

A grayscale image of the Purdue University clock tower, centered in the background. The tower has a clock face with Roman numerals and a pointed top. The text 'PURDUE' is overlaid in large white letters, and 'UNIVERSITY' is overlaid in smaller yellow letters below it, separated by a yellow horizontal line.

PURDUE

UNIVERSITY

**Burton D. Morgan Center for Entrepreneurship
(BDMCE)**

Purdue University

Nikolaus Ladisch
Krannert MBA Student

Nathalie Duval-Couetil
Associate Director BDMCE

Naval Surface Warfare Center (NSWC)

Crane Division

John Dement
Tech Engagement Officer/ORTA

Timothy Bradley
Scientist

1. Project background
2. High level technology background
3. Value statements
4. Technical background and status update – Timothy Bradley
5. Educational Interlude – Market versus Industry
6. Market and Industry Analysis
 1. Emergency Response and Rescue Equipment
 2. Satellite and Spacecraft Meteorite and Debris Protection
 3. Welding and Cutting Equipment
7. Business Idea
8. Q&A

	Fall 2008	Spring 2008	Fall 2009	Spring 2010
	Antenna with Shaped Dielectric Loading	Non-perchlorate Flares	IROS ³	Portable Cutting Device for Breaching a Barrier
Students	2	2	1	1
Business Mentor	0	0	0	0
Academic Advisor	1	1	0	0
Technologies	1	1	6 related	8 related
Horizontal Analysis	X	X	X	X
Vertical Analyses	2	2	2	3
CRANE meetings	0	0	2	1
Teleconferences	2	Weekly	Weekly / Bi-weekly	As Needed
Interviews	Phone / Email	Phone / Email	Email / Survey	Email
Eureka Ranch			Attempted	

	Fall 2008	Spring 2008	Fall 2009	Spring 2010
Commercialization Package	X	X	X	X
Presentation		0	X	X
Initial Meeting		0	X	0
Final Meeting		0	X	X
Horizontal Analysis	X	X	X	X
Vertical Analyses	2	2	3	3
Contacts	0	X	0	0
Marketing Pamphlet	1 created	1 used	1 created	0



Lightweight, Portable and Scalable Laser System

- Built on the need to gain entry in constrained spaces and through multiple materials.
- A prototype of the system has been constructed and tested successfully.



Lightweight, Portable and Scalable Laser System

- What are the unique capabilities of this system?
 - Lightweight: 50 lbs.
 - Portable: Battery Powered
 - Scalable: 3 to 50 kW
- What are the related technologies?
 - #99,998, 99,261 Compact Portable High Power Ytterbium Laser
 - #99,996 High Power Laser System
 - #99,995 Quantum Cascade Laser System
 - #99,994 Scene Illuminator
 - #99,993, 99,265 High Power Ytterbium Fiber Laser Countermeasures
 - #98,846 Ground Based High Power Laser Anti -Missile System

Lightweight, Portable and Scalable Laser System

- This system is capable of delivering laser cutting capabilities in limited space environments with no additional support equipment.
- This system delivers cutting capabilities that are safer than competing technologies. There are no CO₂ from energy sources, there is an optical interlock to detect flash back and the capability of using “eye safe” laser technology.
- This system can deliver various power output from 3kW to 50 kW in an easily scalable package.

A determinant of successful commercialization of technology is the involvement and passion of the inventors.

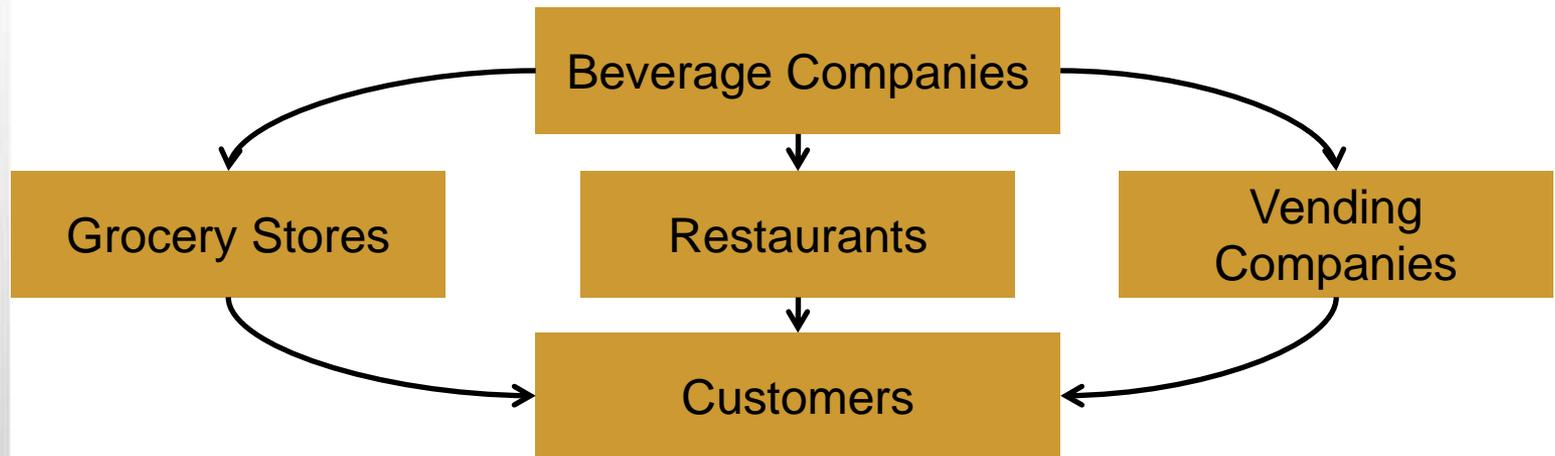
Timothy Bradley will give a short technical background and prototype status update.



Educational Interlude

A Market versus an Industry

“An industry consists of sellers – typically organizations – that offer products or classes of products that are similar and close substitutes for one another.”

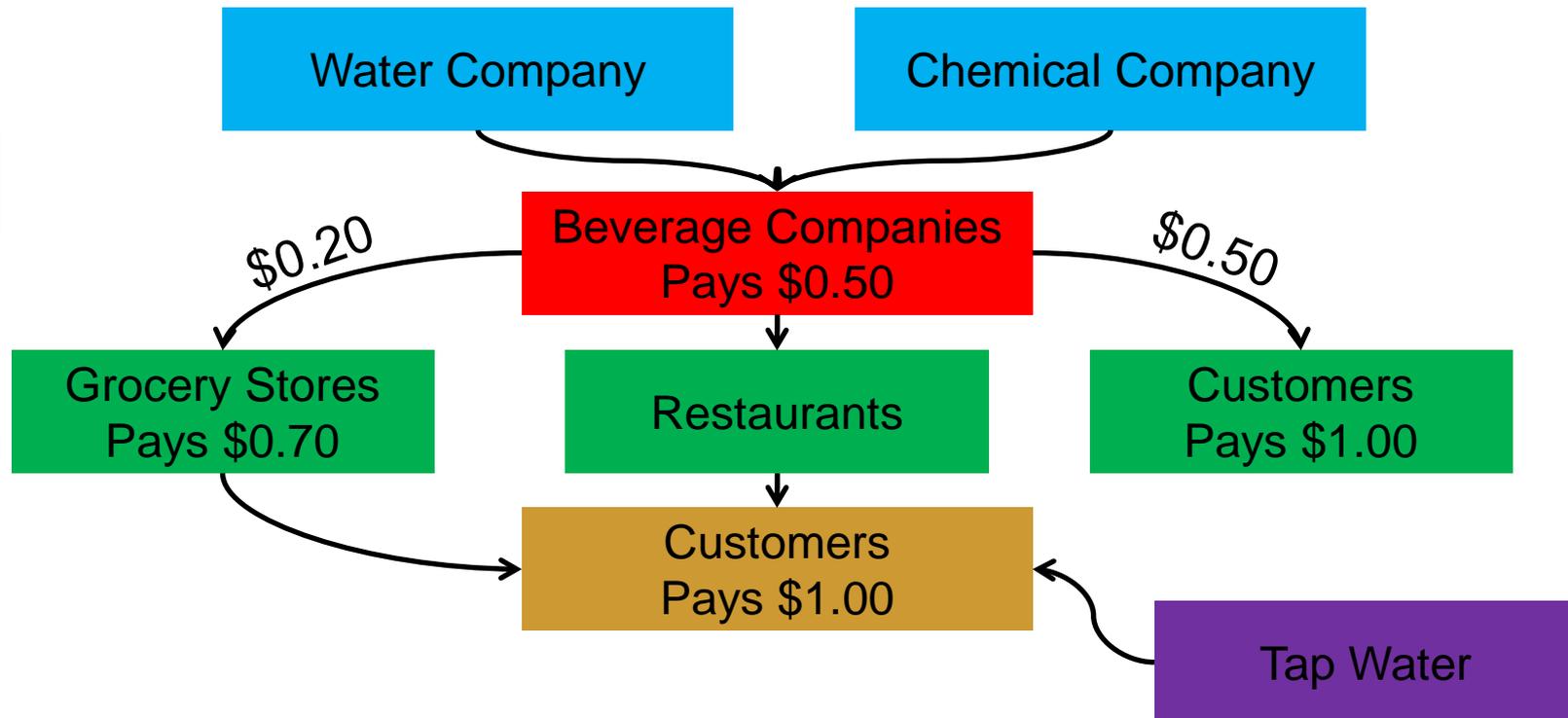


“A market consists of a group of current and/or potential customers having the willingness and ability to buy products - goods or services – to satisfy a particular class of wants or needs.”

Educational Interlude

Why is this difference important?

A Market to you can be an Industry to the end user of your product. The structure of the **industry** defined by **suppliers**, **buyers**, **substitutes**, rivals and new entrants will define profitability.

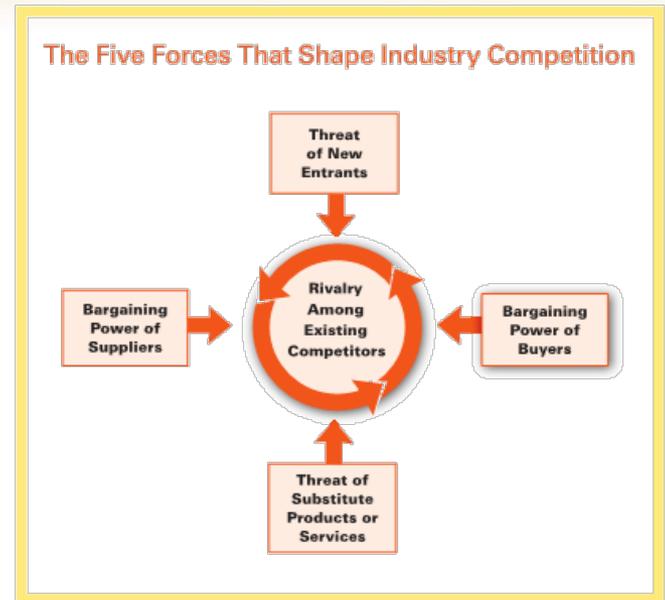


Educational Interlude

Market and Porter's Five Force Industry Analyses

Market

- Macro
 - # of customers
 - \$ spent
 - # of units sold
 - growth rate
- Micro
 - segment growth
 - customer needs versus offering



Picture Copyrighted:

Porter, Michael E. "The Five Competitive Forces that Shape Strategy" Harvard Business Review, (1979) January 2008.

Market Characteristics

- Need for portable cutting (rapid response, confined spaces)
- Need for lightweight cutting (single person, higher precision)
- Need for safety (little ventilation, low noise)
- Need for multiple material cutting (entering unknown environment)
- Need for scalable cutting power

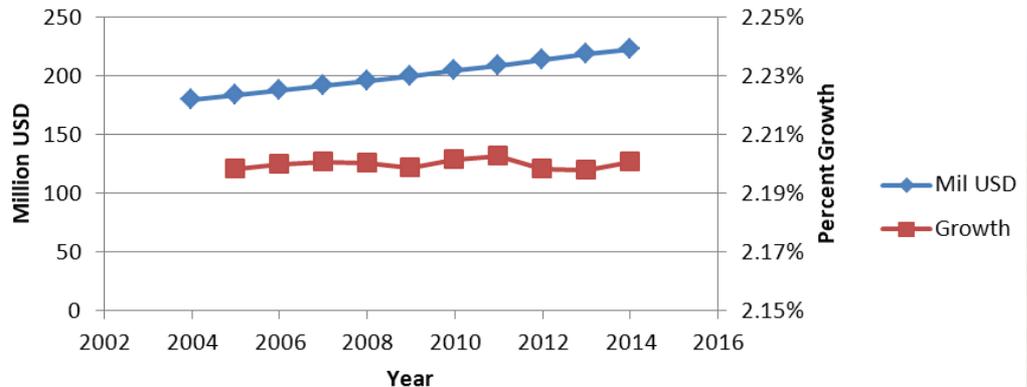
Horizontal or Macro Markets

- Emergency Response and Rescue Equipment
- Satellite and Spacecraft Meteorite Protection
- Welding and Cutting Equipment



- Market growth is stagnant which is expected from a mature macro market
- Target Segments or Micro Markets
 - First Responders
 - Fire Services
 - Police Responders

Ambulance and Rescue Vehicle Produced on Purchased Chassis



Victim Extraction – Speed, Minimize Victim Stress, Tight Spaces

- Speed – Single operator with man portable support equipment
- Minimize Victim Stress – Low noise
- Tight Spaces – Higher precision, not bulky and safely handled by user, no power generation related exhaust fumes

Industry – Tools used for victim extraction

- Hydraulic Systems
- Rotary Rescue Saws
- Rescue Chain Saws

Industry

Threat of Entry - Low

- Incumbent economies of scale
- Network effects (blades, training)
- Switching costs

Supplier Power - High

- Differentiated inputs
- Forward integration

Buyer Power - Low

- Differentiated product
- Many possible buyers
- *Price sensitive*
 - Limited budgets
 - Little change in buyers cost structure

Threat of Substitutes - High

- Cost performance trade off

Rivalry - High

- Stagnant growth
- Numerous competitors

Difficult to enter and low profitability

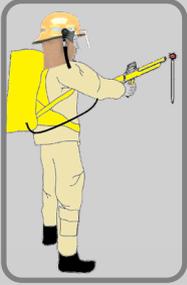
- Buyers have little power but are price sensitive
- Suppliers have high power over the cost structure
- Rivals are committed to their business and can easily duplicate leasing and free training options

Some ideas

- Enter with a leasing option and provide training to reduce switching costs
- Contractual agreement with suppliers and/or multiple sources for components

Competitors

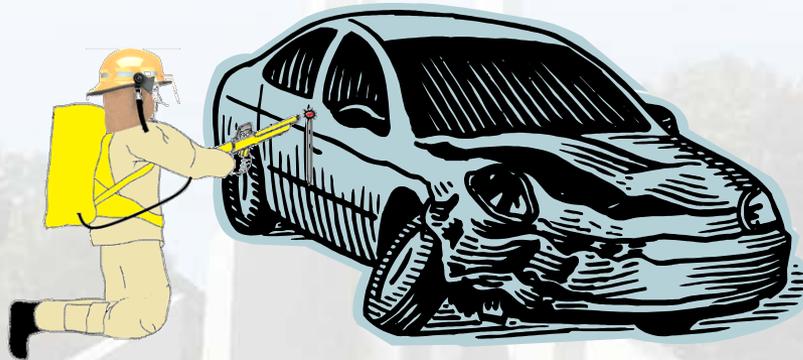
Victim Extraction – Speed, Minimize Victim Stress, Tight Spaces

 <p>Hydro-Pac Cutter S 180 A</p>		 <p>Husqvarna Pro 575XT</p>	
<p>Connection time</p> <p>Motor Noise</p> <p>Large Cutter/Spreader</p> <p>No Emissions</p> <p>~90 lbs., ~\$10,000</p>	<p>Startup time</p> <p>Engine Noise</p> <p>Difficult to Maneuver</p> <p>Fuel Emissions</p> <p>~25 lbs., ~\$1,500</p>	<p>Startup time</p> <p>Engine Noise</p> <p>Difficult to Maneuver</p> <p>Fuel Emissions</p> <p>~25 lbs., ~\$2,000</p>	<p>Immediate</p> <p>Cutting Noise</p> <p>Easy to Maneuver</p> <p>Material Emissions</p> <p>~50 to 100 lbs., \$100,000</p>

Marketing Suggestions

- Appropriate for confined space usage (low emission)
- Safe in tight and low mobility locations
- Appropriate where precision is desired rather than brute force
- Includes optical interlock to protect users eyes

Low Noise Victim
Extraction



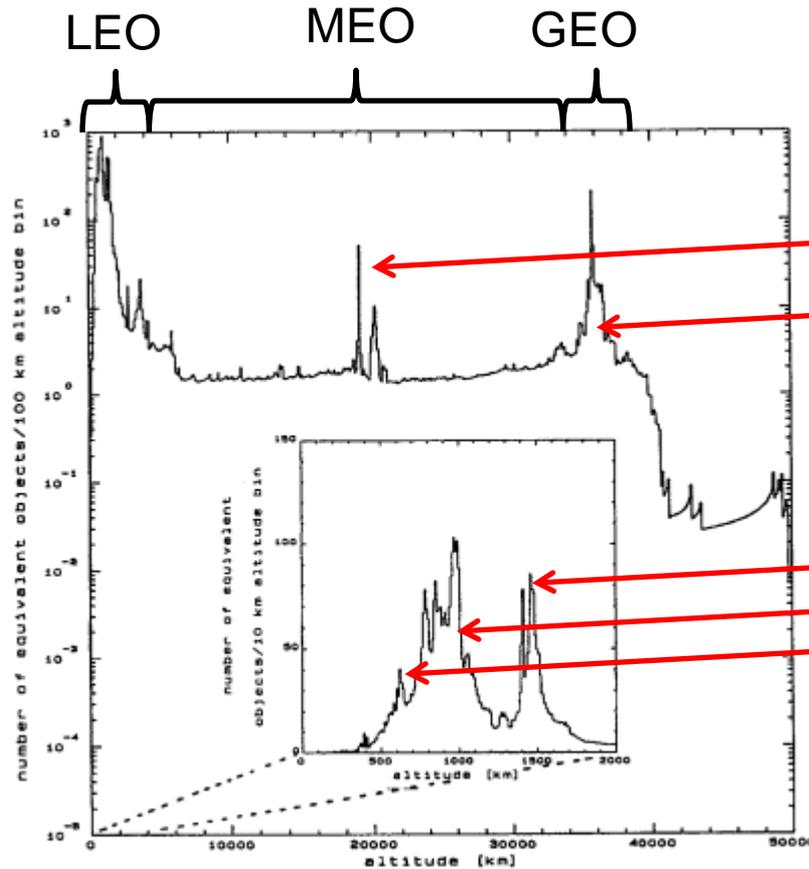
Emergency Entry
through Reinforced
Doors



- Market growth is stagnant however growth can spike in this industry
 - Catastrophic satellite failure (solar flair, collision)
 - New communication capability (Iridium [60 + LEO], Globalstar [40 LEO])
- Target Segments or Micro Markets
 - Geosynchronous Satellites (GSO)
 - Non Geosynchronous Satellites (NGSO)
 - Manned Spacecraft

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	Average
SATELLITES												
GSO Forecast (COMSTAC)	27	21	22	20	20	20	19	20	20	19	208	20.8
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NGSO Small	2	5	4	2	3	2	2	2	3	2	27	2.7
Total Launches	29	31	27	24	26	29	28	28	24	21	267	26.7

LEO	<5,500 km
MEO	5,500 – 36,000 km
GEO	36,000 km



GPS

Television, Military

Globalstar Comm

Iridium Comm

ISS, Shuttle

Active solar panel protection for Communication and Broadcast satellites.

Spacecraft are passively shielded however solar panels are not! They need active shielding.

- Work off of current DC power bus
- Lightweight, especially using current battery power
- Protect against small 0.1 to 1 cm debris that is untracked

Long Duration Exposure Facility (LDEF)
<http://setas-www.larc.nasa.gov/LDEF/index.html>

32,000+ impact craters visible to the naked eye in just under 6 years of spaceflight

Size	Number of Objects	% number	% Mass
>10 cm	8,000	0.02%	99.93%
1-10 cm	110,000*	0.31%	0.035%*
0.1-1 cm	35,000,000*	99.67%*	0.035%*
Total	35,117,000*	100.0%*	2,000,000 kg#

Threat of Entry - Low

- Network effects
- Access to distribution channels

Supplier Power - High

- Differentiated inputs
- Forward integration

Buyer Power - High

- Differentiated product
- Few buyers
- Backward integration

Threat of Substitutes - Low

- Active protection for solar panels isn't available

Rivalry - Medium

- Stagnant growth

Difficult to enter, uncertain future

- Buyers have power and some can backward integrate
- Suppliers have high power over the cost structure

Some ideas / additional info

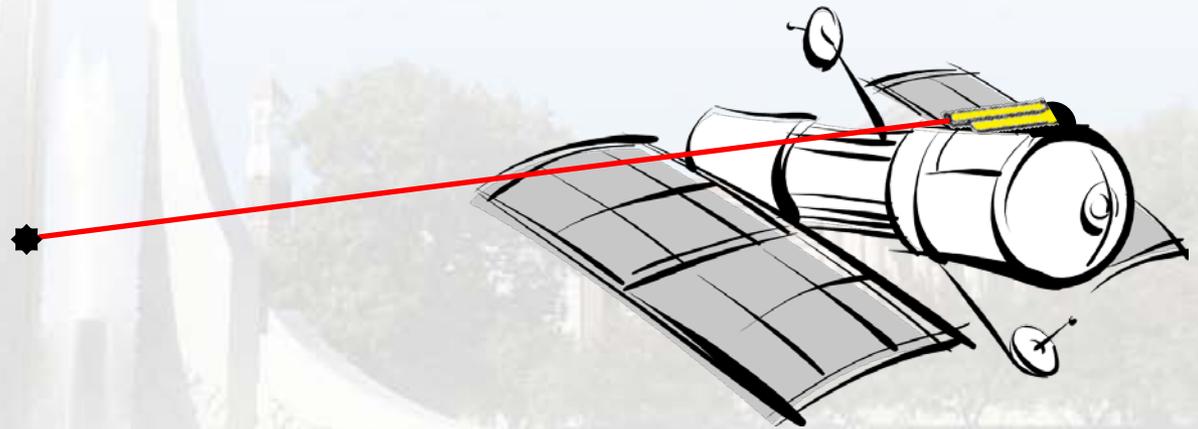
- There are military, large commercial and small commercial satellites
- Communication satellites are at the most risk currently
- Most interest will be large commercial entities followed by small commercial entities if/when they take over NASA's launch capability
- **Outer Space Treaty:** No ban on conventional weapons, just WMD
- **Space Preservation Treaty:** Never signed
- **Space Preservation Act:** Would ban this type of device but hasn't been successful (2001,2002 and 2005)

Competitors

- passive shielding for the spacecraft
- chemical laser systems (Not in Use)
- orbital adjustment



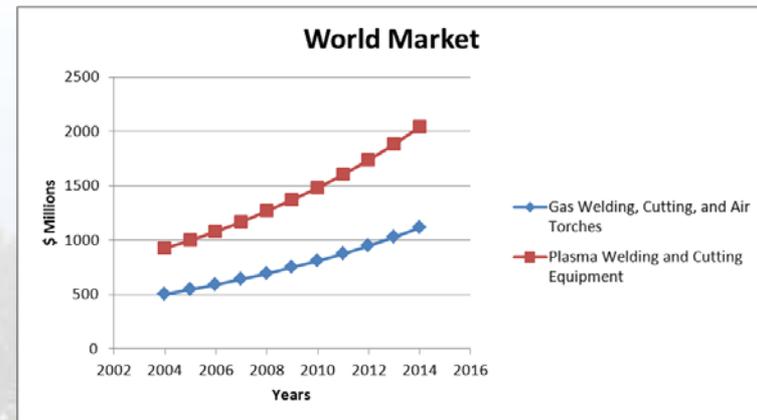
- Active protection from meteorites and debris under 1 cm (Vaporize)
- Active protection from meteorites and debris over 1 cm (Divert)
- < 50lbs and can operate on current power bus designs
- Protect life limiting equipment like solar panels where passive protection is unavailable



- Market growth is about 8% which is above standard economic growth
- Target Segments or Micro Markets
 - Underwater / Salvage operations
 - High quality / precision / temperature applications
 - Extreme and remote operations

Underwater ROV

- 550 New Working Class*
2009-2014
- 900 Work Class as of 2006**



ICON Group, Parker, Philip, **The 2009-2014 World Outlook for Gas Welding, Cutting, and Air Torches**

ICON Group, Parker, Philip, **The 2009-2014 World Outlook for Plasma Welding and Cutting Equipment Excluding Fully or Partly Automatic Equipment**

*http://www.researchandmarkets.com/reportinfo.asp?cat_id=0&report_id=1215926&q=AUV and ROV&p=1

**http://www.businesswire.com/portals/site/home/permalink?nd=ViewId=news_view&newsId=20060926005606&newsLang=en

Underwater / Salvage Operations

- Equipment must survive salt water environments
- Versatile material use (exothermic 10,000F)
- Protect user (electrode risk)
- Usable at diving depth

Industry – Underwater Welding / Cutting Equipment

- Exothermic Cutting Systems
- Underwater Stick Welding

Threat of Entry - Low

- Incumbent economies of scale
- Network effects (rods, training)
- Switching costs

Supplier Power - High

- Differentiated inputs
- Forward integration

Buyer Power - Low

- Differentiated product
- Many possible buyers
- *Price sensitive*
 - Limited budgets
 - Little change in buyer cost

Threat of Substitutes - High

- Cost performance trade off

Rivalry - Medium

- Numerous competitors
- Low cost to exit

Difficult to enter and low profitability

- Buyers have little power but are price sensitive
- Suppliers have high power over the cost structure
- Rivals are committed to their business and can easily duplicate leasing and free training options

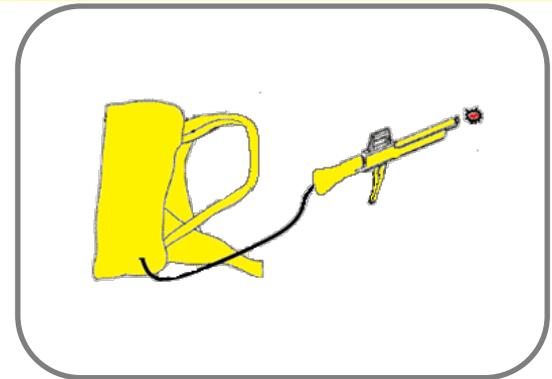
Some ideas

- Enter with a leasing option and provide training to reduce switching costs
- Contractual agreement with suppliers and/or multiple sources for components

Competitors



- Most competitors require multiple people to operate the equipment
- Surface operator and rods require replacement



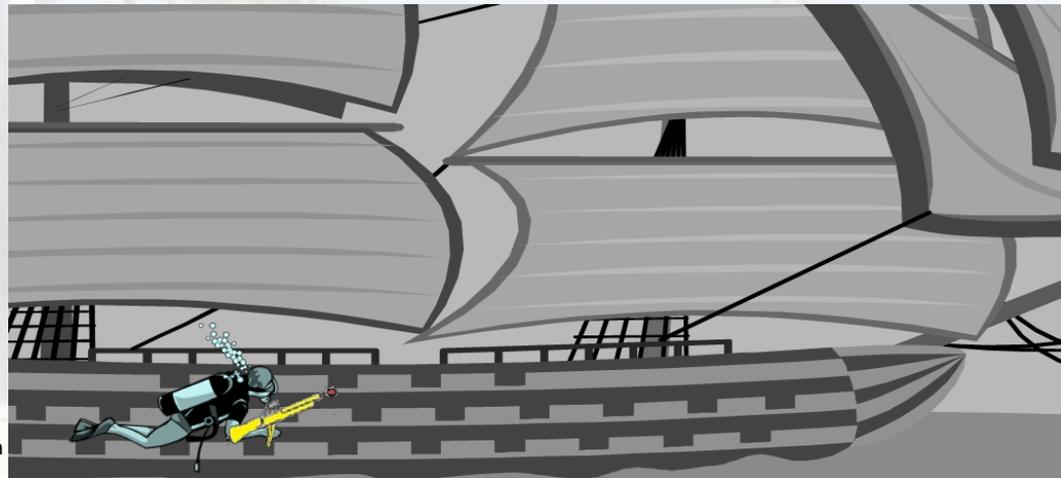
- No replacement rods
- Single operator
- Precision cutting



Salvage operation and resulting cut from exothermic cutting rods

Marketing Suggestions

- Single person operation
- Self contained for tight places
- Reduces entanglement risk
- Minimizes risk of electrical shock



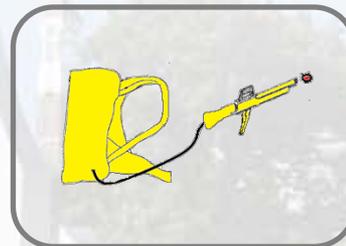
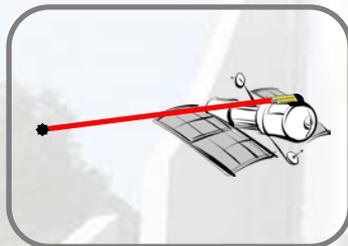
- Emergency Response and Rescue Equipment
 - Depth of Cut
 - Containing Hot / Molten Materials
- Satellite and Spacecraft Meteorite Protection
 - Tracking and Aiming Technology
- Welding and Cutting Equipment
 - Salt Water Survivability
 - Pressure Compatibility



Satellite Protection and Underwater Cutting System

niche offering of a differentiated product based on common platform

- satellite protection solution
- lease for diving salvage
- underwater rover accessory



Satellite Protection and Underwater Cutting System

- Lightweight system which requires no support equipment
- Is capable of tying into current power buses with DC current
- Precision cutting capability

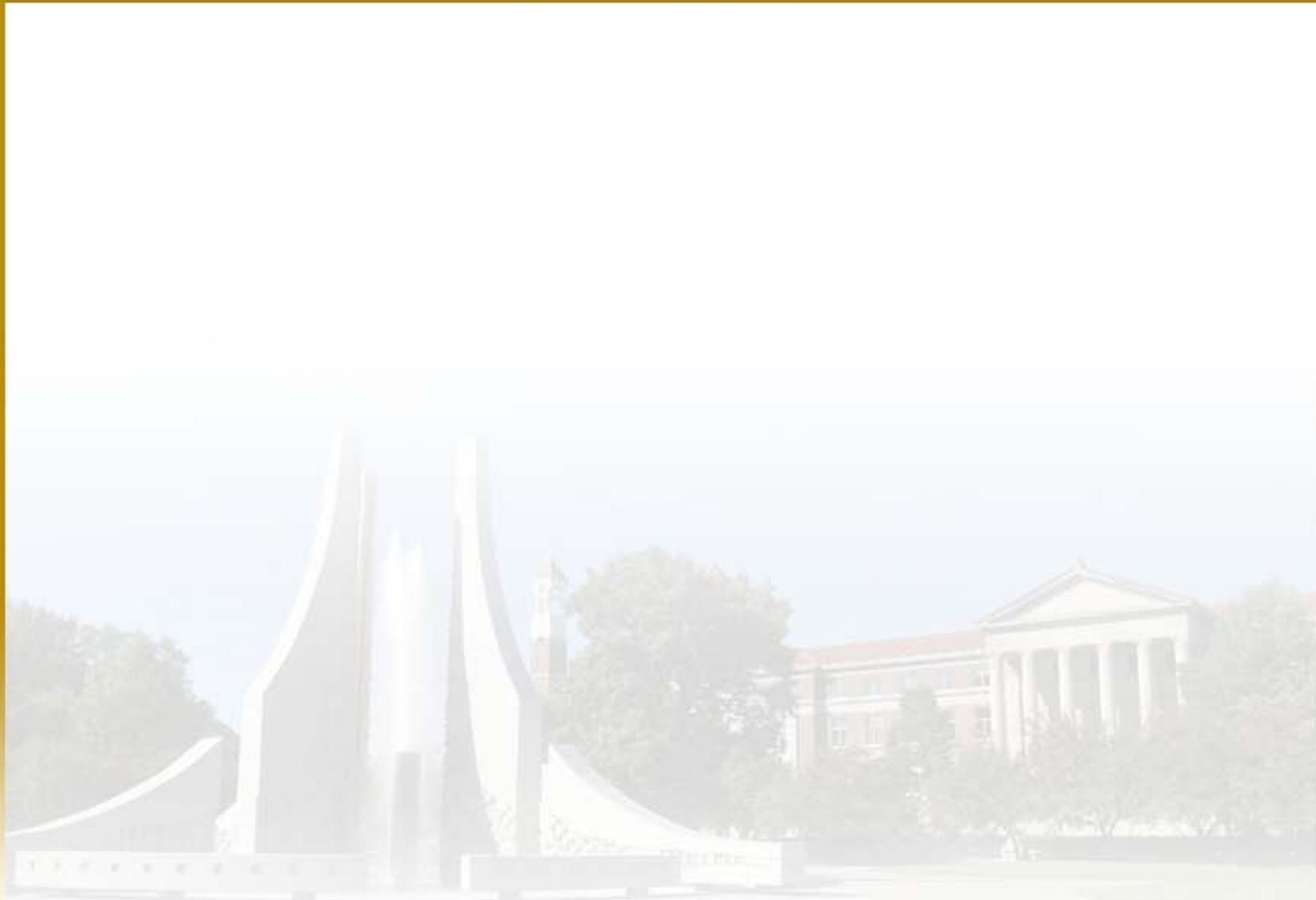
Financial analysis indicates lease is not an option

	Technology Maturity	Early	Middle	Late
	Discount	30%	15%	8%
NPV (000)	Satellite	\$ 7,966	\$ 15,366	\$ 22,890
	ROV	\$ 2,226	\$ 4,588	\$ 7,015
	Lease	\$ (35)	\$ 240	\$ 523

- John Dement
 - For always nudging us in the right direction when we get lost
 - For being patient and supportive of our efforts and providing a great learning opportunity

- Nathalie Duval-Couetil
 - Her support and dedication in making it all work

- Timothy Bradley
 - For presenting an interesting technology and sharing his excitement
 - For very comprehensive and complete answers to our questions



DISTRIBUTION STATEMENT A: Distribution approved for public release; distribution is unlimited.

Lightweight, Portable and Scalable Laser System

Prepared by:

Nikolaus Ladisch

Purdue University, Technology Commercialization Laboratory

John Dement

NSWC Crane Division, Technology Engagement Officer/ORTA

Timothy Bradley

NSWC Crane Division, Scientist

Technology Summary

This group of technologies is based on the use of modular fiber lasers, which can be combined to create multi power level outputs. Advantages to the incorporation of this technology include the ability to modulate the laser frequency by using different fiber materials, a conduction medium that is already flexible, smaller heat dissipation requirements and power output scalability. These advantages allow for a compact system capable of continuous operation at power levels high enough to cut through most materials and in light frequencies, which are safer for human operators and are less affected by atmospheric conditions. Additional advancements in this technology grouping include an optical interlock device that can detect sparkle from the laser and either warn the user or shut the device off as appropriate.

The technologies that are a focus of this commercialization package are filed under one or all of the following Navy Cases:

- Navy Case #99,998, 99,261* Compact Portable High Power Ytterbium Laser
- Navy Case #99,996 High Power Laser System
- Navy Case #99,995 Quantum Cascade Laser System
- Navy Case #99,994 Scene Illuminator
- Navy Case #99,993, 99,265* High Power Ytterbium Fiber Laser Countermeasures
- Navy Case #98,846 Ground Based High Power Laser Anti -Missile System

The development of this technology is continuing with three target applications: a man portable system which has high enough output power and endurance to cut a man sized hole in a bulkhead, an aircraft portable system capable of disrupting, disarming and/or destroying targeting systems, a ground based anti-missile system. In combination with battery technology, a portable prototype system capable of 360 seconds of continuous 3kW power output has been demonstrated.

Business Concepts

Concept #1: Portable Rescue System for Emergency Responders

The portable rescue system allows emergency responders to carry one device, which is capable of cutting through many different materials without the need for different equipment, different accessories or any support equipment. It is compact enough to be worn by the user in tight spaces and can be modified for use in wet and underwater environments. It provides further safety enhancements in comparison to substitute products as it has no rotating machinery, does not generate CO₂ of concern in tight spaces and is very precise, minimizing the opportunity for accidental injury.

Market – Macro Level

The macro market of interest is rescue operations within the United States. As a proxy to this, we are utilizing data for ambulance and rescue vehicles as this is a complementary market.

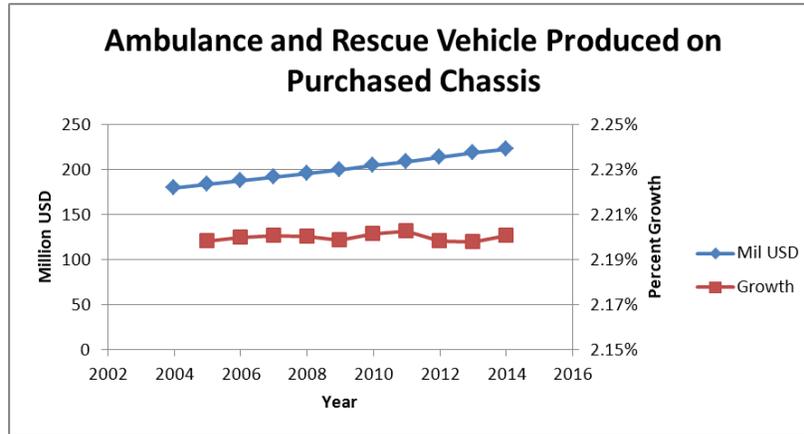


Figure 1 US Macro Market Growth as estimated in 2008ⁱ

Figure 1 indicates the approximate growth rate expected in this market. The percent growth indicates that this market is currently mature and expenditures are planned and growing with inflation. There are no known regulatory changes within this market, however certain segments will likely be affected by upcoming budgetary legislation especially when concerning healthcare (ambulance services). There are no known disruptive technological developments in the near term horizon.

Market - Micro Level

The following is a representative sample of the segments within the rescue operations market: ambulance, fire responders and rescue personnel. Depending on the set up of the emergency responders, fire and rescue personnel are identical. Generally, patient extraction must be carried out in a rapid and safe manner as the first hour is critical. This system addresses the following possible pain points in these segments: use of support equipment for hydraulic spreaders / cutters increases manpower requirements as well as limits areas of operation and the noise of current systems can stress victims. The operational side of the units tend to weigh approximately 50lbs which can cause fatigue in the operators. There are mobile power units but they can weigh an additional 50lbs.ⁱⁱ The system adds the following pain points: adds a possible source of ignition and would require a secondary device if bending or lifting is necessary.ⁱⁱⁱ

Industry

Threat of Entry (Low): There is a threat of entry to this market, however it is currently low. A significant barrier to entry are competing companies scale economies. With the possible exception of some of the hydraulic systems, each product offering is only modified for the target market and not specifically constructed for the market. This indicates that there is strong price pressure. There are also network effects with many of the systems. Commonality of device interface and training drives markets to standardize their products. The most significant switching cost in this market is retraining to use a different system and develop new procedures for equipment use. Brand name, such as Jaws-of-Life has power within this industry and will take time to and resources to overcome.

Supplier Power (High): The suppliers power differs amongst products in this industry. Some of the competing products utilize common parts, which are obtained from many sources for which the switching cost is low (e.g. bolts, nuts). However, the proposed laser technology is different. The suppliers have significant power as they are selling differentiated goods without which the technology wouldn't function. Furthermore, with license or further research and development, the suppliers could forward integrate.

Buyer Power (Low): Buyers have little power if choosing amongst laser technology but have higher power when choosing amongst all industry players. However, there are many individual buyers in the market and therefore their over power is low. It is important to note however that they are price sensitive as many buyers are on limited or regulated budgets.

Threat of Substitutes (High): Within this industry, there are many products under \$20,000, which can perform similarly to the proposed technology. This threatens profitability of a device, which costs an estimated \$100 - \$120K. When entering, one must consider the cost to performance trade off.

Rivalry (High): There is stagnant growth in this market, which indicates that any additional entrant will take market share from a rival. There are also numerous competitors and although, for many companies, there are low barriers to enter (such as repurposed saws), the companies are either focused on this industry and are therefore committed to defending their share or they are diversified and able to hold out at a loss longer than a new entrant.

Weber-Hydraulik ^{iv,v}	Husqvarna Rotary Rescue Saw ^{vi,vii}	Husqvarna Rescue Chain Saw ^{viii}
		
~90 lbs. (40 lbs. cutter, 50 lbs. portable power pack)	~25 lbs.	~21 – 23 lbs.
	97-113 dB	
Battery	Gasoline	Gasoline
	\$1500	\$2000

Concept #2: Satellite and Spacecraft Meteorite and Debris Protection

This system can be incorporated into spacecraft and satellites using their current power systems and batteries to minimize damaging and expensive meteoroid strikes while in orbit. This would help to mitigate the ongoing risk of a catastrophic critical satellite failure in already crowded orbits reducing the risk of worldwide communication and navigation outages. On manned systems, it would increase the chance of protecting orbiters, space stations and astronauts against untracked debris in orbit.

Market – Macro Level

The shuttle system is ending and as of 2010, the replacement system is likely cancelled leaving the US without manned space capabilities for the near to midterm future. Figure 3, extracted from an FAA report indicates predicted satellite and launch demand for the coming years.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	Average
SATELLITES												
GSO Forecast (COMSTAC)	27	21	22	20	20	20	19	20	20	19	208	20.8
NGSO Forecast (FAA)	19	53	26	12	14	37	41	36	12	10	260	26.0
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LAUNCH DEMAND												
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Total Launches	29	31	27	24	26	29	28	28	24	21	267	26.7

Figure 2 Commercial Space Transportation Satellite and Launch Forecast^{ix}

Market – Micro Level

According to NASA documentation^x there are approximately 19,000 pieces of debris greater than 10cm, 500,000 pieces between 1 and 10cm and likely tens of millions of pieces less than 1cm in diameter. Debris larger than 10cm in diameter is tracked while many of the smaller pieces are not tracked consistently. However, objects as small as 3mm can be tracked if necessary. Although orbital adjustments are not common the spacecraft do experience damage sometimes to systems which cannot be afforded protection such as solar panels. Any defensive system would require accuracy, speed and effectiveness over significant distance because the objects average impact speed is about 10 km/s. The target segments would be based upon cost of the vehicle and the increased life expectancy with the inclusion of such a system.

Industry

Threat of Entry (Low): Although difficult to enter for this technology, the threat of entry will also be low. There are network effects within this industry. As the cost and budgeting cycles are long, once a technology has been proven successful, it tends to be implemented over a long period of time. It is also important to gain access to the distribution channels and influencers. Switching costs are also high because of the expense of launching the end item and the risk involved with using unproven technologies. Since the technologies and component technologies are young, the cost of research and development is also high deterring near term entrants to the industry.

Supplier Power (High): The suppliers have significant power as they are selling differentiated goods without which the technology wouldn't function. Furthermore, with license or further research and development, the suppliers could forward integrate.

Buyer Power (High): The product is differentiated and switching costs are very high suggesting buyer power is low, however there is a real threat of backward integration. For instance team ABL (Boeing,

Lockheed Martin and Northrop Grumman)^{xi} already having experience with Airborne Laser systems and also prime contractors on satellite systems have the knowledge and resources to backward integrate. Therefore, as there are few buyers who also have the ability to backward integrate, the buyer power is high.

Threat of Substitutes (Low): The primary devices are already heavily shielded however this does not shield the solar panels which must be exposed. This suggests that any system meant to protect the system from meteorite damage must be active. The laser system is actually a threat of substitute to current industry players as it might offer a good price to performance benefit on launch weight, life extension and fuel savings.

Rivalry (Medium): As there are no known direct active protection competitors, the rivalry is expected to be low however the growth in the market is stagnant indicating that rivalry may occur from passive shielding companies.

Other Information: There are currently some Government regulations (US and World Based) which might interfere with this system. The “Outer Space Treaty”^{xii} which targets weapons of mass destruction being based in space might affect acceptance of a laser based system. However this treaty is generally referencing nuclear weapons. Two other pieces of legislation, “Space Preservation Treaty”^{xiii} and the “Space Preservation Act”^{xiv} although not accepted, target weapons in a more general sense and have a high likelihood of banning this type of system. This indicates that there may be a limited time window to launch this technology and prove its peaceful operation prior to acceptance of the Space Preservation Treaty or Space Preservation Act.

Concept #3: Underwater Cutter/Welder

Using already existent power cabling, the fiber laser system can be used underwater for precise and safe cutting and welding operations. Current welding and plasma cutting systems can pose electric shock risk to divers as the electrodes in use high voltage. Welding, Plasma cutting and Acetylene torch systems lack precision, especially when used underwater where visibility is diminished. Of further advantage, the portable laser system operates on DC current and relies on the fiber system for gain. Since the DC current is lower, the risk of electric shock is decreased.

Market – Macro Level

This market is defined by underwater cutting systems utilized in diving operations such as salvage and repair. Although demand for the underwater market is hard to disaggregate, below is standard demand for all devices including those used underwater. The growth rate in these markets is about 8% which exceeds the standard economic growth rate.

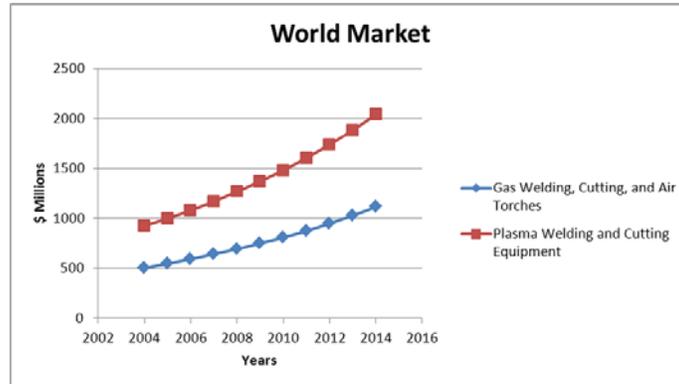


Figure 3 Welding and Cutting Market^{xv xvi}

Market – Micro Level

There would be at least two target segments in the market, salvage operations and rover operations. In each case, versatility is important as well as saltwater survivability. Likely, versatility and saltwater survivability are the qualifier in this market as no additional technologies are currently present. Additional characteristics include concern over entanglement and electric shock of the user or device.

Industry

Threat of Entry (Low): Incumbents enjoy economies of scale, which is a barrier to entry into this industry. There are also network effects like replaceable parts and equipment such as the rods and training on certain machines. Training is also a switching cost for the market participants, which deters entry into this industry. There are well known incumbent brands such as Broco, which can make entry difficult.

Supplier Power (High): The suppliers have significant power as they are selling differentiated goods without which the technology wouldn't function. Furthermore, with license or further research and development, the suppliers could forward integrate. Other industry participants have low supplier power as they construct their offerings to the market from a greater percentage of common items.

Buyer Power (Low): This is a differentiated product and there are many possible buyers however this power may increase with niche markets such as salvage operations. The buyers are also price sensitive as they are on limited budgets especially when looking at treasure salvage versus other salvage operations.

Threat of Substitutes (High): There is a high cost to performance tradeoff amongst the substitutes. Many competing products such as the exothermic cutting tools are very versatile in their cutting capability. However, a laser device would offer control and precision not available to an exothermic device.

Rivalry (Medium): The general market is growing but the underwater salvage and exploration market size is unknown. It is likely that the growth is less than overall market growth and fairly stagnant. However, the cost to exit for smaller producers is low due to the standard nature of the equipment. This indicates that rivalry can be expected to be medium within the industry.

In underwater applications, the primary cutting tool is an exothermic system, which utilizes consumable rods, an oxygen source and ignition source. Once ignition is achieved, usually through electric current, the rod will burn until the rod is gone or the oxygen source is removed. They have the advantage of burning around 10,000F, which is hot enough to cut through most materials and can be used in a plunge operation. However, they typically require a second operator on the surface and also require rod changes. Of further concern is exposed electrical current, like a welder, which can shock the user.

This system should be tested by NEDU (Navy Experimental Diving Unit)^{xvii} which currently uses competing products such as the Broco exothermic cutting torch.

Business Idea

A common platform will be developed based on the scalability of the system and its ability to operate off battery power.

For the satellite and spacecraft meteorite and debris markets, a system without a power unit but adapted to run from current battery technology and combined with a targeting and aiming system will be sold. There are a continuous stream of launches due to satellite attrition due to failure or technology update.

For the rover market, a system similar to that of the satellite and spacecraft meteorite and debris market will be sold. There are currently about 900 units operating^{xviii}, 500 for commercial purposes. From 2009 until 2014, another 550 units are expected to be constructed^{xix}. With the ability to mount on existing mounting hardware and adapted to current DC power units, this system could be implemented with minimal change to existing designs. Light to medium duty ROV cost between \$20,000 to \$50,000. Prices for many ROV's beyond the observation class such as work class and heavy work class (those used on salvage, oil rigs, etc.) are customized and not available.

A lease program for units that have man portable operation will be leased to rescue operations for long-term use and cycled for underwater diver use where precision or compactness is needed. Operating in this fashion allows for market entry where the customers are price sensitive and rivalry is highest by decreasing operational costs and only being used where current technology isn't applicable. This is expected to be a negligible market.

The following is a high level financial analysis based on preliminary cost data, demand data, internal rate of return (IRR) and market.

	Technology Maturity	Early	Middle	Late
	Discount	30%	15%	8%
NPV (000)	Satellite	\$ 7,966	\$ 15,366	\$ 22,890
	ROV	\$ 2,226	\$ 4,588	\$ 7,015
	Lease	\$ (35)	\$ 240	\$ 523

From this analysis, it seems that the lease option is not viable with current technology whereas both the ROV and Satellite markets might be viable. Prior to pursuing this business, willingness to pay would need

to be determined and more accurate cost data would need to be provided. This also assumes that as the technology become more mature, the risk decreases and therefore the IRR would be smaller. The full analyses are in the appendix of this document.

ⁱ Philip M. Parker, INSEAD, Copyright 2008, www.icongrouponline.com

ⁱⁱ http://www.weber.de/wr/download/kompaktaggregate/Hydropac/Datenblatt/MB_Hydropac.pdf

ⁱⁱⁱ <http://emergencytechnologies.com.au/vet.pdf>

^{iv} All Images Copyright Weber-Hydraulik

^v http://www.weber.de/wr/index_en.php

^{vi} All Images Copyright Husqvarna

^{vii} <http://www.husqvarnacp.com/node1552.aspx?nid=66586&pid=34354>

^{viii}

http://www.thefirestore.com/store/product.cfm/pid_2321_ventmaster_husqvarna_pro_575xt_fire_rescue_chain_saw_with_depth_gauge_16_or_20_bar

^{ix}

http://www.faa.gov/about/office_org/headquarters_offices/ast/media/NGSO%20GSO%20Forecast%20June%203%202009%20lowres.pdf

^x <http://orbitaldebris.jsc.nasa.gov/faqs.html>

^{xi} <http://www.boeing.com/defense-space/military/abl/news/2000/012200.html>

^{xii} <http://www.state.gov/www/global/arms/treaties/space1.html>

^{xiii} http://www.peaceinspace.com/sp_treaty.shtml

^{xiv} <http://www.govtrack.us/congress/bill.xpd?bill=h109-2420>

^{xv} ICON Group, Parker, Philip, **The 2009-2014 World Outlook for Gas Welding, Cutting, and Air Torches**

^{xvi} ICON Group, Parker, Philip, **The 2009-2014 World Outlook for Plasma Welding and Cutting Equipment**

Excluding Fully or Partly Automatic Equipment

^{xvii} <http://www.supsalv.org/nedu/nedu.htm>

^{xviii}

http://www.businesswire.com/portal/site/home/permalink/?ndmViewId=news_view&newsId=20060926005606&newsLang=en

^{xix} http://www.researchandmarkets.com/reportinfo.asp?cat_id=0&report_id=1215926&q=AUV and ROV&p=1