.00 | $ 150,000 | 4 |
| 3 | $ 750,000.00 | $ 150,000 | 5 |
| 4 | $1,050,000.00 | $ 150,000 | 7 |
| 5 | $1,500,000.00 | $ 150,000 | 10 |
| 6 | $2,250,000.00 | $ 150,000 | 15 |

This revenue stream only takes into account large organizations who may join ICON - Global Mind. Very small entities, such as individual researchers or groups who join for collaboration, will not be charged. Instead, ICON may choose to take a percentage of profit from any valuable research conducted through the website. Since the probability that such a breakthrough would occur in the first five years is extremely small, it was not included in the calculation. The split in profit from the breakthrough will be decided among the researchers and sponsors themselves, as contract negotiations will need to be flexible to attract a large variety of different research teams and fields.

### Calculating Costs

ICON will attempt to focus its efforts in being a virtual, global platform. Though this will have the potential of greatly increasing the reach of the platform, it will still incur large costs, especially during the startup phase. The costs that were calculated differ from the typical SBIR costs scheme due to the online nature of ICON. To calculate these costs, we have assigned six categories: cost of service, selling cost, administrative cost, financial costs, startup costs, and

research expenses.  All of the categories and their associated costs can be easily edited within the Excel work file to suite the project sponsors preference and expectations.

## TABLE 3: EXPENDITURES

| **Expenditures** | | | | | | |
|---|---|---|---|---|---|---|
| Costs of Service | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Year 6** |
| Selling Costs | $60,000.00 | $90,000.00 | $120,000.00 | $180,000.00 | $240,000.00 | $300,000.00 |
| Administration Costs | $0.00 | $10,000.00 | $10,000.00 | $10,000.00 | $10,000.00 | $10,000.00 |
| **Startup** | $76,500.00 | $76,500.00 | $81,500.00 | $86,500.00 | $86,500.00 | $86,500.00 |
| Research Costs | $ 10,000.00 | | | | | |
| Startup Costs | $ 30,000.00 | | | | | |
| **Total** | **$176,500.00** | **$176,500.00** | **$211,500.00** | **$276,500.00** | **$336,500.00** | **$396,500.00** |

| | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Year 6** |
|---|---|---|---|---|---|---|
| **Cost of service** | **$60,000.00** | **$90,000.00** | **$120,000.00** | **$180,000.00** | **$240,000.00** | **$300,000.00** |
| # Full time employees ($60,000) | 0 | 1 | 2 | 3 | 4 | 5 |
| # Part time ($30,000) | 2 | 1 | 0 | 0 | 0 | 0 |

| | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Year 6** |
|---|---|---|---|---|---|---|
| **Selling Cost** | **$0.00** | **$10,000.00** | **$10,000.00** | **$10,000.00** | **$10,000.00** | **$10,000.00** |
| Advertisement | $0.00 | $10,000.00 | $10,000.00 | $10,000.00 | $10,000.00 | $10,000.00 |

| | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Year 6** |
|---|---|---|---|---|---|---|
| **Administrative Costs** | **$76,500.00** | **$76,500.00** | **$81,500.00** | **$86,500.00** | **$86,500.00** | **$86,500.00** |
| Web Hosting | $1,500.00 | $1,500.00 | $1,500.00 | $1,500.00 | $1,500.00 | $1,500.00 |
| Legal Fees | $70,000.00 | $70,000.00 | $70,000.00 | $70,000.00 | $70,000.00 | $70,000.00 |
| Operation Costs | $5,000.00 | $5,000.00 | $10,000.00 | $15,000.00 | $15,000.00 | $15,000.00 |

**Service Cost**

For our calculations, we are considering the management and upkeep of the ICON - Global Mind website as the service cost. This will require a combination of specialties as the program and system will be proprietary to the company, including information systems and technology (IT) specialists. According to the Cigref report on "Information System roles in Large Companies", there are 33 distinctive roles involved in the creation and management of information systems (Cigref, 2011). This does not indicate that ICON will necessarily require hiring 33 IT specialists immediately upon creation however, IT infrastructure and upkeep will play a crucial role as ICON grows. As mentioned in chapter 2.33, IT will be a necessary part of operating the business. For our five-year projection, only two part-time employees (and no full-time employees) were accounted for in the first three years. These part-time employees would be in charge of the online systems. The average pay of computer system analysts is $65,371 according to Forbes (Forbes, 2017). The equation used is Service Cost= Nf*Wf+ Np*Wp

| | |
|---|---|
| NF | # full time employees |
| WF | Wage of full time employee |
| Np | # of part time employees |
| Wp | Wage of part time employees |

**Selling Cost**

As ICON will be an online entity, the selling costs will focus primarily on advertisement to increase users. The most effective and common method to attract clients is through personal connections and phone calls (Appendix B). Most organizations studied depended on the personal

connections that the founder has acquired throughout his or her professional career. To further assist in contacting new clients, a master list is also commonly used. The master list is a compilation of all possible clients' contact information that exist in the market place. A low initial marketing cost only occurs when the organization already has many previous professional relationships that can be contacted. In order to expand to new markets and promote the consortium (assuming no personal contacts are available), advertisement will eventually become necessary. The five-year projection included only a small advertisement cost as the consortium will focus on building business relationships with known entities for firm's initial years.

**Administration Cost**

The initial administration costs that ICON will incur include overhead and operational costs such as office rent space and web hosting. Of these two main costs, only web hosting and legal fees are essential in the beginning, as today it is possible to run an online company without the need for physical office spaces; however, while this may be possible in the initial stages of the company, it will most likely become untenable as an increase in staff and logistical needs arise.

Due to the sensitive nature of much of the data, and the need for reliable connection, ICON would have limited choices in how to host its website and secure its data. At the very least, it will require a Virtual Private Server (VPS). This will give all the security and flexibility of a dedicated server for only $100 dollars a month, though the limitation of this option is that it cannot handle much internet traffic (VPS Hosting, 2017). For our calculations, we assume that a

VPS server is rented, as dedicated servers cost at least $10,000 to buy, not counting maintenance and dedicated staff (go4hosting, 2018). This purchase would only be required once ICON has a large amount of online traffic. By this stage, it is recommended that computer servers be purchased to increase online speeds and offer further security and data protection. The final administration cost is in the chart is calculated by summing web hosting costs, legal fees, and operational costs.

**Startup Costs**

The startup cost for ICON - Global Mind will mainly consist of software creation. The design and creation of an online application that can handle the various needs of the virtual and global consortium and all of its members will require a third party to develop. The costs of this will vary greatly depending on how quickly and extensively the online infrastructure and user-interface will need to be built, and how many requirements need to be fulfilled.

## TABLE 4: FIVE YEAR INCOME TABLE

| | Depreciation Rate MACRs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| End of Year | $r_t$ | $d_t$ | BV (current Value) | $R_t$ | $E_t$ | $d_t$ | Taxable Income | $T_t$ | BTCF | ATCF |
| **1** | 0.2 | $8,000 | $32,000 | $450,000 | $176,500 | $8,000 | $265,500 | $79,650 | $273,500 | $193,850 |
| **2** | 0.32 | $12,800 | $19,200 | $600,000 | $176,500 | $12,800 | $410,700 | $123,210 | $423,500 | $300,290 |
| **3** | 0.192 | $7,680 | $11,520 | $750,000 | $211,500 | $7,680 | $530,820 | $159,246 | $538,500 | $379,254 |
| **4** | **0.1152** | $4,608 | **$6,912** | $1,050,000 | $276,500 | **$4,608** | **$768,892** | $230,668 | **$773,500** | **$542,832** |
| **5** | 0.1152 | $4,608 | $2,304 | $1,500,000 | $336,500 | $4,608 | $1,158,892 | $347,668 | $1,163,500 | $815,832 |
| **6** | 0.0576 | $2,304 | $0 | $2,250,000 | $396,500 | $2,304 | $1,851,196 | $555,359 | $1,853,500 | $1,298,141 |

| | |
|---|---|
| Basis | $40,000.00 |
| GDS Recovery Period | 5 |

## 4.8 Cluster Analysis

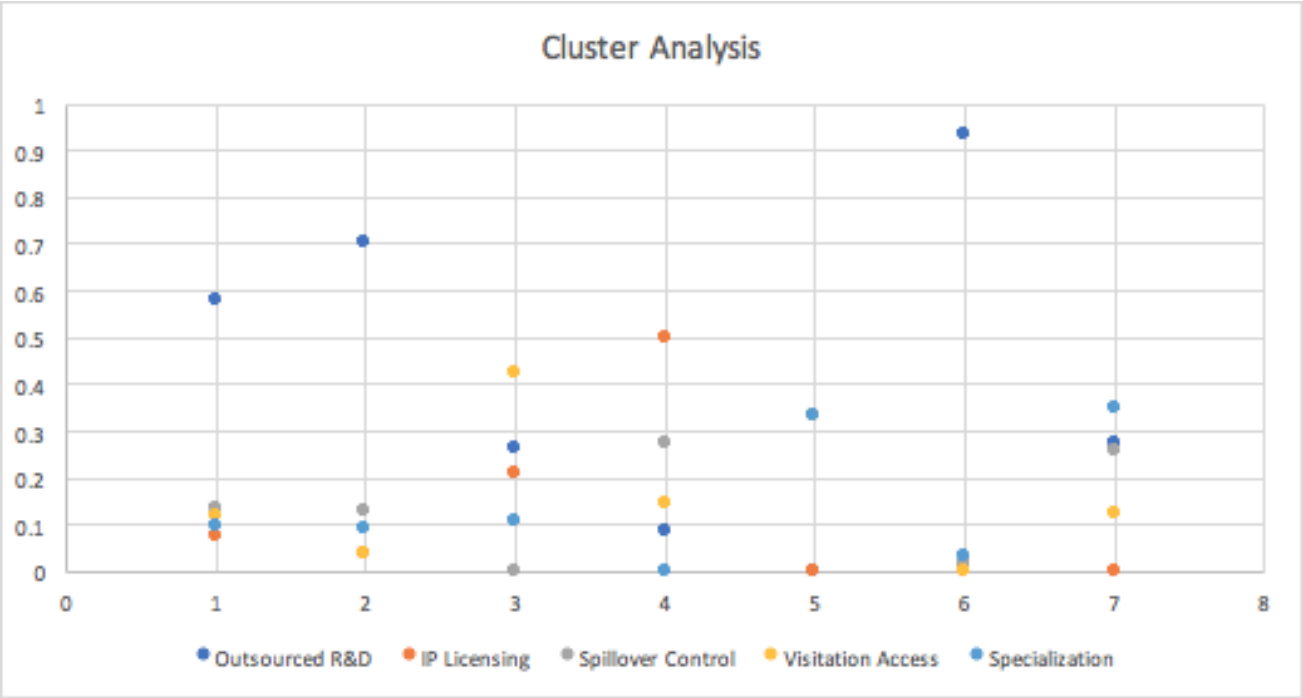
Due to the difficulty of accessing contract-level data from R&D consortia and joint ventures, some of our analysis has focused on surveys of participation motives or examinations of outputs, such as R&D spending and patents. The data gathered came from 128 R&D joint ventures, which can be seen in Figure 6 below. We decided to employ a cluster analysis to find representative types of consortia agreements.

## TABLE 5: R&D JOINT VENTURES

| Group | Outsourced R&D | IP Licensing | Spillover Control | Visitation Access | Specialization | Total |
|---|---|---|---|---|---|---|
| Profit Sharing | 58% | 8% | 13% | 12% | 10% | 52 |
| Cost Split | 71% | 4% | 13% | 4% | 9% | 78 |
| Employee Visitation | 26% | 21% | 0% | 42% | 11% | 19 |
| BIP Licensing | 8% | 50% | 27% | 15% | 0% | 48 |
| Equity Joint Venture | 0% | 0% | 33% | 33% | 33% | 3 |
| Outsourced R&D | 93% | 2% | 2% | 0% | 3% | 60 |
| Other | 27% | 0% | 26% | 12% | 35% | 66 |
| **N** | **56** | **24** | **17** | **8** | **23** | **128** |

The advantage of the cluster analysis is that by using mathematical algorithms for matching observations, the analysis chooses groups according to an objective criterion. To tackle the obstacle of "masking variables" during a cluster analysis, we chose a reduced set of variables that target contract terms contemplated by the industrial organization theory. To examine more horizontal modes of collaboration, we included whether firms split costs evenly, and whether they engage in profit sharing. Lastly, we examined whether the collaboration is structured as an equity joint venture because equity participation is thought to align incentives and reduce the threat of opportunism in the transactions cost economics literature (Williamson, 1985; Oxley, 1997). We recursively added and subtracted members to groups until within-group distances were minimized and between-group distances were maximized, by minimizing the sum of squared errors by variable and by group.

## FIGURE 5: CLUSTER ANALYSIS




The dominant feature of the 'Outsourced R&D' group is that almost half of the ventures, 56 of 128 (43%) outsource the majority, if not all, of their R&D to a third party. Of the mechanism agreements employed in this group, two standout: 98% of firms split costs equally, while 54% of firms profit from innovations. Additionally, the ventures involving process innovation do not share profits. Other results are not as spectacular, with only 9% of outsourcing ventures allowing personnel to revolve between firms and only 9% of outsourcing ventures involving licensing of background intellectual property to firms nor outsourced researchers. This data suggests that consumer goods companies are not the only firms to outsource a portion of their R&D while they continue to work on other or similar aspects of the research.

The ‘IP Licensing’ group is composed of firms that do research for the venture and license background intellectual property rights to their parent companies for the purpose of research, instead of commercialization. As in the ‘Outsourced R&D group, a firm in the ‘IP Licensing’ group is not too likely to allow researchers to rotate between firms (4 out of 24). One interpretation of this cluster is that the background IP licensing facilitates idea exchange and learning. This group, nevertheless, seems to be the vaguest, since it is not clear which ‘common’ mechanism the firms are more likely to follow.

The ‘Spillover Control’ group seems to include, in their contracts, that no firm may license venture-related IP without the approval of all participating firms. Unlike the ‘Outsourced R&D’ group, consortia in this group seem to involve firm R&D (94%). This group also seems to follow the traditional concept of a consortium, where firms establish a separate entity, license their rights to background IP (74%), conduct related R&D, contribute R&D resources, and split costs to share benefits equally (59%). Nevertheless, it is important to point out that profit sharing and equity participation are not as dominant as a traditional consortium would have. As a way of containing spillovers, this group’s mechanisms employ veto power over third party licensing, in which no licensing of consortia technology can occur without the approval of every single member firm involved, and which could be positive or negative depending on various variables.

Employee visitation across firm members is allowed in the ‘Visitation Access’ group. Additionally, almost 90% of the participants involve background IP licensing, and 7 out of 8 involve restrictions on IP licensing without unanimous approval from all firm members. Similar

to the ‘Spillover Control’ group, the ‘Visitation Access’ group is also consistent with attempts to limit spillovers within partners. Interestingly enough, this is the only group from the sample which has 0% outsourced R&D.

Another group with separation and independence to avoid opportunism, hold-up, or spillover is the ‘Specialization’ group. The general pattern of these consortia is that firms conduct R&D (97%), do not share profits or costs (90%), do not exchange personnel or IP (89% and 100%, respectively), and do not restrict licensing of each other’s foreground IP (95%).

From this cluster analysis, there are a number of significant inferences to draw from. The largest proportion of consortia in the analysis conform to mechanisms suggested by models of horizontally related competitors in product markets. Little product differentiation exists in situations where companies outsource their R&D to a third party, or when they have an extreme rivalry, also known as the spillover effect (Katz, 1986). The benefit of collaborative R&D for firms is of cost-sharing and reduced duplication of efforts.

Interestingly, the data shows that firms support learning and technology exchanges, but only 19 out of 128 consortia allowed scientists to revolve across firm facilities. Almost a fifty-fifty division, consortia either involve background IP licensing or employee exchange. Licensing to facilitate rights of way, rather than learning, has been particularly noted in cumulative technology industries such as semiconductors, where firms engage in mass cross-licensing covering entire “fields” of research (Grindley & Teece, 1997).

Additionally, a significant mode of organization is one of specialization. Only 19 out of 128 observations involve member R&D without background IP licensing or restrictions (Katz, 1986). The firms in the ‘Specialization’ group license each other's venture-related innovations on a non-exclusive basis and at the same time retain rights to license their own innovations to third parties. As stated by Connor and Prahalad, the firms that specialize in the study are consistent with the theory that all firms are unique collections of assets, but not with a view that the firms use consortia as opportunities for learning, innovating, and synergizing (Conner & Prahalad, 1996). This comes to the extent that the firms in these consortia are not competitors in research or production, but instead are partners in facilitating each other’s ventures while sharing costs and risks.

## 4.9 Interviews

For part of our research, we conducted twelve interviews. These interviewees had a broad range of experiences with consortia. They included consortium leaders, university professors, and professionals in industries for law and R&D. Despite this wide variety, we were able to find four similarities among the responses to draw several conclusions. All of them have some relevant experiences working with or as part of a consortium.

The first trend we were able to conclude was that consortia tend to group together according to their chosen fields. This is primarily because technical and logistical difficulties that one company faces is likely to be affecting at least one other company as well. The ubiquity of these problems incentivizes the affected fields to tackle the problems for everyone's mutual

benefit. This leads to the second observation: consortia most often only tackle non-critical problems.

The industry issues, which consortia primarily focus on, have two very specific similarities. The first is that they are not to be time-sensitive. The reason time-sensitive research is not conducted is that working in consortia is a slow process, with a high chance of not yielding any useful results. The second is that no proprietary or competitively advantageous research is tackled or shared. The presence of contract and IP laws help ensure that protected information is not stolen; however, the potential losses that can be caused due to the dissemination of competitive research is simply too great. Therefore, any research that holds a very high competitive value is accomplished completely in-house.

Another similarity we found across the board is that professional and personal trust are key components to attracting and keeping clients. Do the nature of the work, all of the research and work being conducted is valuable. Therefore, regardless of the field, the integrity of the consortium and its leaders is paramount. In many of our interviews, we found that the most effective way to acquire this is through leveraging the professional and personal connections that that are acquired throughout one's career. Having previous positive professional experiences will allow customers to trust in the new ventures such as consortia's.

The final similarity that was observed throughout the interview was how differing motives between universities and industry can lead to conflicts of interest. A common topic discussed in the interviews was how universities have a strong desire to publish and research

topics that might advance the field as a whole. They also operate on much slower timeframes as professors and graduate students have several other academic and professional responsibilities besides those of the research projects. Private entities, on the other hand, who may provide the resources, expect the research to be completed as soon as possible to achieve quick return on investments. The problems they face also tend to be unique or highly technical, and not something that would normally be research at universities. This misalignment in objectives has caused several industry-university partnerships to end in recent years.

For our analysis, our team examined our findings based upon the literature review and interviews to help draw conclusions about what ICON should do or consider. This analysis chapter then provides the starting point for our consulting report, and contains in-depth information about the team's thinking process behind our recommendations.

# Chapter 5: Conclusion

## 5.1 Recommendations

Our recommendations are based on our findings in the literature review and interviews. While the consulting report (Appendix A) focuses on only a few concrete points for short and long-term periods, this section lists any additional recommendations that answer several of our questions listed in the introduction. Some of the key success factors for ICON include:

- Differentiation from other consortia using the core competency of a virtual and global network, with open forums for discussion and idea formulation, as well as the creation of a database through appropriate cloud services and IT infrastructure.
- Provide value to R&D companies by emphasizing the ability to utilize a wide range of specialized knowledge and networks, and ultimately saving time and costs for the company (a future MQP group may need to assess more in-depth financials and costs of different types of R&D research). To help qualm fears about IP leakage and trust, we recommend beginning with a hybrid network, where the initial meetings and discussions can be completed in-person, and as relationships strengthen with companies, to move towards a virtual platform for meetings as originally planned. This would be in addition to Non-Disclosure Agreements and other forms of legal contracts. The benefits of a hybrid method are twofold: 1) an in-person meeting will help identify any concerns and nuances from the very beginning that may not be considered otherwise in a virtual or voice-only meeting, and will help establish a sense of trust that will be necessary for a long-term relationship, and 2) while the bulk of the research may be done externally (in universities or other out-of-company laboratories), it may be beneficial for both the company and external researchers to have a company R&D representative(s) or "head" assigned to the research team to not only help guide and ensure the team is making appropriate progress (advisory role), but also

ensure that any IP-sensitive concerns are kept confidential (security role)—to have this smooth integration of a company representative within the team, it will be absolutely necessary to at least meet with the team physically to create cohesion and bonding on a personal level, which virtual barriers often cannot provide. In addition, we encourage hosting networking conferences or events for ICON's partners, as companies seem to value the networking aspect of consortia very much.

- Establish credibility with industry partners by creating a trustworthy, secure website with well-functioning user interface and login user platform. There should also be a page to describe how data security is maintained and what types of security programs are in place, as a breach in data (names and personal information of participants, as well as any confidential company contracts and proprietary material) may lead to litigations and other risks. Each user will need different roles and access permission depending on his or her relationship to the project (researcher, industry contact personnel, board member, etc.). The improvement of the website (and if the need arises, for a mobile app) may be accomplished through an MQP of two to three Computer Science majors. Credibility may also be established after completing the first few projects successfully.
- Amass and develop a master list of personnel who specialize in different fields, allowing for the creation of a database for any potential team structures. It is also

important to note personalities and interests to allow for better matching of teammates. This de-centralized structure would then be able to function online and work independently as well as within a group. If necessary, and if the resources are available, it may be wise to develop or mandate each research personnel to attend brief courses teaching techniques to work with teams virtually (ex. in different time zones, different cultures, etc.).

- We recommend that initial customers be approached primarily through a push method of face-to-face communication, as well as calling or emailing personal contacts and university alumni. Live communication (face-to-face meetings or phone calls) would be best, as potential customers will be able to provide immediate feedback and concerns, which may be resolved quickly (versus back-and-forth emails). While there are many different forms of market outreach, for this type of specialized project where a very costly and IP-heavy service is being provided, a personal connection may be much more effective. While our interviewees voiced several general concerns, it will be necessary to allow these initial customers to provide a voice and feedback for how these projects will be conducted and managed, and may in fact require customization and catering for specific industry partners (for example, depending on their company size, power/influence, financial resources, timeframe, and/or what types of R&D projects are being outsourced). We believe that a “single mold” approach will not

be appropriate for different types of companies and fields with different requirements.

- As a long-term marketing strategy, we believe that a pull method (organic attraction without forced advertising), would eventually be the most effective for ICON. This pull strategy could be done by increasing brand recognition through the creation and use of a logo and/or slogan, as described in chapter 2.12. This will come naturally, as ICON is able to complete its initial projects successfully (and showing that it can complete R&D projects more efficiently than in-house R&D projects, without any detrimental factors).

## 5.2 Challenges

Throughout this project, we have learned about the importance of consortia, and the needs of companies dealing with R&D. As we dealt with many confidential or proprietary data, we frequently faced challenges such as the lack of data or evidence about R&D-related topics, especially regarding specific company challenges or goals. The contract-based information on multilateral consortia agreements have also not been previously available. Consequently, analyses of the questions were mostly explored in the theoretical literature on consortia, rather than an exploration of collaborative R&D mechanisms.

Aside from data collection, our team has also faced challenges in regards to communication and scope creep. Our communication problems seemingly stemmed from the challenge of communicating with the different parties involved, as our team members had to

satisfy the needs of both the respective advisors and client. While we initially faced these internal communication problems, our team improved as the project progressed, through the guidance of our advisors and client, using weekly progress reports and by providing an open-source link for our project for transparency. Scope creep was also an initial challenge, as our project question tackled various aspects of the business, and often seemed to dive too much into one aspect or not enough into others.

For future research, we recommend investigating how an advisory or steering board may be effectively formed through independent research groups and current and retired professionals. Connections through a strong steering board may also help to entice more industry partners to join, and the large number of qualified experts will help lead ICON to success. Any future MQP or other research teams should also determine how a stable IT infrastructure might be established, using cloud services and other online platforms for secure data storage.

# 5.3 Reflections

## 5.31 Project Context

For this project, we designed a comprehensive set of recommendation for a new consortium philosophy centered on global collaboration and low barriers of entry. To accomplish this, we followed methodological engineering design principles and business strategies. The seven phases of the project are written below in order:

1. Identify the customer's needs
2. Define the scope of the project

3. Clarify project deliverables with client
4. Conduct background research and literature review
5. Interview industry, consortia, and other relevant personnel for better context and information
6. Analyze the results and data
7. Report and present recommendations

The first step required in the project was to accurately assess what the wants and needs of the client were. This was accomplished through a few meetings with the sponsor, which better clarified the vision of ICON - Global Mind. With this vision in mind, our group had to narrow the scope of the project into something tangible and deliverable that met the requirements for accreditation by the school. Project deliverables were then written up and sent to both the project advisors and sponsor several times, until a final set was approved of by all parties.

The next phase in the project consisted of research and a comprehensive literature review. This portion of the project took a considerable amount of time to finish as it consisted of a wide range of topics and sub topics. The final report consisted of six main research topics, and seventeen subsections. In order to finish all of this research, the topics were distributed among the three team members and researched individually. Simultaneously, interviews were also conducted to supplement any gaps in knowledge, and to attain answers to questions specific to the MQP. Interviews were conducted throughout the remainder of the project's duration.

The final phase of the project consisted of analyzing all of the research that was conducted. The tools used to analyze the results and come up with recommendations mainly consisted of Industrial Engineering tools. These analyses were split among the team members, and once completed, was combined. From these results, a series of recommendations were derived. The final portion was to summarize these sets of recommendations in a clear and concise consultant report.

## 5.32 Constraints

In the process of designing the final set of recommendations, we identified and took into account a variety of constraints. These constraints were economic, operational, and ethical, and were considered to assess long-term sustainability.

Economic constraints placed upon the design was to present how the business could possibly be operating profitably within the first five years, if not sooner, with a limited number of resources, such as capital, personnel, and time. The way our team worked around this was to leverage two key strengths of the sponsor. The first was his access to university faculty and students for graduate and undergraduate projects. Assigning much of the initial research and development of the website necessary for ICON to students for projects (as we had done) would greatly reduce the majority of the startup costs.

The second constraint that our group encountered was the marketability of the product itself. A consortium, especially a virtual one that relies on the internet for its global reach, will require a very high degree of professional trust to be accepted by any potential clients. The solution to this problem was to initially target a few reputable organizations with which

the ICON - Global Mind founder has worked with in the past. This will allow the branding and reliability of ICON - Global Mind be seen firsthand by those in the market looking for such a service. This leads to the final constraint, the ethical one.

R&D consortia must deal with Intellectual Property. We found through research, analysis, and interviews that companies are skeptical of working with third party entities, as they are inclined to protect one of their most important assets: information and innovation. This is most common with cutting-edge research that may hold enormous value and potential. Therefore, in order for ICON - Global Mind to find success, it will have to either focus on broad, industry-wide problems which have much less value, or implement a highly complex and expensive legal framework that will seek to make enforceable and flexible IP laws.

One potential alternative we determined was to establish an open-source platform, open to the community. By lowering the barriers of entry, and allowing a large community to have a hand in the development and running of applications, many issues could be solved by the community itself (i.e. an online hub for invention and innovation). The most important factor then would be to supply the tools and security necessary for a flexible, safe, and powerful online research collaboration tool to function.

Although this may be a drastic alternative and a stark contrast from ICON's original design, such an open-source platform would also bypass many of the economic, marketability, and IP constraints that the project encountered. The costs of such a platform would be much lower as the coding and structure of the site are built as new needs arise by the community itself. For marketability, a wide scale marketing campaign could target

university students, professors, and researchers. If successful, a strong online community should be able to self-promote the web portal via word-of-mouth. For IP law, it would fall on the community to negotiate their own deals, or ICON may provide some type of paid or free service to draft contracts and agreements, if necessary. This flexibility will ensure that teams can come to an accord on their own terms, and form organically. In this case, ICON's role would be more similar to a "digital witness" and repository for these forums and contracts, and will leave it up to the community to enforce them through the provided platform and other resources. Of course, this alternative would limit the revenue for ICON, as community members would typically only pay a nominal fee, if at all.

## 5.33 Life-Long Learning

### Michael Cevallos

The overall experience of working on this project was positive. Over the course of the entire project, our team encountered a variety of unexpected obstacles; however, with the feedback from our advisors, we were able to confront each of these and forge ahead.

Some things that we could have improved on as a team was the speed and clarity of communication. Though for the most part we kept each other informed and up-to-date, occasionally there would be some miscommunications. This would lead to portions being either delayed or incorrectly done; however, as the project progressed, this occurred with much less frequency as we identified what caused these mistakes, vague instructions, and set out to correct them. For better communication amongst us and our advisors, we made our

final report visible and transparent live time, so that the advisors could be reassured about our progress and continually see our progress to provide feedback.

Learning is a lifelong endeavor. With every new project and experience, it is likely that personal and professional challenges will present themselves, which may be more difficult to navigate through compared to technical problems, as people always have personal agendas and biases that may cause political conflict and tension. Learning to solve and confront these challenges in new ways is necessary to continue a lifelong learning endeavor. This not only means being able to properly conduct research about the most recent studies and findings of relevant professional fields, but also learning to understand interpersonal dynamics, and being able to work in, lead, and manage teams.

Together as a team, we were able confront and overcome challenges and learned several lessons as a result. These challenges and lessons include:

- Balancing the needs of our MQP sponsor's with those of the universities and our advisors', albeit confusing and difficult at times, was possible through constant communication.
- Scope creep and unclear goals: defining the project deliverable and refining the project scope is a key (if not the most important) step.
- Partitioning work among members is crucial, but so is bringing the work cohesively together.
- Having clearly established long-term goals is necessary to keep the project on track, especially when it can be difficult to meet with team members.

The most time-consuming and difficult part of the MQP were the initial phases. Having to reconcile the sponsor's needs with the requirements needed for MQP accreditation within the given time-frame, took our group much longer than we thought would be necessary to solidify a set of project deliverables that satisfy both "customer" requirements. Our group members lacked the experience of working with open-ended assignments, especially for a startup. Unlike the majority of assignments and projects given before, this MQP had open-ended problems, constraints, and deliverables, all of which needed to be identified.
Another difficulty that our group encountered in the first phases of the group was finding meeting times. This caused miscommunication and hindered progress greatly in the first term. As we progressed, not only did we increase the frequency of our meetings, but also learned how to rely on digital tools to communicate ideas and share assignments in a clear and concise manner.

## Marco Castro

The context of the project started as a challenge. We found ourselves working to find whether a potential startup has an attractive business model to succeed. The project itself was not clearly defined, and our research and analysis at the beginning was very broad. Nevertheless, this was one of the main reasons we took on this MQP—the challenge it presented to us. I aim to one day be in the position to analyze, plan, and execute my own business venture. Therefore, after trying to figure out exactly what everyone (students, advisors, and sponsors) wanted to

accomplish, we were able to abbreviate our research, and as a result, complete our models, analyses, and data.

Normally, R&D consortia target a specific field or industry; however, it was a constraint for us to clearly tackle which specific industry or industries ICON was aiming to pursue. Another constraint, being college students with little-to-no industry connections, was to identify and contact industry partners and experts to better identify and analyze the needs, as well as gaps, in R&D joint ventures.

The Major Qualifying Project has taught us many lessons. One is the importance of not only developing our own ideas, but also synthesizing knowledge and designs collected from other researchers, business owners, industry experts, and our advisors and sponsors. We gained many experiences from this project, which will, without a doubt, last for a lifetime. These are the different analytical methods, the different data we handled, different type of people we dealt with, and different goals and milestones we had to face.

Besides the coursework, we also learned how to deliver and present our milestones to our advisors, how to better organize our busy schedules to produce the best MQP possible, and how to interview industry professionals effectively and efficiently. As college seniors, we had the opportunity to face constant challenges that are common when dealing with a potential startup, as it was more than just numbers and analyses. We believed in an idea someone shared with us, and aimed to help organize, manage, and overcome obstacles that we will see in the “real” business world— the place and challenges we will encounter after our graduation.

The learning endeavors will continue. After facing adversity through our years at WPI, we consider ourselves ready to go to the world and learn every single day. As this MQP has taught us, it is in what we do or constantly work towards that matter, and where we can make a difference

## Takayoshi Tsutsui

My overall MQP experience was positive. As my other two partners have described, many of the challenges we faced were quite often interpersonal and non-technical in nature. From communication issues to problems deriving from compromising and fulfilling the needs of multiple parties involved, this project instilled in me the knowledge and confidence of solving some real business problems. Another major challenge was scope creep, as there were so many different analyses, improvements, and challenges that came with thinking about how a startup would function. My intent beginning this project was to learn more about the process and time required to begin a startup business, as my future goal is to establish a company one day as well. While many of our courses focus on aspects of business that are undoubtedly important, this MQP project gave us the opportunity to actually implement and apply the knowledge we gained. I also better understood that many of the challenges real businesses face often stem from political tensions and the ability to cohesively work well with other people, which can be very difficult to navigate around without prior experience and fundamental understandings of such issues. Not every problem can be solved using data, graphs, and other technical analyses as engineers may think about, but requires a delicate balance of both technical and personal

understanding, which is what I believe the Management Engineering major embodies. I intend to continue this learning endeavor by applying my business and engineering knowledge gained at WPI to solve real business problems, as we have done in this MQP. I would ultimately like to keep improving my business skills at a higher-level.

## 5.34 Interdisciplinary Aspect

As an interdisciplinary project, our team utilized knowledge from various Industrial Engineering and Management Engineering fields. Although these two majors have many similarities, the IE portion focused much more on specific data analyses and quantitative perspectives, while the MGE portion often integrated more business applications. Through these two disciplines, our team designed a framework for the business.

We first partitioned the workload into portions that covered each of the team members' areas of expertise. This allowed those sections to be accomplished in a much quicker and more efficient manner. It was also vital in ensuring that the problem was viewed from a variety of different angles and fresh perspectives. When all of the research was compiled, a much more comprehensive framework was drafted than otherwise possible.

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# Appendix A: Consulting Report

The Consulting Report is our final product for the sponsor, and synthesizes our learning outcomes into next steps. The purpose of this section is to provide concrete short and long-term recommendations for our sponsor, and to provide a blueprint for the sustainability of the project. The Consulting Report also provides an analysis for effective use of resources, and a rationale for why ICON needs to move in a certain direction in order to initiate the first steps towards transforming the idea into an actual company.

## A.1 Recommendations

Below are our short-term and long-term recommendations, based on our research and interviews:

Short-term recommendations:

1. Lower startup costs as much as possible, by using university students (future MQPs) to build and design the ICON website, as well as the data and IT infrastructure.
2. Begin contacting a handful of local or SMB professionals with personal and business relationships to negotiate terms of agreement, and simultaneously consult with legal professionals to draft template contract and NDA forms, tailoring them to specific companies.

Long-term recommendations:

1. Target and leverage untapped resources that only ICON can provide These include industry experts, private individuals, professors, small business who currently do not have access to consortiums due to limited resources.
2. Offer flexible and enforceable contracts to let researchers decide their own terms.

## A.2 Reasoning

The largest potential cost that will affect the profitability of ICON - Global Mind in the first five years is the designing and programming of the web portal and relevant online applications. These costs will depend on the number of features, flexibility, depth, and necessary security measures that the system will require.

Revenue of ICON - Global Mind in the first five years will most likely come solely from member dues. Thus, it is important that when ICON begins operating, to have already gauged interest of potential research areas among clientele, and to have listened to any provided feedback. To do this, it is important to begin reaching out to existing personal contacts within the nanotechnology and optics field through phone calls and face-to-face meetings. With this information, it will be possible to have clients already confirmed for the first few research projects. We recommend beginning with small or local companies, and succeeding their research projects. This will bolster ICON’s reputation, and will act as a trial run to improve for major customers afterwards.

Whether an R&D project involves research conducted by members or at the members' facilities, and whether R&D personnel revolve between the firms and the consortium facility generally varies from project to project. In many cases, as presented in the data, the same independent research house will run multiple projects using different mechanisms.

We recommend ICON's business model to maintain its goal of achieving success in the R&D consortium venture. While there may not be a straightforward path for the company to follow, listening to feedback from customers and following some of the recommendations and procedures presented in this report will increase the likelihood of success. Through interviews, analyses, data models, and studies of other consortia, we have acquired short and long-term recommendations for the global network of expertise and facilities. We believe ICON's model and potential resources will make the business attractive to solve many industry R&D problems, but will need to heavily consider IP laws and contracts through professional legal consultation services.

The outsourced R&D mechanism works best when product market rivalry is high because it short circuits the outcome where firms all shirk in equilibrium. Therefore, it would be beneficial for ICON to begin by targeting certain industries, to then targeting specific corporations within those industries. As gathered from the cluster analysis, over 90% of the companies in consortia maintain their core Research & Development in-house. Nevertheless, the interviews and analyses suggest that many of those companies also form third party joint

ventures to benefit from a larger pool of people and resources, when faced with specific needs or overarching problems.

Another aspect that makes ICON unique is the company's aim to only be a partner. As mentioned by some interviewees, universities and other similar consortia partners typically request a percentage of the IP share, as well as the possibility to publish the results, whereas companies normally want to keep such information confidential as an advantage against competitors. Therefore, it is essential for ICON to remain with the idea of collaborating with firms without requesting any share of the IP or the ability to publish it.

## A.3 Alternatives

If the primary recommendations do not present a sufficient return on investment or feasibility, an alternative is to consider an open-source platform for research and development. Instead of dealing with complex contracts, political tensions, and the need to develop highly specialized and ultra-secure web tools and databases, an open-source platform would give customers and partners worldwide, unlimited access of free-flowing knowledge to allow for innovative design and collaboration. Unlike other open-source platforms, ICON could help any definitive and innovative ideas come to fruition, and help facilitate compensation of involved parties, as originally intended. Such a platform would enable immense flexibility for all parties, as there would be minimal legal documents involved until a feasible idea comes to life. If a loyal and dedicated community can be built around this website, then the chances of it succeeding rise greatly. To ensure that a large user base has access, the site should start with a free-to-use model,

with potential later implementation of a monthly low-cost subscription to join. Alternatively, it can be kept completely free to the public, with higher levels of access enabled for premium members who pay. This would work similar to other academic programs that give free limited access and keep any high-level content behind paywalls. With this open-source platform, the target market audience would need to be reevaluated, as companies would not want to openly leak any internal problems. ICON would be able to gain additional revenue through appropriate and relevant in-site advertisements or through a proportion of revenue for any ideas that are indeed developed.

Though this is a drastic alternative, it also solves many of the constraints that the project encountered such as economic, marketability and IP protection. The costs of such a platform would be much lower, as the coding and structure of the site are built as new needs arise by the community itself. For marketability, a wide scale marketing campaign could target university students, professors, and researchers. If successful, a strong online community should be able to self-market the platform through word-of-mouth. For IP laws, it would fall on the community to negotiate their won deals, though ICON would help facilitate and initiate the process. This flexibility will ensure that teams can come to an accord on their own terms. ICON would act as a "digital witness" and repository for a plethora of ideas, and most importantly, allow students, researchers, professionals, and the public to help solve worldwide problems.

# Appendix B: Interviews

In this section, we have compiled transcripts based on our interviews. In order to retain confidentiality, interviewee names and companies have been redacted. Furthermore, most answers have been paraphrased with key points, and are not word-for-word replications of the actual conversation.

## Interview A

Interviewee: Respondent A; Consortium Member/Industry Professional

**Transcript**

**Q: What was the initial reason that you and your company joined [the consortium]?**

**A:** [The company] has been a part of the consortium for the last 50 years. The inception of [the consortium] was through companies such as P&G, who were drivers of innovation, and [the consortium] had different challenges and goals at the time. When [the company] joined [the consortium] it was very different, and mainly consisted of oil, chemical, and automotive companies. These were the drivers of innovations at the time; however, methods of innovation have changed, and [the consortium] has co-evolved along with the industrial environment. Industry has shifted from a corporate R&D model to one with more corporate oversight, focusing on business' core competencies—shift from conglomerates to single focused-businesses. Membership of the consortium 25 years ago was dominated by corporate R&D executives, but now has moved to more business and innovation leaders. [The consortium] offers an opportunity for the more focused business to network with peers, learn from practitioners

from the same and different industries, and improve policies and development opportunities for leaders. They do this through providing research committees, conferences, and teaching seminars. University research-on-research partnerships in the past have been unsuccessful, so now provide this in-house. In the past, there was more resistance from universities to move away from academic subject matter research to industrial research (for-profit). In recent years, universities have become much more comfortable with doing industrial research.

**Q: What benefits did you/the companies gain from being a member?**

**A:** Companies that sustain their membership in [the consortium], understand that they have people engaged with the consortium, and creates a development opportunity for leadership to create a network—forces people to think about generalities around processes, policies, and functions, which can be brought back to the organization. Knowledge and networking are the primary benefits, which can then be brought back to the company with a fresh perspective, and cause change.

·**Q: How far does [the consortium] go in terms of facilitating services—does it go beyond connecting companies with researchers, or does it simply provide a platform for networking? If there is some outcome that stems from networking, does [the consortium] capitalize that in any way?**

**A:** Forums and collaborative platforms help companies themselves, but [the consortium] does not facilitate services. For startups (small industry partners), this might be helpful.

**Q: What are some R&D negotiations, products, and/or services that have risen from its members networking?**

**A:** Company alliances for development of things like hydrogen fuel cells. Company relationships form into product**s.**

**Q: How could [the consortium] improve its value proposition and services?**

**A:** Establish easier networking opportunities (ex. c-suite networking events), make membership easy for better communication between its members, and help companies form relationships out of [the consortium's] core mission—can it go one-step further? Provide the platform to allow people to do what they want to do.

**Q: [The consortium] seems to focus on a variety of fields/industries (of which the companies represent). Does that create any kinds of problems (such as scope creep in providing value, not being able to specialize and having too many different companies, etc.)? Conversely, does having too many similar companies create any unwanted competition or tension?**

**A:** Some companies do not find the consortium too valuable; some technology is too foreign, so companies come and go, which is a problem for [the consortium], which wants to embrace all fields, but is challenging. Another might be IP and not sharing ideas—relationships might help with that**.** If companies were in different industries or had customer-supplier relationship, the consortium was useful, but companies in same industries were difficult to work together with (nothing more than a personal relationship).

**Q: Are you aware of any overarching problems regarding R&D that companies must tackle, and may attempt to solve via consortia or associations (ex. Too much time/money wasted on finding appropriate internal/external researchers, IP issues, etc.)?**

**A:** [The consortium] was a host of open innovation. There has been a trend going forward of open collaboration (contracting), and managing that (distributing innovation). [The consortium] may be thinking about virtual networking.

**Q: Does [the consortium] partner with any universities that specifically provide their laboratories/research? If not, do you see any potential benefits or pitfalls for companies to have connections with university research teams versus federal laboratories?**

**A:** Depends on the effort. [Previous university partnerships] had ideas for research topics, but needed information. High-level research for universities vs. companies wanting personal gain/profit. Partnership between universities and industry work best when a university is already researching and consistently producing information that industries might require. This gives the company confidence that any investments made in a partnership has a good chance of producing industrially applicable results going forward. It is rare for a company however, to partner with a university and begin a research program because results beneficial to the company are not assured. Another possible problem that arises when working with universities is that the time frame and focus between the academics and private industry rarely align. Political aspects, and philosophies and goals of companies and universities must align.

**Q: As a non-profit, how does [the consortium] gain revenue to sustain itself?**

**A:** Membership fees, conferences, special events and training courses make [the consortium] profitable/sustainable. The largest revenue source is the membership fees. The Corporate Executive Board works on material and output, which are used for many of the conferences and events.

**Q: What is the biggest problem [the consortium] faces in terms of organizational structure and mission?**

**A:** One problem of consortia is that [companies in] similar industries might clash due to legal/competitive issues. [The consortium] provides a relationship for companies to connect, but success hinges on companies' relationships themselves. [The consortium] focuses on ethics (ex. Big Data)—a core competency that makes it different from other consortia.

**Q: Because [the consortium] is now a mature association with a long history, companies may come to request membership; however, are there specific types of members that [the consortium] looks for (that adds value), and how does it reach out to these potential members?**

**A:** Medium to large R&D organizations are the target of [the consortium]. Universities, small companies, and federal research labs are admitted under more scrutiny. Federal labs have only been allowed since the past decade.

**Q: Is there a reason [the consortium] may reject a membership application (what is the "bar/standard")?**

**A:** Larger companies [are preferred], not universities or smaller companies. Partnership with universities did not work out because there was resistance from universities to move away from core academic subject matter research for industrial. Now universities are more comfortable.

# Interview B

Interviewee: Respondent B; Consortium Member/Industry Professional

**Transcript**

**Q: How can [the consortium] improve its value proposition and services?**

**A:** There needs to be a better ROI, given the short-term focus of companies. Would I say that [the consortium] has been able to "connect the dots" in there that I would hope to? I would say no. [The consortium] is a roundtable, so we have no real influence over policy. [The consortium] needs to 1) define its value proposition, and 2) understand what the partnership between industry, university, and government going to look like?

**Q: What benefits do companies and universities expect to gain from being a member?**

**A:** Relationships.

**Q: How does [the consortium] gain revenue to sustain itself?**

**A:** There are three sources of revenue: 1) membership fees from industry-university [partnerships] are $30,000 per partner, 2) federal government funding, and 3) the academies.

**Q: What would you say is [the consortium's] core competency/competitive advantage?**

**A:** 1) One of the only places I know that connects all of those three segments [university, industry, and government], 2) it's attached to one of the most prestigious and well-respected scientific groups of thinking (access to brilliant group of people), and 3) the OPM side (networking). Needs a broader relationship, addressing the needs described in Maslow's hierarchy.

**Q: Other experiences [No specific question asked]**

**A:** I was a board member of [redacted], an online resource which offered patents and intellectual property. The goal was to make them easily accessible and inexpensive, with the ultimate goal of creating a network. Unfortunately, the program was, "a catastrophic failure" due to universities disputing over who should have access to the rights. The program was sold and relocated [elsewhere]. Only a few university systems stayed on, and the organization switched to a more local-focused business in order to be sustainable.

**Q: You have extensive experience working with universities, industry, and government. What are some of the challenges and benefits that you have seen occur?**

**A:** Universities still thought that the .com bubble had value, even several years after the bubble had burst. This showed how out of touch many academics had been in comparison to private enterprises. The relationship between government and universities however, is much smoother, in part due to the Bayh-Dole Act. Because of this, it is much easier now for universities and federally sponsored research to occur, since universities have much more to gain from a partnership.

**Q: Are there any other challenges that you see occur between companies and universities?**

**A:** Well, the best research universities like Cal-Tech are not in any real need of private funding due to the already large federal funding they receive. This is $300 million for approximately 300 faculty. When I was there as a representative, they didn't want to have to bother with companies because it would mean having to deal with more deadlines, IP negotiations, and extraneous work, for funding that wasn't even needed. Another challenge is that companies do not want to

make an investment in universities unless they are assured of a ROI, which cannot be guaranteed unless the project is already well underway.

**Q: How successful has federal funding been?**

**A:** Only $55 billion out of the $64 billion is put into the scientific community, and the scientific community has not prioritized commercializing the research. This is why I call OPM—"other peoples' money"—what drives much of the research.

**Q: What would you say is one of the greatest benefits of [the consortium] having attended as both a leader of the conference, and a university representative?**

**A:** It is an "enormous opportunity to connect with the people who fund all the federal research". The current federal funding for R&D at universities is $64 billion annually. By attending these meetings, it allows connections to be made by all parties, and allows the organization to see where the money is going.

**Q: What have been some challenges that [the consortium] has attempted to overcome in the past?**

**A:** I was one of the 30 subject matter experts for the White House Lab to Market Conference, to help programs that are pressured to put research out of the universities and out into the marketplace. It has not gone very well because universities are not good at doing that, even worse than private research, which has a tough time already. Patents are difficult to make viable, and universities have a different mindset—they aren't interested in product outcome.

**Q: What do you think is the biggest stumbling block in the relationship between the "Triple Helix" Federal, Private, and University research?**

**A:** The most important connect point is the university, but unfortunately, universities are not geared to work with either [government or industry]. None of the people at universities who want to go to the marketplace know what that means, and are inept at business management. A successful example is I-Corps, an organization that has been setup at Stanford to help those in academic setting become familiar with the marketplace and see the feasibility and applicability of their research in the market.

**Q: Has the relationship between private business and [the consortium] changed recently?**

**A:** Many private enterprises have dropped long-standing relationships with universities because of "Corporate Short-Termism". Businesses cannot look at an ROI that is beyond three months, which is much longer than most research enterprises.

# Interview C

Interviewee: Respondent C; Open-Source Consulting Group/Network

**Transcript**

**Q: How do you understand and implement IP dynamics and critical factors for success?**

**A:** Normally, we have a common procedure we follow to guarantee success for us and our clients. The companies that come to our office for our services generally want to license technology they already developed. If they haven't, they submit a patent application. After this, they share non-confidential information and sign non-disclosure agreements with the other participant party. There is always limited risk with the last part of the process however, it mainly goes well for both parts.

**Q: How does [the company] gain value to sustain itself?**

**A:** For the first time, technology transfer is becoming a key part of business across the globe, driven by a combination of forces that have spurred activity from both buyers and sellers of technology. Therefore, Yet2 has many forms to sustain itself.

**Q: What competitive advantage does [the company] have over alternatives?**

**A:** The process of searching for and buying technologies is time-consuming and inefficient. Companies devote substantial resources to R&D however, innovations, sometimes, are commercially underutilized. That's when [the company] comes into play, by providing companies with a highly qualified audience of prospective buyers as well as access to never-before-seen research from world's leading technology companies.

**Q: Does [the company], or other IP and out licensing institutions, partner with universities?**

**A:** The most common client for [the company], or a similar company, would be large institutions. Therefore, we work with universities, but we do not represent universities. Higher Education Institutions are sort of in a different kind of 'business'.

**Q: Is there a gap in IP, R&D, and/or out licensing for which [the company] addresses that gap in a way that is superior to alternatives?**

**A:** Tech-licensing is a corporate overhead function. This means that the majority of the companies run with tight margins within their internal functions. Therefore, our de-risking mechanism, additional non-confidential information and innovative services help clients monetarize their technology.

**Q: What assumptions underlie the ICON concept? Are they realistic or problematic?**

**A:** A little of both. It sounds problematic because, in theory, other companies provide similar services as the one ICON would potentially provide. Additionally, keeping track of an updated database can be challenging without forgetting it can be costly.

Via another perspective, it can be realistic due to the potential market target perspective. Many companies don't have the internal resources or time to access information that is so fragmented and disperse.

# Interview D

Interviewee: Respondent D; Consortium

**Transcript**

**Q. Why do companies consider participating in [the consortium]?**

**A.** Networking. This and the search for innovation are the main reasons why companies participate.

**Q. What gaps in R&D activities/processes does [the consortium] help fill that others cannot? What value do members derive?**

**A.** There's no single answer to that question. It is based mainly on which specific need the company has. The gaps within R&D are sometimes big and other times just minor difficulties.

**Q. How far does [the consortium] go in terms of facilitating services? If there is some outcome that stems from networking, does [the consortium] capitalize that in any way?**

**A.** Three areas: organizational, strategic, and operational. We provide value to each of those areas, and it depends where the corporation needs the value to be added to.

**Q: How could [the consortium] improve its value proposition and services for its members?**

**A.** By creating the most value possible for our partners and transforming ideas into actual innovation.

**Q: [The consortium] seems to focus on a variety of fields/industries (of which the companies represent). Does that create any kinds of problems?**

**A.** Counterfeiting. Some companies have resources other can't have. Having too many similar companies also creates unwanted competition, but with a higher-level focus. For example, the financial industry.

**Q: Are you aware of any overarching problems regarding R&D that companies must tackle, and may attempt to solve via consortia?**

**A:** Managing time horizons and portfolio.

**Q: Does [the consortium] partner with any universities that specifically provide their laboratories/research? If not, do you see any potential benefits or pitfalls for companies to have connections with university research teams versus federal laboratories?**

**A:** All of our members partner up with universities. The technical research, as well as the laboratories, are specifically provided to them from universities the majority of the cases.

**Q: As a non-profit, how does [the consortium] gain revenue to sustain itself?**

**A:** The main resource is membership fees; however, there is also support by gaining monetary value through journals and events.

**Q: What is the biggest problem [the consortium] faces in terms of organizational structure and mission?**

**A:** Like in any industry, associations want to see improvements from, for example, machine learning and innovative technology.

**Q: Because [the consortium] is now a mature association with a long history, companies may come to request membership; however, are there specific types of members that [the**

**consortium] looks for (that add value), and how does it reach out to these potential members?**

**A:** The question would honestly be how we can innovative better. This is because we are open to bringing any corporation in as long as they have parallel goals to our corporation.

**Q: Is there a reason [the consortium] may reject a membership application?**

**A:** No.

**Q: Do you see any R&D trends (in the next five to ten years)? Do companies like to outsource R&D or prefer in-house?**

**A:** Outsource/external nowadays.

**Q: Do you see any benefit in virtual networks/consortia?**

**A:** Yes, it is an industry with constant exponential growth.

# Interview E

Interviewee: Respondent E; Consortium

**Transcript**

**Q: What are the top three reasons that urge companies to join [the consortium]**?

**A:** The main reason is process improvement. Next would be looking for new products, and the third is to see if it can be done in a more environmentally and economically friendly process. These are the technical reasons, but networking and access to the talent pool are other big reasons as well.

**Q: How could [the consortium] improve its value proposition and services?**

**A:** We get feedback from companies, mainly to make more commercially ready and applicable products, techniques, and processes. Our proposition then is not just to research new metal processing techniques, but also to make them economically valuable.

**Q: Does having competing member companies in a similar field create any unwanted competition or tension?**

**A:** There are three centers currently, and we see that two of them are more open and cooperative with each other. This is because the research for those two centers is more focused on particular topics that many companies have similar issues with (metal casting and heat-treating); however, the third one is a recycling research center. The needs that the partners have differ greatly due to the great variety of recyclable electronic material, and so they don't see as much reason to work together. Electronics waste is a large problem because of the great variety of electronic waste that lead companies to have different needs, and their own proprietary, competitive research.

Companies will not bring these proprietary problems and ideas in the first place, and if there are any problems, the companies will let us know if we are getting too close to such research.

**Q: Where is line between pre-competitive research, and where it becomes competitive?**

**A:** We focus on problems that three to four companies have. If these are specific enough and do not encroach on any sensitive information, then it would be pre-competitive research. If something is competitive, companies will let us know and they can back out of the center. If at least two companies have similar problems, they can have their own center. The customers define the problems and have control of the process.

**Q: Are you aware of any overarching problems regarding R&D that companies must tackle, and may attempt to solve via consortia or associations such as [the consortium]?**

**A:** Electronics waste is a large problem because the great variety of electronic waste will lead companies to have different needs, and their own competitive research. This is an overarching problem that is currently being tackled by several different consortia.

Another is aluminum. The auto industry is starting to use aluminum more and more in their manufacturing of cars, along with the aerospace industry. This great need has had companies seeking to partner and solve many of the same problems that they all face.

**Q: Would you say that R&D is shifting towards consortia or still conducted in-house?**

**A:** Majority of the work is still done in-house. The consortia are for more general problems that do not require immediate answers, such as developing casting techniques that can be used in automotive manufacturing.

**Q: How concerned are companies with IP?**

**A:** We have not faced it. The three centers have developed 20 patents, of which [the university] has the provincial right to patent, along with the partnering company. All bylaws and patent rights are agreed to before joining. Approximately half of the patents are used in industry.

**Q: Are there other ways [the consortium] gains revenue to sustain itself, besides grants?**

**A:** Membership cost is approximately $20,000-$40,000 per partner. In addition to this, there are several federal projects that add up to $2 million dollars. The total revenue is approximately $3.5 million dollars.

**Q: Is there a desire to shift away from federal grants to more private investments?**

**A:** No, because first of all, the money is big, and the time allowed to do the work is sufficient, as opposed to private investments. Unlike federal money which is fairly stable, private investment depends entirely on the economic outlook. When companies need to cut budgets, research is usually the first thing to go.

**Q: How often do companies sponsor their own projects?**

**A:** Not that many—currently only one project, which has many different project centers across the country.

**Q**: **What is the biggest problem [the consortium] faces in terms of organizational structure and mission?**

**A:** We have to listen much more than we talk to our members. We do this by making sure to have focus meetings with our members so that we can get feedback on upcoming possible research centers. These meeting ensure that the members have complete control to talk with each

other and [the consortium]. Another problem is retention. Many companies will leave once they have completed their research center project.

**Q: Are there specific types of members that [the consortium] looks for (that adds value), and how does it reach out to these potential members?**

**A:** Most of the members are known already due to experience in the industry. If there is a vacancy, we use a master list to call possible partners. It is normal for previous members to join again after having left the organization for a couple of years.

**Q: How did [the consortium] attain its first customers?**

**A:** [Redacted] started the [the consortium]. His field was in casting and is known in the casting industry, so leveraged his contacts to tackle known general problems that faced the industry. Since then, two new centers have been opened with a professor who already had experience in the field. Even now, most growth is through personal connections. Phone calls to personal contacts work best.

**Q: Is there a reason that [the consortium] might reject an application?**

**A:** [The consortium] has decided to not make tiered membership levels, as it creates management problems. Small companies typically are unable to join because of the fee. Another is for associations so that patents cannot be shared among large organizations by paying only one fee. We also listen to members if they are hesitant of bringing specific members on (which can create a conflict of interest).

**Q: How do you see [the consortium] growing within the next 10-20 years?**

**A:** 25-30% growth. The challenge will be about keeping the growth stable.

**Q: Does [the consortium] see itself as more of a coordinator between university and industry research, or more of a place for research?**

**A:** It is both, more as a place for research, but it also acts as a coordinator.

**Q: How many members is the steering board made up of, and to what extent do their decisions have an impact on the operations?**

**A:** Six to eight members (industry member representatives) who rotate every two years. They select the projects, and vote in internal meetings.

# Interview F

Interviewee: Respondent F; Research Center/Industry Professional

**Transcript**

**Q: What are the top three reasons that urge companies to join the center? How could you improve its value proposition and services?**

**A:** This center is a very low-cost and low-risk option for companies looking to solve very specific industry problems. Many of the companies that join are local, and do not have the resources or manpower to dedicate much time to these problems. Currently it is doing very well, with about half of the companies finding some sort of whole or partial solution.

**Q: Does having competing member companies in a similar field create any unwanted competition or tension?**

**A:** This is not seen here, as the companies that come to us already have a very specific problem in mind that uniquely affects their process or product. The chance the proposed solution can help another company is low.

**Q: Are you aware of any overarching problems regarding R&D that companies must tackle, and may attempt to solve via consortia or similar associations?**

**A:** This research center does not face many of the same issues that other consortia have. This is primarily because it services primarily local companies, and offers to do research directly with the customer, as opposed to joining up several different companies to tackle one problem. This allows for the center to avoid many problems and issues. One overarching problem though, is that small to midsize companies do not have the resources to solve highly technical problems.

**Q: Are there other ways the center gains revenue to sustain itself, besides grants?**

**A:** The research center is funded by state programs with the primary goal being to assist local businesses in research. The goal is not to be profitable, but to offer low-cost research for businesses in the state of Massachusetts.

**Q: What is the biggest problem [the research center] faces in terms of organizational structure and mission?**

**A:** Currently it is just the founder doing most of the work required to facilitate the running of the program. It needs more faculty involved in logistical and leadership roles to help continue the program.

**Q: Are there specific types of companies that [the research center] looks for, and how does it reach out to them?**

**A:** The program looks for applicants that have problems that can be feasibly solved with the resources and time that the students and faculty have at their disposal.

**Q: Does [the research center] see itself as more of a coordinator between university and industry research, or more of a place for research?**

**A:** [The research center] is solely a place for research.

**Q: Is it a part of your mission to specifically employ students, instead of already experienced professionals? Why so?**

**A:** This is an opportunity for many students to work on real industry problems. This is done through the state funded program to give companies low cost research alternatives. Experienced professionals would be too expensive.

**Q: Do you see value in potentially having a virtual network to connect universities with industries?**

**A:** Yes. This could be very helpful in facilitating communication across a wide spectrum of resources and consumers.

# Interview G

Interviewee: Respondent G; Consortium

**Transcript**

**Q: What are the top three reasons that urge companies to join [the consortium]?**

**A:** There are several reasons. One is that it is economically very beneficial. The money they pay has a significant amount of return. Every company pays $50,000 for membership, but enables them to see eight to nine projects at any given time, and not just their projects. In terms of indirect cost, normally universities would charge 57% for overhead, but for us, the NSF requires only 10%, so it is very cost-effective. The main thing is that they also have access to 20 faculty for any technical information. Finally, the students that graduate and conduct work in this center are very relevant to these companies, so they would be hiring people that have already been trained.

**Q: How many projects is [the consortium] currently running?**

**A:** We have eight projects currently, plus one small exploratory project running. Every company has access to all projects here (share, see the results, etc.); however, they may be only interested in three of them, so then they become monitoring representatives for those projects (get engaged and give input). A given project has two to three monitoring companies.

**Q: Do you see ways [the consortium] can improve its value proposition and services?**

**A:** Yes. Funding is very important. We have plans to increase funding for [the consortium] for almost one order of magnitude, getting us to over $5 million per year. That will enable us to do a lot more for the companies and increase our company numbers to 20-30. The projects will also

be more prototyping projects as well, such as transfer of technology, which can be developed and evaluated here by the companies.

**Q: Does having competing member companies in a similar field create any unwanted competition or tension?**

**A:** In the beginning. Every company wants to be a member, and they feel hesitant saying "hey, so and so is there too", and they don't feel comfortable in the beginning. Once they join, they actually see that it brings them back by having competition there as well. Because the research we do is pre-competitive (open to everyone and not unique for one member). If they have confidential projects, they have to have a different agreement to do that on the side, that remains confidential for them. This would be under [the consortium], but not under the membership, and they would have to pay extra for these confidential projects.

**Q: Are you aware of any overarching problems regarding R&D that companies must tackle, and may attempt to solve via [the consortium]?**

**A:** Yes, drying is a very critical stage of their process, so being able to use new technologies would mean cheaper operations, better products, and being more energy efficient (sustainable).

**Q: Are there other ways [the consortium] gains revenue to sustain itself, besides grants and membership fees?**

**A:** We are too new for any additional revenue, but we are filing one patent right now, and hope that will bring in additional fees. Patent revenue are split 50/50 between the university and inventor.

**Q: Do you prefer grants or private investments—which is typically easier to work with in terms of revenue source?**

**A:** Money coming from industry is very demanding, and they want you to be available for them with short notice. With grants, this doesn't happen. But, there is a great deal of value for students to work on industry-supported funds, because they learn what goes on in industry (timetables to adhere, deadlines for deliverables, etc.), and it prepares them for a real job. Funding from industry sometimes gets overwhelming, since students have other things to do, so the conflict of the students and business needs can be sometimes problematic.

**Q: Does [the consortium] face any problems in terms of organizational structure and mission?**

**A:** The turnaround time for money to be distributed for projects can be improved, but overall is doing well. We need to bring in more member companies to become much more stable. Within the next five years, we need to have over 20 companies. Our goal from the beginning to reach 25 companies.

**Q: Are there specific types of members that [the consortium] looks for, and similarly, is there a reason [the consortium] may reject a membership application?**

**A:** So far, we haven't had any problems of that kind. As long as they're paying their membership fee and following the center agreement form, they have the right to be members.

**Q: Does [the consortium] see itself as more of a coordinator between university and industry research, or more of a place for research?**

**A:** It's officially an industry university cooperation research center, so we consider ourselves to be more of a place for research.

**Q: Is it a part of [the consortium] mission to specifically employ students, instead of already experienced professionals? Why so?**

**A:** Yes. They're part of the next generation workforce, so that is definitely one of the outcomes we look for.

**Q: How many members is the steering board made up of, and to what extent do their decisions have an impact on the operations?**

**A:** The center has an industry advisory board, so every company has one person sitting on that board, who vote to select the projects, presented by [the consortium]. Then, they volunteer to be monitors for select projects.

# Interview H

Interviewee: Respondent H, Industry Professional

**Transcript**

**Q: What are some key pitfalls, or things to keep in mind that you regret, or wish you knew about early on?**

**A:** In terms of patent pooling, at least for startups, having more collaborative leadership will help with mutual benefit through personal relationships. Aspects or divisions of the company might compete with others, but other functions can collaborate, though this innovation may be dependent on specific industries as well. General Counsel for IP and data usage will be important. Consider whether to attract a few companies with a stronger pull, or more companies with a little less pull. In terms of success factors, understand the stakeholders' perception of their association with the company and think about how close of a connection you want with the stakeholders.

**Q: In its first-mid stages, what were some of [the company's] critical methods of reaching new customers?**

**A:** Relationships and networking with successful companies. The bigger they got, the bigger we got. Find and partner with transformational customers—the bigger the customer, the less the website mattered; however, the website is a requirement and proportionally good for smaller customers. In terms of design and user interface, our design and color scheme helped to stand out from competitors.

**Q: How did you achieve financial sustainability in the early stages of the business?**

**A:** For the first eleven years, all of our revenue was purely from customers (no grants, investments, etc.).

**Q: What were some of the biggest problems [the company] faced in terms of organizational structure and mission?**

**A:** Changing from a consumer-based to enterprise-based company. As the company grows, the market changes quite a bit.

**Q: As primarily a business in the virtual world, how did you deal with cybersecurity? Did you hire a third party to take care of that?**

**A:** We used external personnel to help augment what we did, but we mostly did this ourselves. Security consists of integrity and availability of the data, as well as making sure the data doesn't get stolen. I think most people now are comfortable with cloud technologies. Security means a lot of different things, and it becomes more about how well the standard operating procedure is. You need to compartmentalize data (properly label), and make sure appropriate people are in charge, and make this transparent. Consider five levels of data: confidential, public, sensitive information, need-to-know basis, and information that we don't have (ex. credit card information to keep anonymized). Understand information security policies.

**Q: Besides technical skills, what were some key characteristics that you looked for in initial employees?**

**A:** Being able to do stuff. It sounds like an easy thing to train or screen for, but to see, we did projects with them ahead of time to get a feel. Be more specific about what you're asking for, communicate clear objectives for them.

**Q: Besides executives, do you/did you have a steering board, or was that something you considered at any point?**

**A:** We did. Five years after we were formed, we had a technical advisory board of four people. Eleven years in, we had a real advisory board for good corporate hygiene.

**Q: To what extent did their decisions have an impact on the operations?**

**A:** Indirect assistance for leadership, but not what makes the company great.

# Interview I

Interviewee: Respondent I, Industry Professional

**Transcript**

**Q: What does your company do?**

**A:** We aim to leverage innovation and intellectual property to leverage pioneering products to treat skin, hair, and mucous membrane disorders. We believe we bring a novel approach to products in aesthetic and medical dermatology.

**Q: Based on all the research that is done in-house in your company, would you ever consider joining a consortium?**

**A:** The company invests time and resources into Research & Development to offer the best product possible to our clients. Therefore, the opportunity of joining a consortium could be relevant to achieving our industry goals. Nevertheless, we would prefer to have most of our R&D in-house.

**Q: What are some of the weaknesses you encounter when dealing with R&D?**

**A:** Research and Development has several weaknesses; however, it is a great way to bust innovation in an organization. The main issue I have encountered with R&D is not being able to translate great information directly into an innovative product or idea.

**Q: Is there a gap in IP, R&D, and/or out-licensing for which [the company] addresses that gap in a way that is superior to alternatives?**

**A:** Running with tight margins within internal functions, any mechanism that makes it more efficient and effective to protect IP and out-licensing is of value to us; however, in-house, we already have an efficient mechanism service that helps us monetarize our technologies.

# Interview J

Interviewee: Respondent J; Industry Professional

**Transcript**

**Q: Has [the company] outsourced or shared R&D before? With what types of partners**

**A:** The company has worked within consortia, specifically with universities like Massachusetts Institute of Technology; however, the company values its Intellectual Property so much that the Research & Development rarely outsourced the most valuable technology and innovations.

**Q: What aspects has your company enjoyed or disliked about a shared endeavor?**

**A:** Being part of a consortium has benefits as an added competitive edge, and access to new markets. In addition, a consortia open the door to intellectual capital from outside, as well as potentially obtaining innovative resources from a larger pool of people. Nevertheless, consortia have disadvantages, too. For example, working with universities, it is common to encounter the problem that universities expect companies to fund the R&D; however, from this R&D, universities expect to publish the results and have an IP share, whereas we want to use it as a competitive advantage towards our competitors, since we were the ones that paid for the R&D.

**Q: What are some of the concerns you have about outsourcing R&D, especially in terms of photonics, and optoelectronic nanomaterials?**

**A:** The company develops and studies nanotechnology. A large portion of our R&D investment is in nanotechnology. We have encountered a problem when dealing with R&D from outside the company because of the disparity in companies over the percentage of owner of this R&D.

**Q: Can you share any specific problems or concerns in the company's in-house R&D?**

**A:** The core R&D, the core Intellectual Property, the core research—all of this would remain in-house because of our successful infrastructure; however, minor aspects or a very specific industry or subject is something we are open to, in terms of using 3rd parties.

# Interview K

Interviewee: Respondent K; Lawyer/Previous Industry Professional

**Transcript**

**Q: What types of potential problems would industries in R&D attempt to solve via partnerships, consortia, etc.?**

**A:** Product-type products. The timeframe for these projects vary.

**Q: What are some specific needs and possible concerns that may arise?**

**A:** IP, copyrights, trademarks, patents. You would need a contract to decide who does what, who is going contribute what kinds of dollars, etc. If [universities] don't perform, the industry partners will quickly "pull the plug". Generally, industry solves their own problems, but universities don't necessarily push it.

**Q: How much would they pay to solve these problems within a reasonable timeframe?**

**A:** Consulting firms would know best, because there are many variables depending on the project.

**Q: What might be some critical factors to consider when approaching companies about partnering for R&D?**

**A:** You're going to need something that a consulting firm can't do—"why should we hire you?"

**Q: Did you see a trend of R&D moving from in-house to being occasionally outsourced?**

**A:** Everything was done in-house. We never outsourced.

**Q: What would you say were some of the key factors for success in R&D?**

**A:** You need to know what your objective is, which can also be a problem with a lot of R&D, since they can lose opportunities due to a myopic vision/scope.

**Q: Is there anything you could tell us about any potential problems from a law perspective that may need to be addressed early?**

**A:** International laws and security for R&D and patents, especially as a virtual business.

# Interview L

Interviewee: Respondent L; Industry Professional

**Transcript**

**Q: Has [the company] outsourced or shared R&D before, and if so, what aspects did the company enjoy or dislike about a shared endeavor? Whom did you outsource to (consortia, universities, third party researchers, etc.)?**

**A:** Have never outsourced R&D before. Instead, [the company] acquires companies all over the world that have some kinds of R&D research, so that everything is done in-house, with vertical integration.

**Q: What types of values might encourage outsourcing R&D through partnerships?**

**A:** Hard to tell. The company is so strongly against outsourcing, especially due to IP aspects. The know-hows and trade secrets leak. Differing state (and international) laws make it difficult to enforce IP laws. Even enforcing would be costly, with court fees, lawyers, etc.

**Q: What are some problems in-house R&D is causing for your company—what are you unable to achieve due to specific types of problems?**

**A:** I personally don't know of any. In general, I would have to say that because of the things we do that nobody else does, the company solves R&D problems one way or another, even if it costs some time. It would not be worth, even with lower costs, to outsource. If anything, it would only be small, minor (non-essential) components or something that is not too IP-heavy, to be outsourced.

# Appendix C: Project Resources

## Client Agreement

### ICON GM MQP Meeting

Attendees: Professor Sergei Krivoshlykov, Professor Frank Hoy, Marco Castro, Michael Cevallos, and Taka Tsutsui
September 12, 2017

### ICON Vision:

Based on our discussion on Tuesday, 9/12/17, we understood the vision for the International Consortium for Outsourcing and Networking - Global Mind (ICON GM) to be the following:

• A for-profit, virtual company that would connect world-wide industrial customers and investors (various companies, big and small) with researchers at universities, research institutions, and other R&D facilities via a global network and Web portal.

• The main purpose would be to help the industrial customers anticipate and develop future emerging technologies, while bypassing political agendas (expensive, time-consuming processes dealing with governments, grants, etc.). Intellectual Property would ideally be protected through Non-Disclosure Agreements and legal Partnership Contracts. Researchers would generate new concepts and perform experimental proof-of-feasibility studies/prototyping on specific projects addressing needs of the industrial customers and solving their problems.

• There would be a fair compensation system in place for researchers and those who come up with successful ideas. Virtual meetings (ex. through Skype or other platform) would be recorded/documented, and would be a place for open discussion and brainstorming sessions.

• ICON itself would generate revenue via contract fees and/or membership fees, as well as from commercialization of the developed technologies.

• Initial challenges include attaining credibility to attract companies who may be interested in ICON service, securing the first customers (contracts), as well as developing a sustainable financial model.

• ICON would eventually be led by an "Innovation Steering Board" (i.e. a board of directors including representatives of the industrial customers).

# Goals for ICON MQP Group:

Our primary focus for the ICON GM MQP Project will be to answer the question: “What are the key success factors that will determine whether ICON GM’s business model can achieve financial sustainability?"

In order to answer this question, the team will be looking at answering sub-questions, such as:

• What direct and indirect analogues already exist on the market (such as Science Exchange) and what are essential differences?

• What value proposition will lead to success?

• How can ICON establish credibility with potential industrial customers?

• What are the most important steps to assess feasibility?

• What are the biggest challenges ICON will have to overcome?

• How will ICON find customers?

• What is the most efficient marketing strategy for ICON?

Based upon our findings, the team will draft a consulting report, answering the main question, assessing potential courses of actions, and providing specific recommendations for ICON to be able to function as a virtual company (next steps). Due to the limited time for the project, and necessities of fulfilling major requirements, the team may choose to focus on one particular subject area or industry to begin with. From this, the team intends to answer potential questions, such as:

- What are the specific wish list items, immediate needs, and future needs for ICON industrial customers (conduct interview with company representatives)?
- Is this model (global, virtual network) feasible and sustainable?
- Would early adopters assist and collaborate in development of the financial model (including how to finance the pre-tax cash flow development)?
- What would be the overall business strategy/model?
- What is ICON's value proposition and core competency/differentiating factor?
- What are the specific customer needs?
- What are their current goals and achievements in R&D, and how are they achieving it?
- What they are NOT achieving and why?
- How can ICON identify and approach its initial customers (early adopters)?
- How can ICON secure early customers by fulfilling their needs?
- Ways for ICON to gain revenue?
- What would be the composition of the ICON team and organization structure?