WORCESTER POLYTECHNIC INSTITUTE

Major Qualifying Project

Business Plan & System Dynamics Model for Red Mud Recycling Startup

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1.0 Introduction

ABC is an emerging startup company with a unique patented chemical and process that enables it to safely and efficiently clean up and dispose of Red Mud, a toxic, dangerous byproduct of aluminum production that has been a cause for disaster and pollution around the world. While this company certainly has the potential for great success, there are risks involved for investors just like with any other new startup. To combat this, we have created a system dynamics model to simulate a number of different potential outcomes for the first five years of business given a variety of circumstances, with the intention of defining the extent of the risks and the level of potential upside. The results of this analysis are then incorporated into the business plan for the company, providing us with a dynamic business plan and model from which to base our investment decisions. This report will provide complete analysis of our potential startup, as well as explain the advantages of using system dynamics over traditional spreadsheet modeling techniques in business plans.

2.0 Red Mud

Red mud is a toxic chemical produced by the Bayer method of aluminum production. With a growing supply and billions of tons of it already in existence, it has become a serious environmental hazard. This is especially true given the recent disaster in Hungary in which millions of tons of red mud burst through a retaining wall, destroying several villages and extinguishing virtually all of the wildlife in the surrounding area.

2.1 How red mud is created

A byproduct of the Bayer method, Red Mud is produced in the process of refining bauxite into alumina. Specifically, "Red mud or bauxite residue is the denomination of the residual material obtained from the dissolution of the hydrated alumina minerals of bauxite in the caustic Bayer liquor."[1]

This method for producing Aluminum Oxide was originally invented by Louis Le Chatelier in 1855, where it was later improved and then perfected by Karl Josef Bayer[2] in 1892. This process was originally developed to "satisfy the needs of the textile industry since aluminum hydroxide was used as a mordant in dyeing cotton"[3], and has been utilized in aluminum production ever since. Below is a diagram of this process illustrating the steps involved.

[1] (Huan and Bánvölgyi n.d.)
[2] (Habashi 2003)
[3] (Habashi 2003)

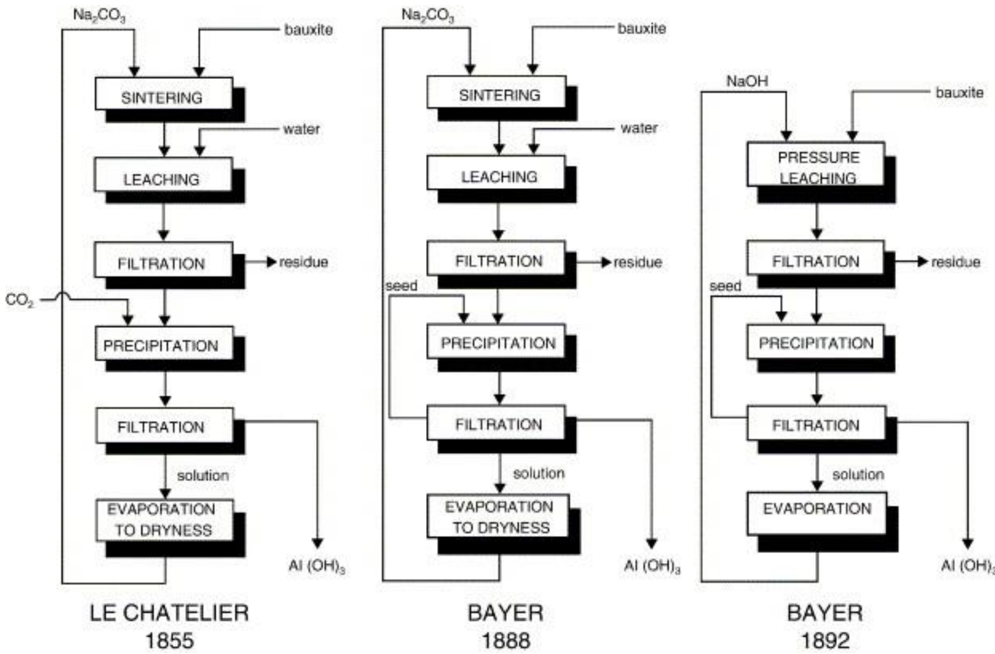


Figure 1 - Bayer process[4]

From this flow chart you are able to see how this red mud, labeled as 'residue' above, is created in the filtration stage very early on in the process.

2.2 Chemical Composition

This 'residue' has a very unique consistency. This product contains metals such as iron oxide, aluminum dioxide and titanium dioxide, which can be extracted by ABC and later sold in the marketplace. The complete chemical makeup is shown in the table below for samples of red mud from many different regions around the world.

[4] (Habashi 2003)

	Weipa (Australia)	Trombetas (Brasil)	South Manchester (Jamaica)	Darling Range (Australia)	Iszka (Hungary)	Parnasse (Greece)
Digestion temperature	240°C	143°C	245 °C	143 °C	240 °C	260 °C
Components, %						
Al_2O_3	17.2	13.0	10.7	14.9	14.4	13.0
SiO_2	15.0	12.9	3.0	42.6	12.5	12.0
Fe_2O_3	36.0	52.1	61.9	28.0	38.0	41.0
TiO_2	12.0	4.2	8.1	2.0	5.5	6.2
L.O.I.	7.3	6.4	8.4	6.5	9.6	7.1
Na_2O	9.0	9.0	2.3	1.2	7.5	7.5
CaO	-	1.4	2.8	2.4	7.6	10.9
Others	3.5	1.0	2.8	2.4	4.9	2.3

Table 1 - Chemical composition from different region[5]

This substance can be found as either a solid, or much more commonly a liquid form. The billions of tons of it found throughout the world are generally found in man-made reservoirs built to contain it. Unfortunately, these lined reservoirs are sometimes not enough to hold back the vast amount of toxic sludge they contain and have on occasion been breached, causing serious environmental disasters in the surrounding areas.

2.3 Disaster in Hungary

In October of 2010, Hungary experienced one of these disasters firsthand when a retaining wall ruptured at a local bauxite refining plant at Ajkai Timfoldgyar. The red mud burst through the barrier and flooded miles of Hungarian land, damaging homes and local businesses. Numerous amounts of plants and animals died and all life was wiped out of the Marcel River when it reached it. Below is one image of the broken retaining wall that was inspected not one week before this incident.

[5] (Huan and Bánvölgyi n.d.)

Figure 2 - Ajkai Timfoldgyar plant in Kolontar, Hungry [6]

The red mud escaped from this reservoir to contaminate no less than 8 million square meters of farm land, killing at least nine people and injuring many more[7]. The flood sped through local villages, reaching a height of nearly 12 feet before it entered the Marcel River[8]. Workers on the scene scrambled to stop the red mud from reaching the Danube River by pouring hundreds of pounds of plaster into it, but in the end were unsuccessful in containing the spread of the toxic sludge.

[6] (Poisonous red sludge floods Hungarian towns 2010)
[7] (Cain 2010)
[8] (A flood of toxic sludge 2010)

This devastation continued and can be seen in some of the pictures below.

Figure 3 - Local Farmland

Figure 4 - Ariel view of the spill

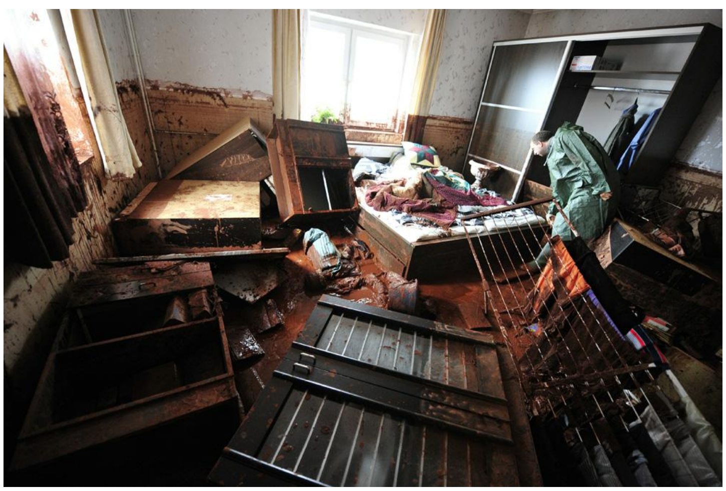


Figure 5 - Urban Destruction

Figure 6 - Flood level

From these pictures[9] it is apparent the complete devastation that these poor villagers had to go through. Their homes were destroyed, their businesses ruined. They suffered chemical burns and

[9] (A flood of toxic sludge 2010)

other injuries, and in some cases were even killed. By cleaning up the huge reservoirs of red mud found around the globe, prevention of destruction like this is possible.

2.4 Recycling Process

Currently, there are different organizations with different ideas on how to combat the red mud problem. These options vary from storing it in a lake to drying it up and using it as a building material, and while some are able to neutralize the red mud, none are capable of actually transforming the liability of red mud into an asset like ABC will be able to do.

2.4.1 Lake Storage

The first idea is to simply contain this red mud in a man-made lake, exactly like the one that broke in Hungary. Unfortunately with this there are many inherent problems, the first being that it is not the safest option, as is evident with the disaster that occurred. The next is that before 1960 no lining of these lakes was required. This allows the toxic sludge to seep through the ground and to pollute the fresh water sources, posing health hazards for the people living nearby[10]. These lakes are also an eye-sore to the land and they can have an effect upon people living in the area.

2.4.2 Sea Disposal

Another idea is to dispose of this waste into the sea, as sea water neutralizes the causticity of the red mud. Many tests have been carried out near these sites to determine the effect upon the local ecosystem, with the results being "no bioaccumulation of chemicals found on fish and sandworm."[11] This essentially means that this is a safe way to get rid of the red mud.

2.4.3 Drying

One more idea, which is probably the most utilized, is the process of drying out the red mud and then storing it in that form. There are various different ways to dry this red mud, from using a vacuum drum filter to a hyper baric filter (also known as hi-bar filtration). Below is an image of the process of this dry mud stacking technique.

[10] (Huan and Bánvölgyi n.d.)
[11] (Huan and Bánvölgyi n.d.)

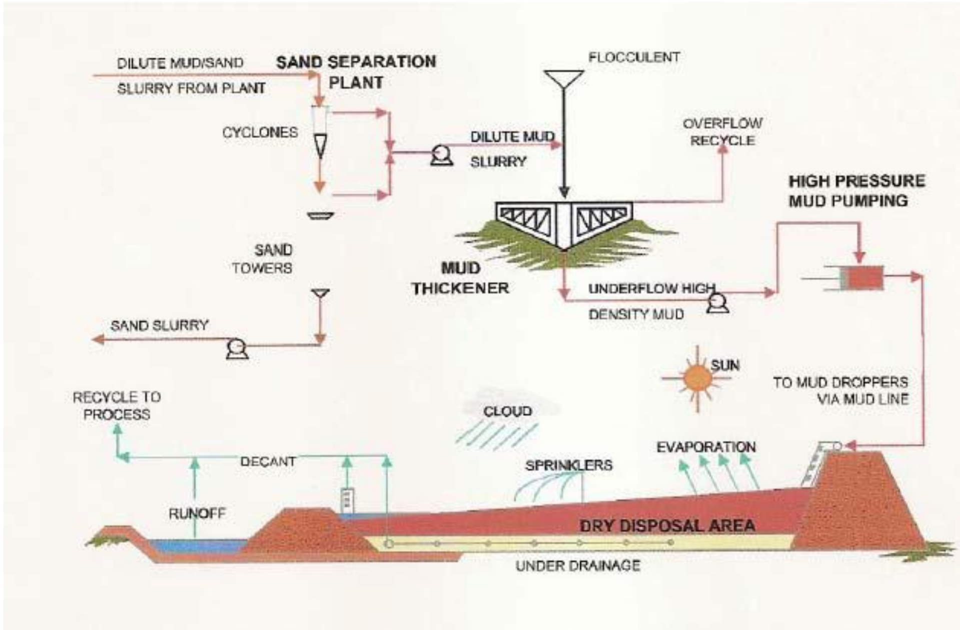


Figure 7 - Dry Mud stacking system[12]

As this picture demonstrates, the process is very streamlined and it works.

2.4.4 Oil Production

Another, somewhat recent idea is to use this red mud in a process that turns oil from agricultural and forestry byproducts into usable heating fuel.[13] This idea to combine the two substances of red mud and agricultural byproducts was thought up by a Professor Marcel Schlaf at the University of Guelph. "Schlaf made his discovery while investigating ways to lower the high acid levels found in 'bio oil'. Bio oil is produced by pyrolysis - subjecting biomass to high temperatures for short periods while excluding air."[14] After tests of this idea it was found that the red mud contained the perfect amount and mixtures of metals which in fact "catalyze a chemical reaction in the oil to lower the acid level of the organic liquid and produce higher-grade oil."[15] This process also takes the previously toxic red mud and makes it inert, even usable as a building material or spreadable as topsoil.

[12] (Huan and Bánvölgyi n.d.)
[13] (Prof discovers way to recycle red mud 2010)
[14] (Prof discovers way to recycle red mud 2010)
[15] (Prof discovers way to recycle red mud 2010)

2.4.5 Lowering pH levels

On top of all of these methods there is also the possibility of taking the red mud and then mixing it with certain chemicals to reduce its pH level. This process then renders the red mud inert and spreadable as topsoil. It can also then be utilized as building material, stacked together to form bricks and flooring tiles.

2.4.6 Drawbacks

These ideas are helpful and capable of putting the red mud out of sight and mind, but unfortunately the cost to implement any of these is quite high. For the lake storage method, money is not as much of an issue as the liability associated with a giant lake of toxic sludge, and the potential for catastrophe that exists with it. For methods like the sea disposal it is evident that it works at neutralizing the red mud and there are no storage issues, but piling it onto a ship just to dump it out at sea can be extremely expensive, and the material is not being recycled like it could be. For methods like the oil production it is evident that red mud can be turned into something useful, but this technology is both new and underdeveloped.

As of yet no company or process has been able to recover the metals that make-up red mud in an efficient and cost effective way. Despite numerous attempts and many false claims of a solution, none exists. However, rigorous testing has proven that ABC’s new method is not only capable of extracting these usable metals in a cost-effective way, but also makes any left-over red mud nontoxic and spreadable as topsoil. It solves the issue of price and use of the material that all of the above options simply do not.

3.0 System dynamics

System dynamics is a modeling technique utilizing computer simulation for the purpose of defining, understanding, and analyzing complex issues and problems. It was created in the 1950's by Professor Jay Forrester at the Massachusetts Institute of Technology.[16] Forrester came to MIT to pursue his graduate degree in electrical engineering. In time, he began to apply his background in science and engineering to the world of corporate management. His goal was to determine how this knowledge could be used to address the issues that determine the success or failure of corporations. He became involved with managers at General Electric, and worked to determine the cause of a significant three-year cycle in employee hiring and layoffs at their appliance plants. Forrester performed calculations by hand which were intended to replicate the existing corporate decision-making structure. From these he was able to show how the instability in GE employment was due to the internal structure of the firm and not to an external force such as the business cycle. These hand simulations were the beginning of the field of system dynamics.

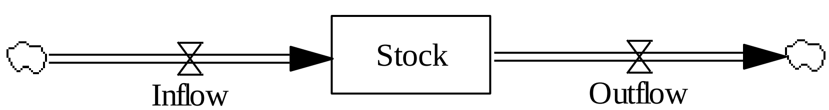
During the late 1950s and early 1960s, Forrester and a team of graduate students transformed the hand-simulation method that was used at the time into the formal computer modeling method that is currently practiced. For a time, system dynamics was focused solely on corporate/ managerial problems, and Forrester's book Industrial Dynamics became a classic in this realm.[17] In 1968, John Collins, the former mayor of Boston, became an acquaintance of Forrester's and the two began to discuss the problems of cities and how system dynamics might be used to address these problems. This was the first major non-corporate application of system dynamics, and the result of these discussions was a book called Urban Dynamics. This book became quite controversial, however, as the model presented in the book illustrates why many well-known urban policies are either ineffective or make urban problems worse. It also showed how often times counter-intuitive policies would yield surprisingly effective results. For example, a policy of building low income housing was shown to actually *create* a poverty trap that helps to stagnate a city, while a policy of tearing down low income housing creates jobs and a rising standard of living for all of the city's inhabitants.

[16] (Intro System Dynamics n.d.)
[17] (Intro System Dynamics n.d.)

In 1970, Forrester was invited by the Club of Rome to a meeting in Switzerland. This meeting was focused primarily on what is called “the predicament of mankind”. That is, the possible global crisis that may arise as a result of the world’s exponentially growing population and the strain that would put on the world’s finite resources. The model that resulted from this meeting eventually evolved into the WORLD2 model, and was used to identify policy changes capable of moving the global system into a sustainable path and avoid a socioeconomic collapse that was shown likely to occur during the twenty-first century. This model was later expanded by Dennis Meadows, a student of Forrester’s. This model was known as WORLD3, and was later published in a book titled *The Limits to Growth*.[18]

System dynamics models are made up of mathematical equations which attempt to recreate the relationships between variables that exist in the real world. The computer then performs these calculations over and over again at tiny intervals, or time steps. Once the simulation is complete, the modeler can then look at graphs that show the time shape of a chosen variable, graphically displaying the value of that variable at any given time and how it changes over the length of the simulation.

In system dynamics, there are stocks and flows. Stocks, or levels, can be thought of as “bathtubs” that hold a given amount of “stuff”, while the flows are the rates at which the stock changes. Just like in a physical bathtub, stocks generally have inflows (the faucet) and outflows (the drain), though they can sometimes have one or the other. These rates of change can either be fixed, or they can change depending on the surrounding algebraic structure of the model.



3.1 Why system dynamics should be incorporated into plans

The goal in making any system dynamics model is to learn about the real world via computer simulation, and it is the task of the modeler to determine the relevant variables and feedback loops that should be included in order to best replicate the dynamics that the real

[18] (Intro System Dynamics n.d.)

system displays. The modeler can then go back and change variables and initial values in order to shed some insight on possible solutions to the real world problem. For the purposes of this project, however, we were interested in simulating a series of future cash flows for the proposed red mud business, under numerous different potential scenarios. Extensive research was done to approximate the market value of the metals ABC plans to extract and sell, and different simulations were done to show what could happen to the value of the company given the best, worst, and most likely future price levels. In addition, several possible scenarios were modeled to show what could happen should an unforeseen event such as a shortage of necessary chemicals or an accident that requires the facility to be shut down for a period of time. System dynamics is an ideal tool for such simulations, and by including a system dynamics model in a business plan it enables the modeler to create a dynamic business plan that can be adjusted to show these types of alternate futures.[19] This is important in presenting the proposed business to potential investors as the presenter is better prepared to address the uncertainty inherent in any new business venture. This is especially true in cases like ABC Corp where the success of the business is largely dependent on factors outside the firm itself, in this case the volatile metals market. These types of simulations cannot be done with simple spreadsheet modeling. In spreadsheet modeling, there are no feedback loops, delays, or any other non-linearities. This makes spreadsheets more practical for entering data in simple cases and creating a model that can help predict future values, but system dynamics is much better suited for long-term, non-linear problems such as a business plan.[20] System dynamics allows the modeler to create different future scenarios based on different "what-if" scenarios, and that is why it offers a distinct advantage over spreadsheet modeling when it comes to modeling the complexity and uncertainty that comes with a new business venture.

[19] (Kennedy n.d.)
[20] (Myrtveit 2007)

4.0 Business Plan

ABC Corp.

(a newly formed subsidiary of Organic Technologies Corp LLC, focused on metals recovery from waste streams – aka Red Mud – of Aluminum manufacturing)

President/CEO Paul Kennedy

COO Fred Rucker

1.0 Executive Summary

ABC Corp. is a new business entity that has been established by Organic Technologies Corp, LLC, a Milwaukee Wisconsin based technology development firm, to market a patented fine particle separation process for metal recovery in the waste streams of Aluminum and Steel manufacturing. This process uses an innovative combination of physical and chemical forces to accomplish the desired outcomes in a low-energy, ambient temperature, no-emission, and economically attractive fashion. ABC was established as a new globally focused entity to license and establish metal recovery facilities adjacent to Red Mud waste sites at Bauxite reduction facilities. The ABC process neutralizes the material and allows the separation of 80% to 90% of the embedded metals based on their market values. The materials currently removed are: Iron in the form of either black oxide fine particles or pelletized Iron oxide for smelting; Aluminum Oxide for smelting and Titanium dioxide.

With over 3 billion metric tons of Red Mud in sites around the world, ABC is positioned to address 2 important challenges representing a multi-billion dollar business opportunity for ABC and its investors. The first challenge is addressing an enormous environmental issue of Red Mud storage and disposal. Red Mud is toxic in either a wet or dry form and, as evidenced by a massive spill in Hungary in 2010, can destroy plant and animal life for multiple square miles upon a breach of holding ponds. These waste ponds represent a huge potential liability for the Aluminum makers and have, at present, no positive economic value to these manufacturers. The second challenge lies in addressing the global demand and cost for raw materials required for steel and aluminum manufacture, which require significant mining and material logistics investment. The ABC process reduces the volume of toxic waste associated with Red Mud by a factor of 95%, while yielding valuable recovered metals and organically rich top soil, using a low energy, low heat, environmentally friendly or "green" process that has significant financial benefits to all stakeholders.

This technology has been developed with a suite of like technologies by Organic Technologies Corp over a period of 20 years. It has been Patent Pending and has been proven through the bench and small demonstration phases. In Phase II it is the desire of ABC to raise capital to build a full operational demonstration plant to prove out the plant ecosystem in the logistics and sales points of operation.

There are three initial candidates for commercial launch of this technology: 1) in China, through the establishment of a new, independent entity organized by a highly successful Chinese business executive, Glenn Yee, the Chairman and CEO of Pacific Can, one of China's largest makers of aluminum cans; 2) in Hungary, at the site of an old Aluminum manufacturing plant which experienced the internationally reported, massive Red Mud spill in the fall of 2010. The Hungarian sites contain nearly 50 million metric tons of Red Mud waste which would support the deployment of an ABC facility initially scaled to process 500,000 to 1,000,000 metric tons per year of Red Mud; and, 3) in the USA, in a strategic collaboration with Alcoa, the world's largest aluminum maker.

ABC seeks one or more strategic investors to launch commercial operations in these attractive markets. This business plan calls for an initial investment of $2,670,000 to launch the global entity and provide the seed capital to establish at least one commercial operation in China, Hungary or the USA by end of year 2013. Depending on the capitalization structure, these country specific operations can be structured as independent business entities with a minority ownership holding by ABC. In China, for example, it is envisioned that the Chinese business partner will hold a controlling share in the equity of the Chinese operation and pay license and chemical product consumption related fees to the ABC global entity. For a full scale production facility, capital costs will typically run between $20,000,000 and $30,000,000.

It is fully understood that this business plan describes the development and implementation of the ABC process through the operation of the first full production facility. Concerning the implementation of follow on Plants: It is the management intention to explore those opportunities and strategic alternatives such as continued deployment, licensing or strategic partnering as the velocity of demand for this technology in the market is defined.

Business Plan Highlights:

1.1 Business Objectives

1. Reduce global pollution by converting the byproduct of the Bayer method, Red Mud, into usable and sellable metals.
2. Generate a profit by selling the recovered metals as raw material at market value.
3. Build facilities at profitable Red Mud reservoirs in order to produce the largest volumes of recovered metals and maximize shareholder equity.

1.2 Mission

ABC's mission is to clean up pollution caused by the creation of Aluminum via the Bayer process. This service would recover metals from the Red Mud and render the rest inert and usable as topsoil.

1.3 Keys to Success

1. **Location:** preferred to be located next to a Red Mud reservoir to eliminate transportation costs.
2. **Strategic Relationships:** build and maintain strategic alliances with Aluminum producing companies in order to maintain a constant input.
3. **Management:** manage the business well by paying close attention to the metal markets and knowing when to sell the materials in order to maximize profits.

2.0 Company Summary

2.1 Company Ownership

ABC is a privately-held C corporation owned in majority by an American technology firm, Organic Technologies Corp LLC, a Milwaukee Wisconsin based entity. Country or Region specific ABC affiliated entities will be establish as independent entities with capital structures dictated by the terms of investment.

2.2 Summary of Financial Requirements

Initial ABC Global Start-up Requirements	
Legal Fees & Patent Filing	$300,000
Office Rent	$36,000
Managerial Payroll	$144,000
Subsidy Related Costs	$180,000
Travel Expenses	$10,000
Total Start-up Cash Expenses	$670,000
Initial Production Demo Facility	$2,000,000
Full Scale Production Plant Capital	
Start-up Inventory	$748,800
Other Current Assets	$5,000,000
Long-term Assets	$27,000,000
Total Assets	$32,748,800
Total Requirements	$35,418,800

Table 2

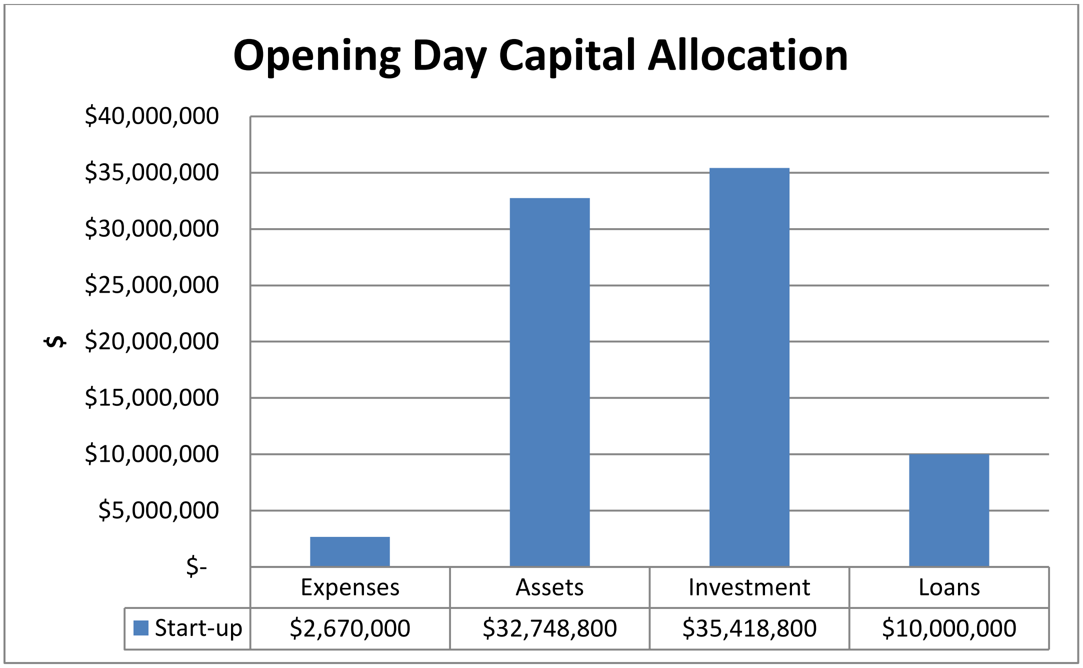


Figure 1

3.0 Products and Services

ABC uses a patent pending chemical and process that breaks down Red Mud into its component parts. Thus, ABC provides both a service that cleans up environmental waste as well as raw material products that are to be sold on the open market. The remainder can be used as inert topsoil, which has been verified by the EPA.

These plants can operate anywhere in the world and are only limited to where there is Red Mud. The recovered metals, mainly Alumina, Iron Ore, Black Iron Oxide, and Titanium dioxide, can then be sold at market price anywhere in the world.

4.0 Market Analysis Summary

Global production of magnetite in 2010 was estimated at 1.08 billion tons. At peak production, the Hungarian plant should produce around 240,000 tons per year. In our market research, we found the price of iron ore has increased drastically in recent years as a result of fast-growing developing economies in India, Brazil, South Africa and China.[21] Because of this, the iron ore market has seen great expansion in production and investment in additional capacity, especially in large, global corporations such as Alcoa, Rio Tinto, BHP, and Vale. In fact, forecasts from the Australian Bureau of Agricultural and Resource Economics and Sciences predict that global exports of iron ore may gain 28 percent to 1.4 billion metric tons by 2016. Even so, iron ore remains a tight market, and prices are projected to continue to

[21] (FitzGerald 2011)

advance in the near future—as high as $158[22] a ton by the fourth quarter 2012. However, over the next two years global iron ore capacity is poised to outgrow global steel demand, and experts at Goldman Sachs contend that the iron ore market will move into over-supply in 2014, at which point prices should fall significantly. However, projections are that the price should stabilize at around $80 per ton—three standard deviations from where it currently trades (using a 12 month moving average). [23]

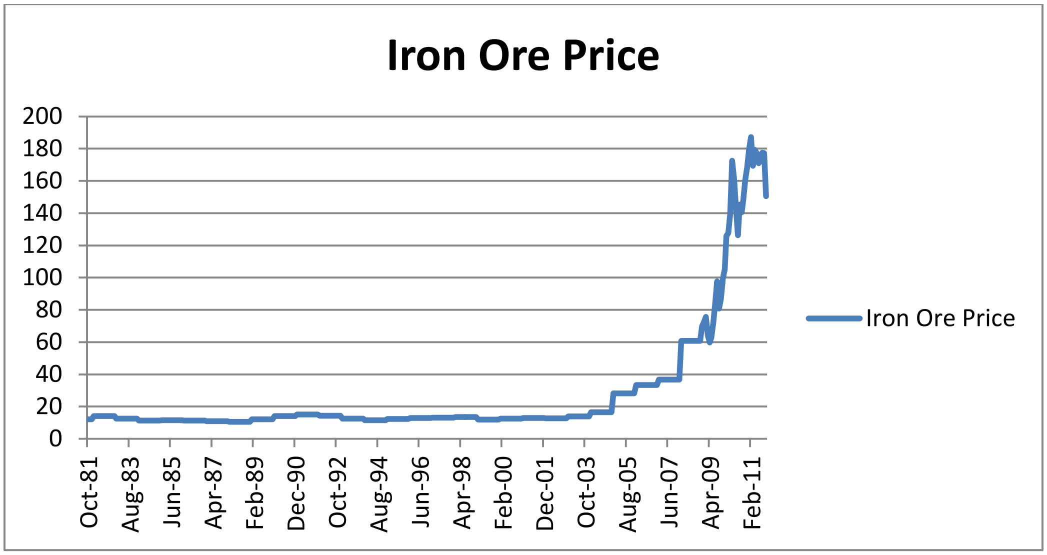


Figure 8 - Iron Ore Price

In addition to raw iron ore, ABC Corp. is also able to produce high-purity, fine particle black oxide from the magnetite content it is extracting. This is generally used in paint products and as an industrial coating to protect metals from corrosion. While black oxide is not an exchange-traded commodity and is therefore difficult to estimate the size of the market, in contacting professionals within the industry we found that it currently retails for about $0.79 per pound, or about $1,740 per metric ton. As such, ABC is confident that it can receive a conservative price of $1,100 per metric ton of black oxide produced and sold on the wholesale market.[24]

Global production of titanium dioxide has been growing recently; it is estimated that global production may reach 7.5 million tons per year in the near future. At peak production, the Hungarian plant should produce about 60,000 tons per year.[25] Because of its brightness and very high refractive index, it is the most widely used white pigment in the world. As such, it is used in paints, coatings, plastics, papers, inks, foods, medicines, cosmetics, and most toothpastes. While some of these products such as plastic, paper, and ink are subject to the business cycle and would likely see a drop in demand in the event of a global recession, food, medicine, cosmetics, and toothpaste are consumer durables and can therefore be expected to remain relatively stable in demand and price. Also, paint products tend to be counter-cyclical,

[22] (Newswires 2012)
[23] (Yuan 2011)
[24] (Carpentaria Exploration Limited n.d.)
[25] (MarketPublishers, Ltd. 2010)

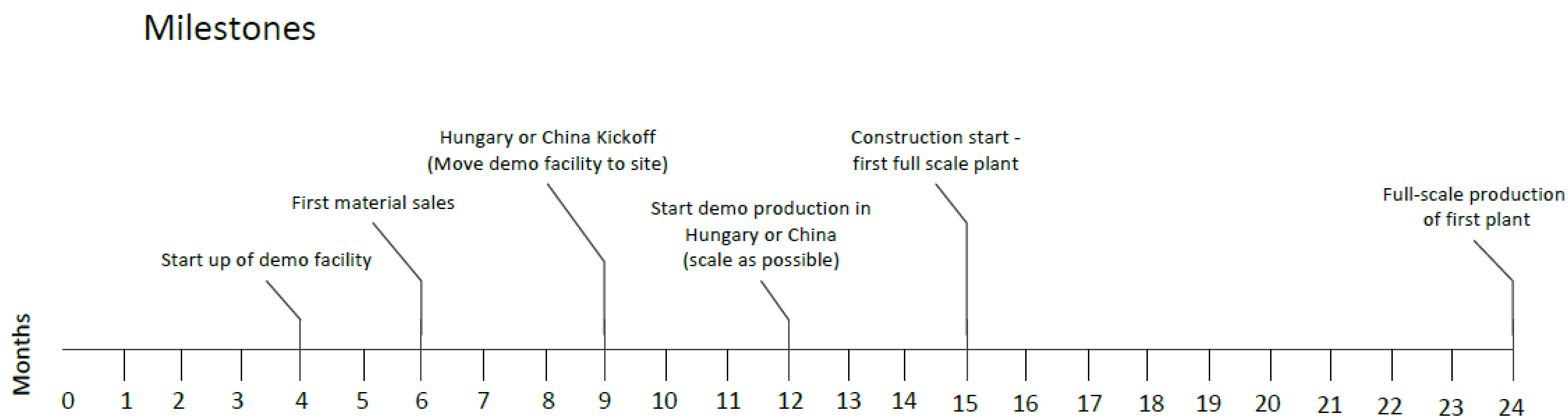
as tough economic times cause people to want to improve the value of their homes. This bodes well for both titanium dioxide and black oxide prices in the event of a global slowdown, which provides added security to ABC and its investors. In speaking with industry professionals, we found the price of titanium dioxide to generally range between $1.40 and $2.20 per pound, and currently trades at around $1.70 per pound in the retail market. We figure a conservative wholesale price to be about $1.25 per pound, giving us around $2,750 per ton of titanium dioxide sold on the wholesale market. In addition, we were told that the price generally experiences a 5-10 cent pop in the spring and summertime from added demand once warm weather returns.[26]

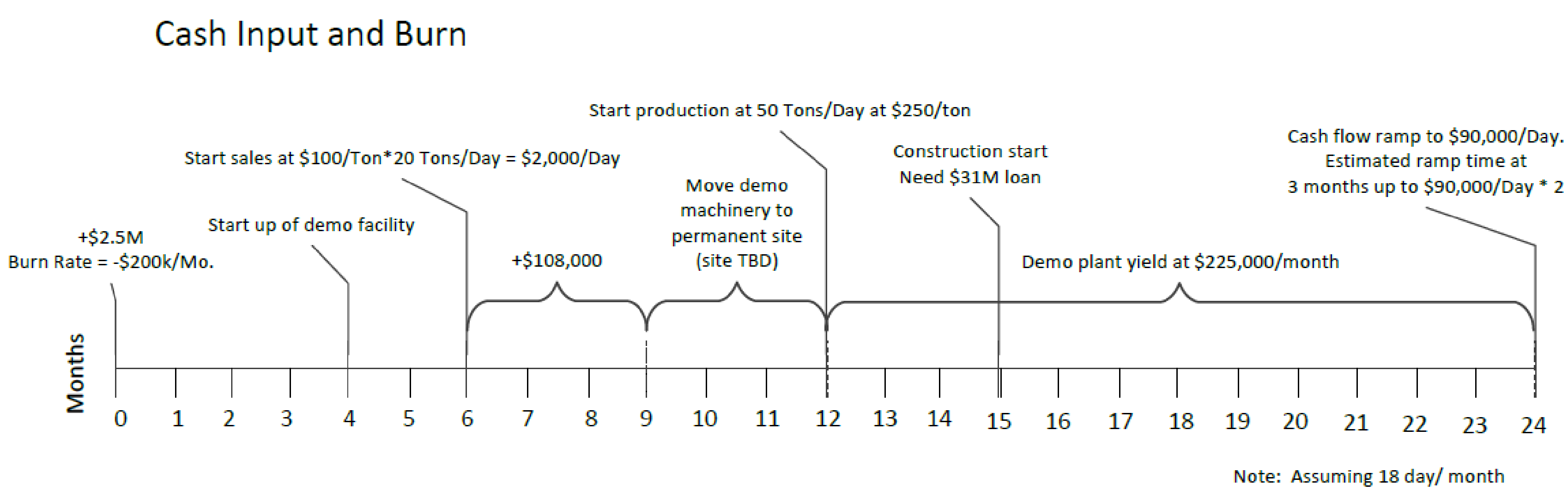
Global production of aluminum is strong, with over 20 million tons produced annually. Alumina is becoming more valuable as a result, and at peak production we should be able to produce over 120,000 tons per year. Aluminum as a finished metal currently trades at about $2,000 per ton, and our research has shown that a good rule of thumb in the past for the price of alumina has been around 15% of the cost of aluminum, or about $300.[27] In addition, recent articles found online are showing even higher peak prices, around $420 per ton as of March, 2012. However, discussions with Alcoa gave us a rate of about 8 cents per pound, or about $175 per ton, which we shall use as a conservative estimate for our base case scenario. Currently, aluminum production is picking up as the global economic recovery continues, though a shock to global markets would cause this to reverse as aluminum is heavily dependent on global industrial production, especially in emerging markets such as China.

Figure 9 - Alumina FOB in Australia[28]

[26] (MarketPublishers, Ltd. 2010)
[27] (Aluminum Industry n.d.)
[28] (Aluminum Industry n.d.)

5.0 Timeline and Milestones





5.1 Timeline explained

As you can see on the previous page there are two different timelines. One accurately shows the milestones of this company, while the other shows the cash input and cash burn rate. The milestones start at month four and show the start-up of the demo facility, then move on to the first sales and profit. The cash input and burn show some of the numbers, specifically how much this company will be earning at different times throughout the first two years of operation.

These timeline runs under the assumption that 80% of the equipment is off the shelf. This means that the machines are available to buy right away and will not have to be custom designed or built. This ends up being a big time saver and allows ABC to earn more money in the long run. Another very important note about these timelines is that they are also very conservative. The numbers regarding the cash input and burn start off very low, and are for the most part 50% of what they should be. These numbers can speak for themselves.

From these timelines it is easy to see the development of this company and how it progresses throughout the years. It can be seen that the development process after the first 24 months is now a matter of scaling up the operation as opposed to developing new technology.

6.0 Strategy and Implementation Summary

6.1 SWOT Analysis

The following SWOT analysis captures the key strengths and weaknesses within the company, and describes the opportunities and threats facing ABC.

6.1.1 Strengths

1. Turns aluminum producer liabilities into assets.
2. Provides a new source of production for aforementioned metals. In other words, when it is not financially wise to mine these metals they can be harvested from existing red mud waste.
3. This company is unique. As their technology is patent protected, there is no other company in the world that can do what ABC does.
4. ABC's process has a very low operating cost and a high potential reward
5. Solves long-standing environmental issue.
6. Vast supply of red mud with over 5 billion tons in the world.

6.1.2 Weaknesses

1. Revenue is dependent upon volatile metals market.
2. Scalability of ABC plants and production rates at an aggressive rate is required. This will require strategic financial partners.

This business hinges off of gaining profit from the metals market. At times this market can go up and down, even left and right without warning, playing havoc upon ABCs profit. A way to go about and solve this dilemma is to lock in a price in the metal futures market. This will ensure that the income line will be more stable and not be dependent upon the little bumps and dips in price that happen on a daily basis.

Another factor when dealing with income is how much red mud can be processed per day. Once a red mud source runs out then another one must be found or else ABC will not be profitable. In order to combat this possibility it is in ABCs best interest to find strategic financial partners who would provide a constant supply of red mud. This would then ensure that ABC does not run out anytime soon. As of right now this is not a huge risk seeing as how there are billions of tons of red mud in the world and they are all a liability on those companies that hold them. In the near future it should be a simple matter to get as much red mud as needed.

6.1.3 Opportunities

1. As long as aluminum is being produced through the Bayer process, there will be a growing supply of red mud for ABC to harvest.
2. Potential for global growth. Aluminum is made all over the world, and when producers realize that ABC offers a real solution to the red mud problem it will experience strong growth by expansion around the world.
3. Strategic alliances would help to produce a steady income independent of metal prices.

6.1.4 Threats

1. Competitors somehow reverse-engineering the process.
2. Serious global recession that sends metal prices to the floor, leaving ABC unable to turn a sufficient profit to justify investment.
3. Governmental threats in Hungry

It is always a possibility in business that another company can reverse-engineer your design, then that company can produce the same product and undersell yours. Unfortunately this is also a possibility for ABC. Once other companies see how well this process works they will want to get in on those profits and try to steal the design. In order for this not to happen a patent is currently being developed. Once that process is complete this idea will only be ABC's and no one else's.

The current global economy is one that has had ups and downs. A threat to this company is if that economy experienced a recession which would make the metal prices plummet. For a company that makes all its profit off the market that would obviously be disastrous. One cannot afford to think like this though, global recession is always a possibility but a very distant one, and it should not be worried about.

In Hungary, where the first plant will be installed, there has been a lot of political movement recently. The important thing to note is that the government is taking control of the judiciary system. They are replacing judges with government friendly ones and moving the retirement age forward, effectively kicking them out. Overall this should not be a problem but it is definitely something to look out for.[29]

[29] (New York Times 2012)

6.2 Competitive Edge

Because of the fact that the majority of the metals that are produced from this company are sellable on the world market, it turns out that the competition lies with the big producers in the world, such as RioTinto. The competitive edge that this company has is the ability to produce the same kind of metals that RioTinto does at a constant low price.

In addition, there is no real competition for red mud recovery technology. Currently aluminum producers are able to neutralize the acidity of the red mud, making it less environmentally hazardous. Companies like Alcoa also incorporate a drying process that turns the red mud into bricks.

There is no direct competition to ABC’s patented technology.

6.3 Sales Strategy

6.3.1 Sales Forecast

For the purposes of this business plan, a system dynamics model was created to simulate the cash flows given different circumstances out of ABC’s control, such as changes in metal prices or supply chain disruptions. For metals pricing, there are four distinct cases: the base case, the best case, the worst case, and the most likely case. To illustrate some possible negative situations that could arise in the course of doing business in a brand new industry, we ran simulations using the base case price structure that include a) a disruption in the supply chain for the chemicals necessary to separate the red mud, b) a corporate tax rate hike, c) required payments for the red mud, and d) an event that causes a prolonged shutdown of the facility.

6.3.1.1 Base Run

- All prices constant through year 5
    - Alumina = $175/ tonne
    - Iron Ore = $130/ tonne
    - Black Oxide = $1100/ tonne
    - 50% allocation of iron content between iron ore and black oxide
    - TiO_2 = $2750/ tonne
    - 30% Corporate Tax Rate
    - Chemical Inventory Coverage = 2 months

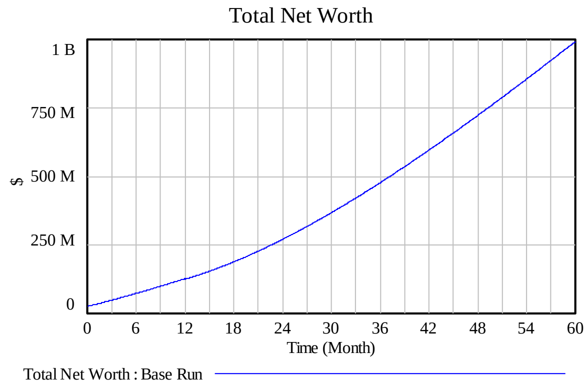


Figure 10 - Base Run Total Net Worth

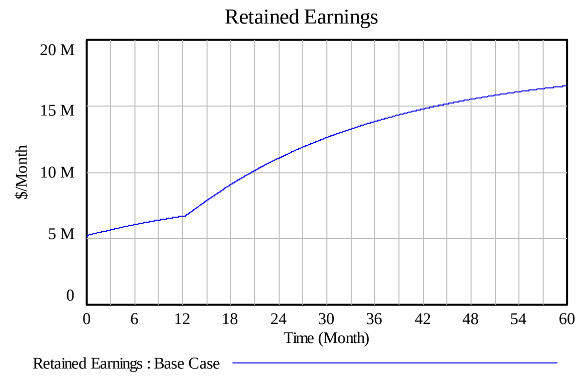


Figure 11 - Base Run Retained Earnings

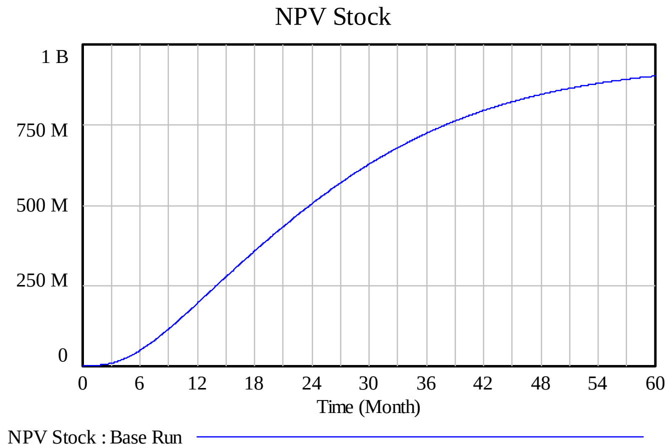
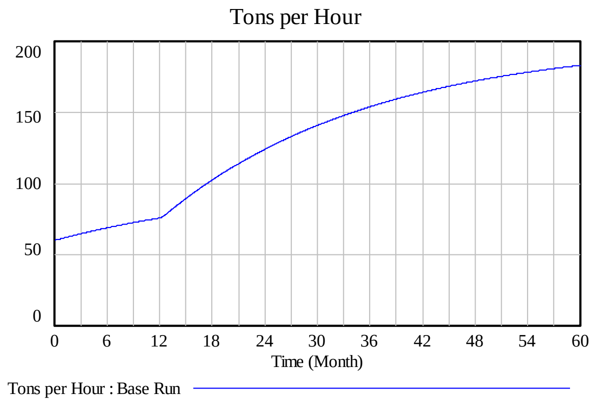


Figure 12 - Base Run NPV Stock

*NPV uses a 10% discount rate

6.3.1.2 Operational Efficiency (Metric Tons/ Month)



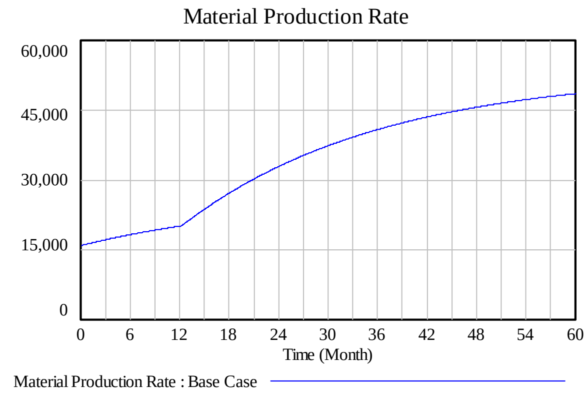


Figure 13 - Red Mud Processed

Figure 14 - Sellable Materials Produced

6.3.1.3 Sales Revenue Breakdown ($/ Month)

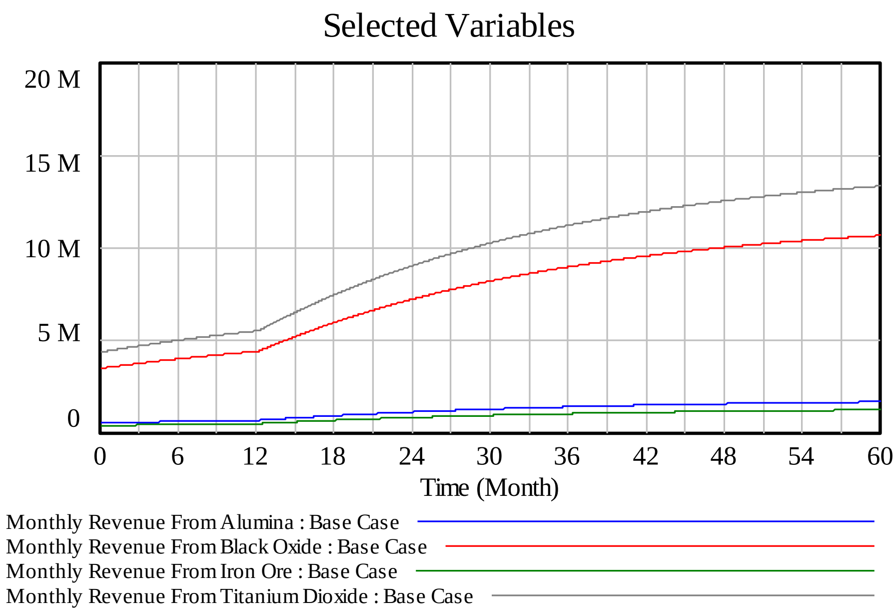


Figure 15 - Sales Revenue Breakdown

6.3.1.4 Potential Negative Situations

a) Chemical Shortage

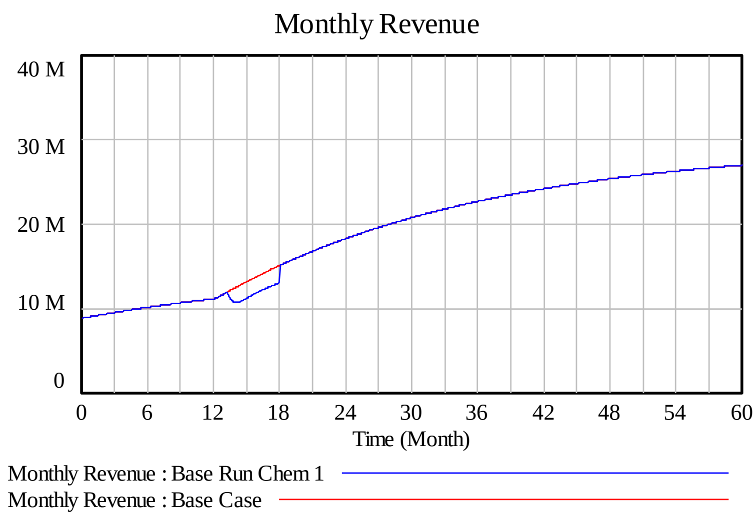


Figure 16 - Chemical Shortage

The chart above shows the base case with a shock initiated at time 12 that brings the time to receive new chemicals from 2 weeks to 3.5 months. This would be a rather serious disruption, but it would have little impact on the bottom line. However, this shock only lasts for 6 months. A similar shock lasting 12 months is shown below.

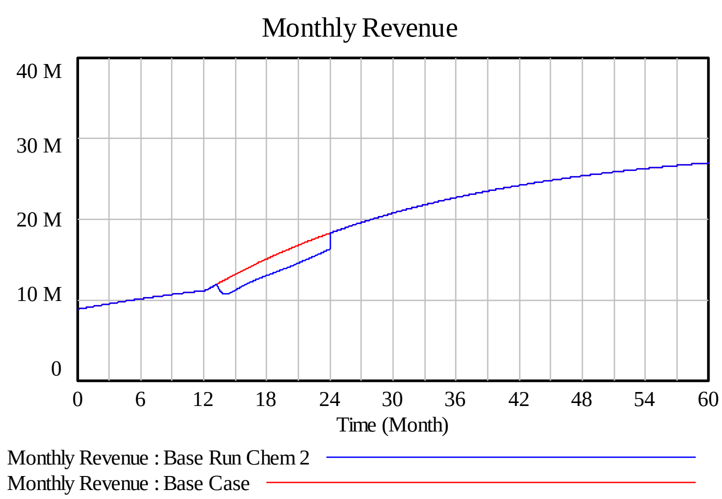


Figure 17 - Twelve Month Chemical Shortage

As long as the firm carries enough chemicals to serve its needs for at least 2 months, a shock to the chemical ordering structure would have little impact on the firm's monthly revenue or total net worth. However, it is important for ABC to keep a sufficient supply of chemicals on hand in order to avoid suffering from a serious bottleneck in production capacity. Simulations have shown that ABC must carry at least 1.5 months of chemicals in order to avoid such a bottleneck, though it is important to note that in reality certain parameters may end up differing from those used in the model.

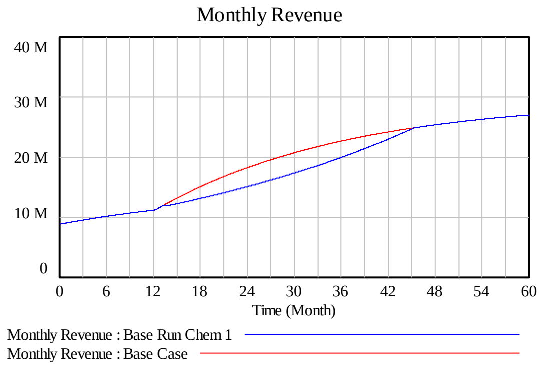


Figure 18 - Chemical inventory coverage of 5 weeks

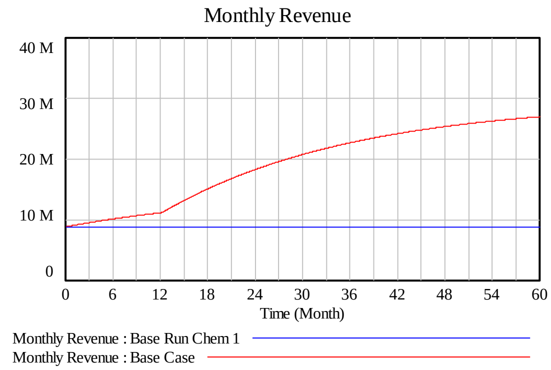


Figure 19 - Chemical inventory coverage of 1 month

It is also important to note that while 1.5 months of chemical inventory coverage may be sufficient enough to avoid a bottleneck in the amount of red mud that can be processed, a shock to the time to receive more chemicals as described above would be more disruptive to the firm in this case than if it had a 2 month supply on hand.

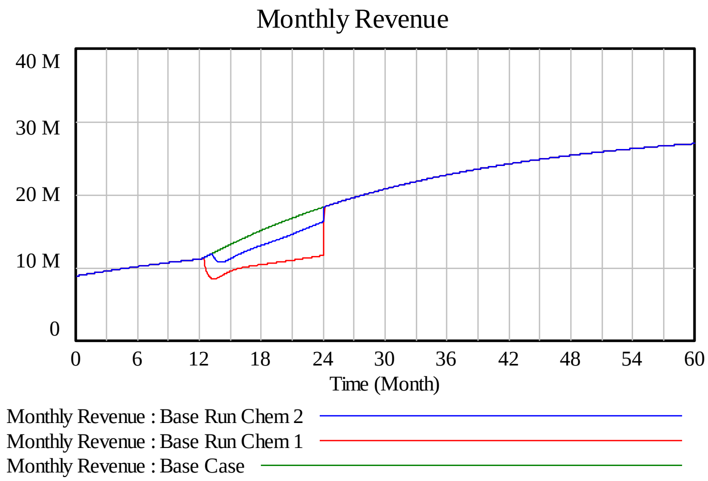


Figure 20 - Chemical Shortage Shock

*Base Run Chem 1 = 1.5 months chemical inventory coverage
**Base Run Chem 2 = 2 months chemical inventory coverage

b) Tax Hike

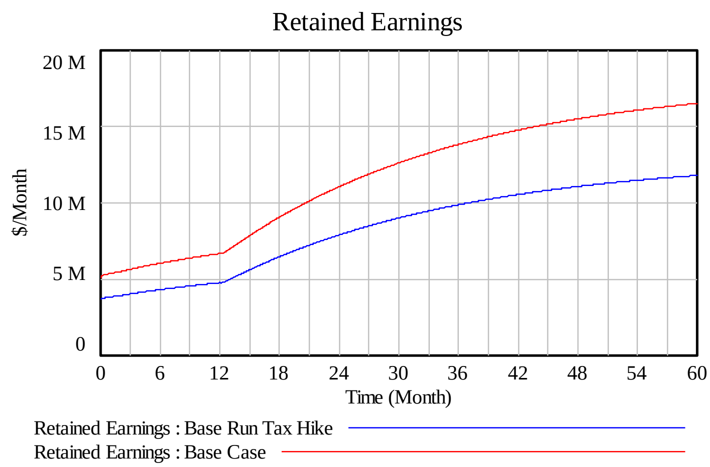


Figure 21 - Tax Hike

A rise in the corporate tax rate from 30% to 50% would obviously drive retained earnings down. However, this would not have much of an effect on the long term total net worth of the proposed project.

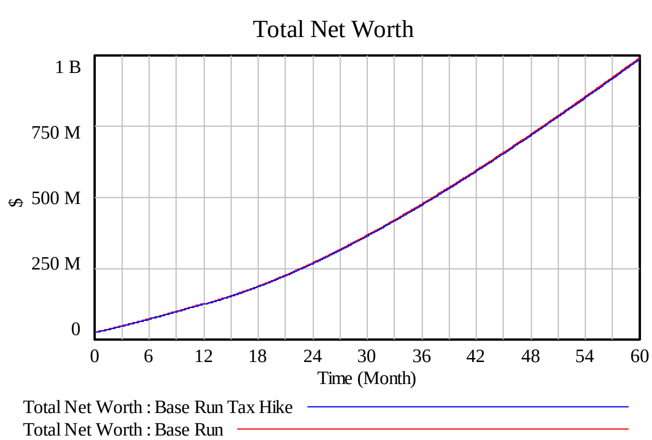


Figure 22 - Net worth with tax hike

Payment Required for Red Mud

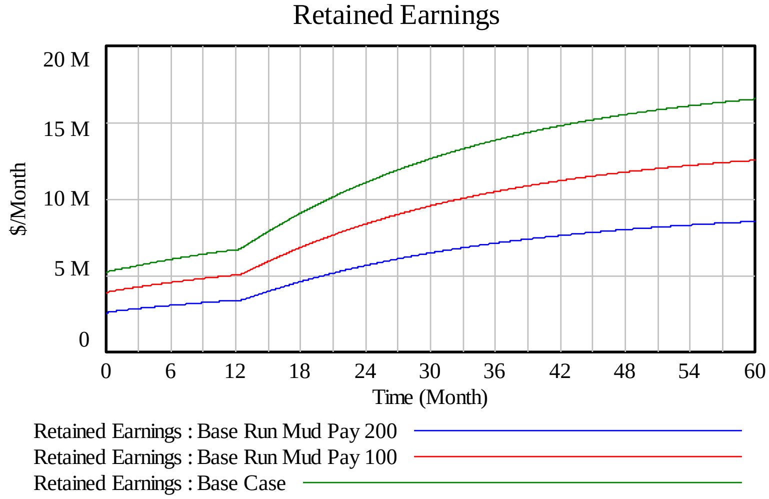


Figure 23 - Payment required for Red Mud

Under the base case scenario with no additional negative situations, ABC is able to pay at least $200 per ton of red mud while still remaining profitable. However, this would certainly cut a large portion out of retained earnings.

c) Production Downtime (Labor Strike or Mechanical Breakdown)

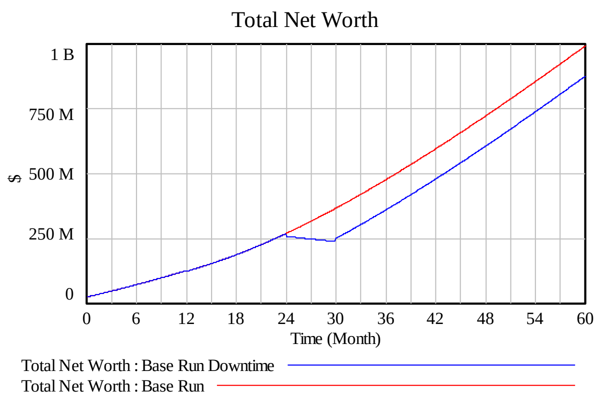


Figure 24 - Six month production downtime

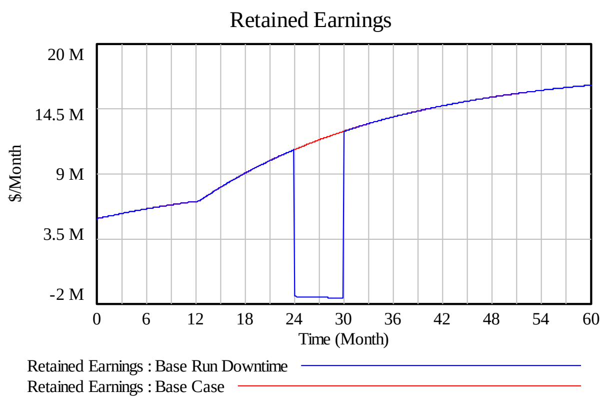


Figure 25 - Retained earnings with production downtime

In the event of a sudden and prolonged shutdown in production, either as a result of a labor strike or accident that requires a temporary shutdown, retained earnings would become negative for the time being as ABC would still have expenses it had to pay. However, assuming they are able to resume production after some time (6 months in the above simulation), the drop in total net worth by year 5 would not be too substantial.

6.3.1.5 Best Case Scenario

- Continued commodity inflation means steadily rising prices for all outputs
  - Alumina = $175/ tonne, increasing @ 5%/ year
  - Black Oxide = $1100/ tonne, increasing @ 5%/ year
  - TiO2 = $2750/ tonne, increasing @ 5%/ year
  - 100% Black Oxide allocation to maximize profits
  - 30% Corporate Tax Rate

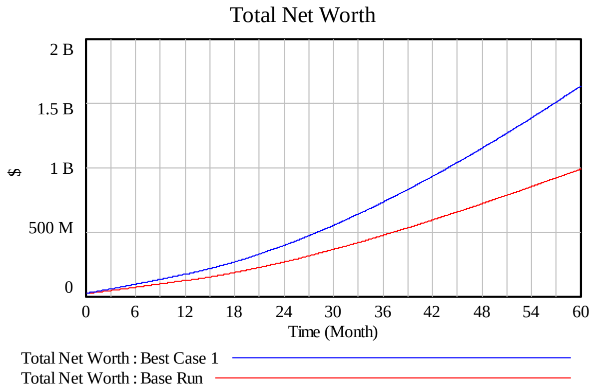


Figure 26 - Best case total net worth

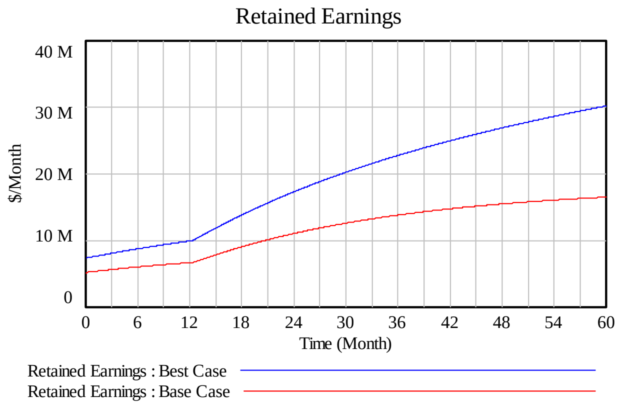


Figure 27 - Best case retained earnings

6.3.1.6 Worst Case Scenario

- Widespread deflation and collapse of global commodity markets
  - Alumina = $175/ tonne, decreasing @ 10%/ year
  - Iron Ore = $130/ tonne, decreasing @ 10%/ year
  - TiO2 = $2750/ tonne, decreasing @ 10%/ year
  - Unable to produce Black Oxide—100% Iron Ore allocation
  - 30% Corporate Tax Rate

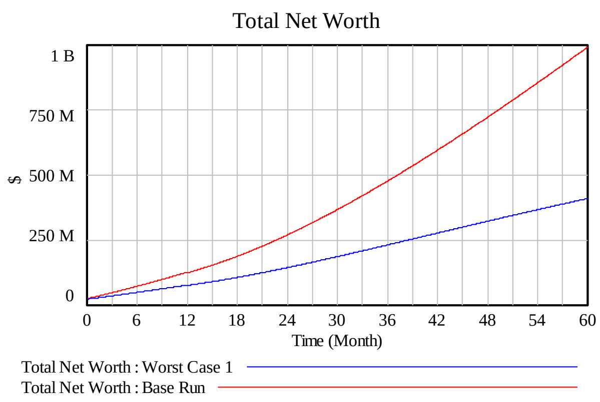


Figure 28 - Worst case total net worth

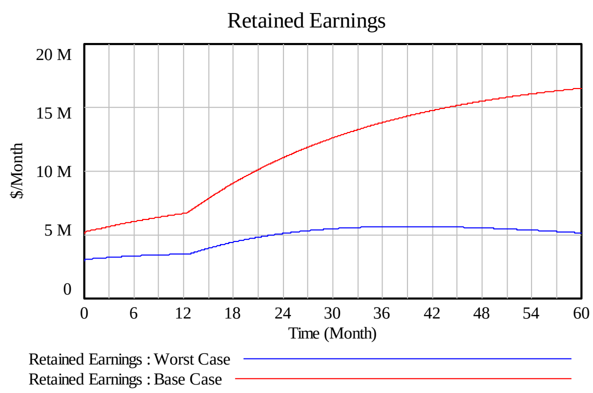


Figure 29 - Worst case retained earning

6.3.1.7 Most Likely Case

- Slowdown in Chinese growth means lower prices for Iron Ore and Aluminum
- Black Oxide and TiO2 are not affected, prices for these continue to rise slowly
    - Alumina = $175/ tonne, decreasing @ 5%/ year, price floor at $150
    - Iron Ore = $130/ tonne, decreasing @ 10%/ year, price floor at $80
    - Black Oxide = $1100/ tonne, increasing @ 2.5%/ year
    - TiO2 = $2750/ tonne, increasing @ 2.5%/ year
    - Effective Black Oxide allocation = 85%
    - 30% Corporate Tax Rate

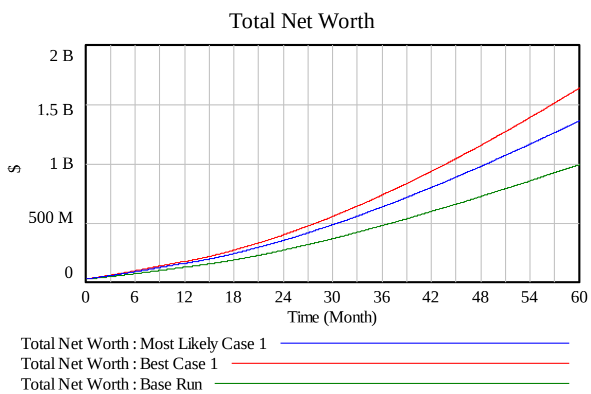


Figure 30 - Most likely total net worth

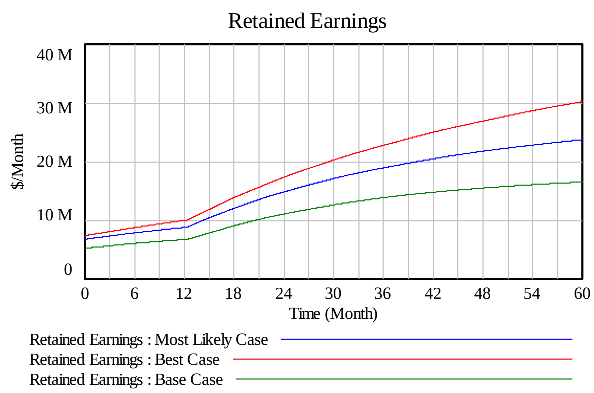


Figure 31 - Most likely retained earnings

7.0 Management Summary

Organic Technology Corp has tapped Paul Kennedy, a seasoned veteran from the Aluminum manufacturing industry to head up the ABC. The primary advisors to Mr. Kennedy are Denise Swink, USDOE retired; Elwin Rooy, Alcoa retired; and Fred Rucker a seasoned international business executive.

7.2 Exit Strategy

TBD

Appendix

Table: Profit and Loss

Assumptions	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Price Iron Oxide	-	130	130	130	130	130
Concentration Iron Oxide from processed	0%	20%	20%	20%	20%	20%
Price Al2O3	-	175	175	175	175	175
Concentration Al2O3 from processed	0%	20%	20%	20%	20%	20%
Price TiO2	-	2,750	2,750	2,750	2,750	2,750
Concentration TiO2 from processed	0%	10%	10%	10%	10%	10%
Price Black Oxide	-	1,100	1,100	1,100	1,100	1,100
Concentration Black Oxide from processed	0%	20%	20%	20%	20%	20%
Black Oxide % Allocation		50%	50%	50%	50%	50%
COGS % of sales	**0%**	**24%**	**34%**	**28%**	**25%**	**23%**
Operating Costs/Sales Iron Oxide		0%	0%	0%	0%	0%
Operating Costs/Sales TiO2		0%	0%	0%	0%	0%
Operating Costs/Sales Licensing	0%	0%	0%	0%	0%	0%
Estimated Tax Rate	**0%**	**30%**	**30%**	**30%**	**30%**	**30%**
US 10-yr Risk Free Rate	3%	3%	3%	3%	3%	3%
Expected Market Return	30%	30%	30%	30%	30%	30%
rE Cost of Equity	57%	57%	57%	57%	57%	57%
rD Cost of Debt	10%	10%	10%	10%	10%	10%
WACC	11%	11%	11%	11%	11%	11%
Royalties to TKV $/ton	2	2	2	2	2	2

Advertising and Product Placement costs	0%	0.05%	0.05%	0.05%	0.05%	0.05%
Dividend Payout Ratio	**0%**	**0%**	**50%**	**60%**	**80%**	**80%**
Managerial Salaries per annum	**72,000**	**150,000**	**150,000**	**150,000**	**150,000**	**150,000**
# of managers	2	2	2	2	2	2
Low Skill Employee's salary per annum (incl. provisions)	**-**	**21,000**	**21,000**	**21,000**	**21,000**	**21,000**
# employees	0	15	30	30	30	30
High Skill Employee's salary per annum (incl. provisions)	**-**	**35,000**	**35,000**	**35,000**	**35,000**	**35,000**
# employees	0	5	10	10	10	10
Suggested Sales Commission	**0%**	**5%**	**5%**	**3%**	**2%**	**1%**
Legal Fees+Patent filing+subsidy	**300,000**	**300,000**	**300,000**	**50,000**	**50,000**	**50,000**
Office rent/month	**3,000**	**3,000**	**3,000**	**3,000**	**3,000**	**3,000**
Facility Utilities per annum	**-**	**200,000**	**200,000**	**200,000**	**200,000**	**200,000**

Projected Income Statement	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenues:						
Iron Oxide Sales Price	**-**	**130**	**130**	**130**	**130**	**130**
Unit tons to be Sold (extract)	-	43,400	60,200	86,000	101,800	111,800
Total	-	5,642,000	7,826,000	11,180,000	13,234,000	14,534,000
Al2O3 Sales Price	**-**	**175**	**175**	**175**	**175**	**175**
Unit tons to be Sold (extract)	-	43,400	60,200	86,000	101,800	111,800
Total	-	7,595,000	10,535,000	15,050,000	17,815,000	19,565,000

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
TiO2 Sales Price	**-**	**2,750**	**2,750**	**2,750**	**2,750**	**2,750**
Unit tons to be Sold (extract)	-	21,700	30,100	43,000	50,900	55,900
Total	-	59,675,000	82,775,000	118,250,000	139,975,000	153,725,000
Black Oxide Sales Price	**-**	**1,100**	**1,100**	**1,100**	**1,100**	**1,100**
Unit tons to be Sold (extract)	-	43,400	60,200	86,000	101,800	111,800
Total	-	47,740,000	66,220,000	94,600,000	111,980,000	122,980,000
Tailing remainings tons	-	65,100	90,300	129,000	152,700	167,700
Total Tonnage to be Processed	**-**	**217,000**	**301,000**	**430,000**	**509,000**	**559,000**
Total Sales Revenue	**-**	**120,652,000**	**167,356,000**	**239,080,000**	**283,004,000**	**310,804,000**

Expenses	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Overhead:						

Demo Facility	2,000,000					
Managerial Payroll	144,000	300,000	300,000	300,000	300,000	300,000
Low Employee Wages	-	315,000	630,000	630,000	630,000	630,000
High Employee Wages	-	175,000	350,000	350,000	350,000	350,000
Office Rent	36,000	36,000	36,000	36,000	36,000	36,000
Utilities (power+water)	-	1,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Chemicals ($20/ton)	748,800	4,340,000	6,020,000	8,600,000	10,180,000	11,180,000
Tailings Discard ($30/ton)	-	1,953,000	2,709,000	3,870,000	4,581,000	5,031,000
Equipment Maintainence	-	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000
Shipping ($1k/30 tons sold)	-	3,616,667	5,016,667	7,166,667	8,483,333	9,316,667
Insurance	-	600,000	600,000	600,000	600,000	600,000
Royalties to TKV	-	434,000	602,000	860,000	1,018,000	1,118,000
Travel	10,000	10,000	10,000	10,000	10,000	10,000
Subsidy related costs (1.5% of received)	180,000	-	-	-	-	-
Legal Fees+Patent filing	300,000	300,000	300,000	50,000	50,000	50,000
Total	**3,418,800**	**14,579,667**	**20,073,667**	**25,972,667**	**29,738,333**	**32,121,667**
% of total operating expenses	*100%*	*71%*	*70%*	*78%*	*84%*	*91%*
Selling & Marketing Costs:						
Sales Commission	-	6,032,600	8,367,800	7,172,400	5,660,080	3,108,040
Advertising	-	60,326	83,678	119,540	141,502	155,402
Total	**-**	**6,092,926**	**8,451,478**	**7,291,940**	**5,801,582**	**3,263,442**
% of total operating expenses	*0%*	*29%*	*30%*	*22%*	*16%*	*9%*
Total Expenses	**3,418,800**	**20,672,593**	**28,525,145**	**33,264,607**	**35,539,915**	**35,385,109**

% of Total Sales Revenue	*0.00%*	*17.13%*	*17.04%*	*13.91%*	*12.56%*	*11.39%*
cost/units sold	***0***	***$ 136.09***	***$ 135.38***	***$ 110.51***	***$ 99.75***	***$ 90.43***
EBITDA/Operating Income	**(3,418,800)**	**99,979,407**	**138,830,855**	**205,815,393**	**247,464,085**	**275,418,891**
Capital Expenditures	27,000,000	2,000,000	1,000,000	500,000	500,000	500,000
Depreciation	-	3,000,000	2,000,000	1,000,000	1,000,000	1,000,000
% of total operating expenses	*0%*	*15%*	*7%*	*3%*	*3%*	*3%*
EBIT	**(30,418,800)**	**94,979,407**	**135,830,855**	**204,315,393**	**245,964,085**	**273,918,891**
Interest Expense ($10M, 5yr, 10%)	-	2,200,000	2,200,000	2,200,000	2,200,000	2,200,000
Taxes	-	28,493,822	40,749,257	61,294,618	73,789,225	82,175,667
Net Income	**(30,418,800)**	**64,285,585**	**92,881,599**	**140,820,775**	**169,974,859**	**189,543,224**
% of Gross Sales	*0.00%*	*53.28%*	*55.50%*	*58.90%*	*60.06%*	*60.98%*
growth %			*44%*	*52%*	*21%*	*12%*
Dividend Payout	-	-	46,440,799	84,492,465	135,979,887	151,634,579
Retained Earnings	(30,418,800)	33,866,785	80,307,585	136,635,895	170,630,866	208,539,511

Table 3 - Profit and Loss

Table: Cash Flow

Cash Flow Analysis	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Beginning Cash Balance	5,000,000	1,581,200	71,866,785	122,307,585	180,635,895	216,630,866
Operations:						
Total Revenue	-	120,652,000	167,356,000	239,080,000	283,004,000	310,804,000
Total Operating Costs	(3,418,800)	(20,672,593)	(28,525,145)	(33,264,607)	(35,539,915)	(35,385,109)
Interest Paid	-	(2,200,000)	(2,200,000)	(2,200,000)	(2,200,000)	(2,200,000)
Taxes	-	(28,493,822)	(40,749,257)	(61,294,618)	(73,789,225)	(82,175,667)
Depreciation	-	3,000,000	2,000,000	1,000,000	1,000,000	1,000,000
Total Cash Inflows	(3,418,800)	72,285,585	97,881,599	143,320,775	172,474,859	192,043,224
Available Cash Balance	1,581,200	73,866,785	169,748,384	265,628,360	353,110,754	408,674,090
Financing:						
Financing Investment (w/$10M loan)	10,000,000	-	-	-	-	-
Government Subsidy (40% of TC)	12,000,000	-	-	-	-	-
Equity Investment	10,000,000	-	-	-	-	-
Dividends Paid Out						

	-	-	(46,440,799)	(84,492,465)	(135,979,887)	(151,634,579)
Total	32,000,000	-	(46,440,799)	(84,492,465)	(135,979,887)	(151,634,579)
Investment:						
Capital Expenditures	(27,000,000)	(2,000,000)	(1,000,000)	(500,000)	(500,000)	(500,000)
Ending Cash Balance	**1,581,200**	**71,866,785**	**122,307,585**	**180,635,895**	**216,630,866**	**256,539,511**

Table 4 - Cash Flow

Table: Balance Sheet

Pro Forma Balance Sheet													
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Assets	Starting Balances												
Current Assets													
Cash	$0	$332	$527	$757	$1,006	$1,276	$1,567	$1,884	$2,227	$2,600	$3,005	$3,444	$3,922
Inventory	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Current Assets	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Current Assets	$0	$332	$527	$757	$1,006	$1,276	$1,567	$1,884	$2,227	$2,600	$3,005	$3,444	$3,922
Long-term Assets													
Long-term Assets	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Accumulated Depreciation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Long-term Assets	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Assets	$0	$332	$527	$757	$1,006	$1,276	$1,567	$1,884	$2,227	$2,600	$3,005	$3,444	$3,922
Liabilities and Capital		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Current Liabilities													
Accounts Payable	$0	$97	$86	$93	$100	$108	$117	$127	$138	$150	$162	$176	$191
Current Borrowing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Current Liabilities	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Current Liabilities	$0	$97	$86	$93	$100	$108	$117	$127	$138	$150	$162	$176	$191
Long-term Liabilities	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Liabilities	$0	$97	$86	$93	$100	$108	$117	$127	$138	$150	$162	$176	$191
Paid-in Capital	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Retained Earnings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Earnings	$0	$235	$441	$665	$906	$1,167	$1,450	$1,757	$2,089	$2,451	$2,843	$3,268	$3,730
Total Capital	$0	$235	$441	$665	$906	$1,167	$1,450	$1,757	$2,089	$2,451	$2,843	$3,268	$3,730
Total Liabilities and Capital	$0	$332	$527	$757	$1,006	$1,276	$1,567	$1,884	$2,227	$2,600	$3,005	$3,444	$3,922
Net Worth	$0	$235	$441	$665	$906	$1,167	$1,450	$1,757	$2,089	$2,451	$2,843	$3,268	$3,730

Table 5 - Balance Sheet

Table: Break Even Analysis

ABC-Break Even Analysis		Base-Case Scenario			
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Units Sold (iron oxide) @ $130	43,400	60,200	86,000	101,800	111,800
Units Sold (Al2O3) @ $175	43,400	60,200	86,000	101,800	111,800
Units Sold (TiO2) @ $2750	21,700	30,100	43,000	50,900	55,900
Units Sold (black oxide) @ 1100	43,400	60,200	86,000	101,800	111,800
Gross Revenues	$120,652,000	$167,356,000	$239,080,000	$283,004,000	$310,804,000
Total Variable Costs (incl. commissions)	$17,926,593	$25,779,145	$30,768,607	$33,043,915	$32,889,109
Fixed Costs (excl. commissions)	$2,746,000	$2,746,000	$2,496,000	$2,496,000	$2,496,000
Total Costs	$20,672,593	$28,525,145	$33,264,607	$35,539,915	$35,385,109
Gross Profit:	$99,979,407	$138,830,855	$205,815,393	$247,464,085	$275,418,891

Break Even Unit Analysis	**$**	**%**
Composite Weighted Unit Price	$794	100%
Unit Variable Expense	**$136**	17%

Contribution Margin	€ 658	83%
Contribution Margin Ratio	83%	
Break Even Sales Volume	**$20,672,593**	
Break Even Unit tons	**26,026.65**	

Table 8 – Break-Even Analysis

Justification of prices

On the previous page you are able to see the make up of one metric ton of Red Mud. From that table you are able to see that the one metric ton consists of three main recoverable metals. They are 80% Iron Oxide (in two different purity forms), 20% Aluminum DiOxide, and 10% Titanium DiOxide. Because of the two different forms of Iron Oxide and the difficulties that are inherint with each one there will initially have to be a transition period. One where the Iron Oxide of the lower purity will be sold without refining it into a higher purity, in other words Black Oxide.

The two different purity forms of Iron Oxide varry by 25%. Iron Oxide which is meant for the ore market has a purity of approximately 65% while the Iron Oxide which is meant for the Black Oxide market is greater than 90%. The difference in their prices varry with a usual difference of about $850. This is because the higher purity takes more time and energy to produce with a sell price usually around $1000/ton and the lower purity going for around $150/ton. A proof of these numbers can be found below.

Initially there will be a transition period. Since there are two different forms of the Iron Oxide there will have to be.

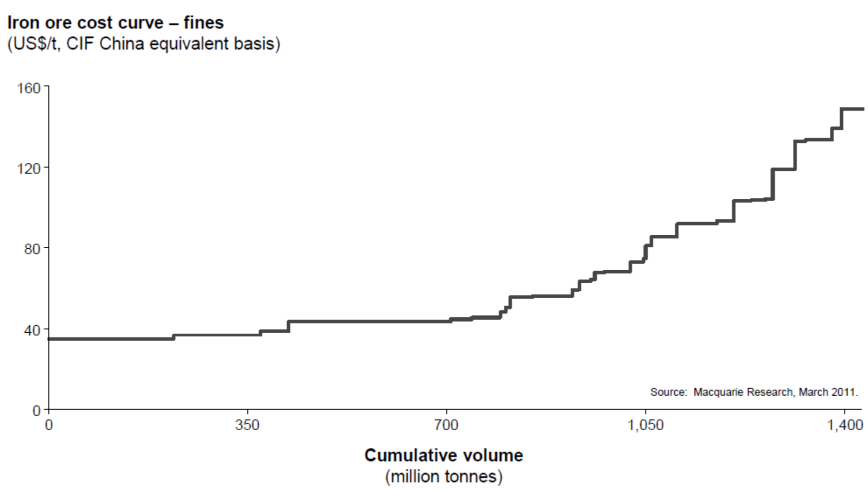


Figure 32 - Iron Ore Cost per Ton[30]

As can be seen above the cost for producing a ton of Iron Ore varies.

[30] (Visser 2011)

The Process

Red Mud (Fe2O3) is produced during the Bayer process for alumina production. It is the insoluble product after bauxite digestion with sodium hydroxide at elevated temperature and pressure. It is a mixture of compounds originally present in the parent mineral, bauxite, and of compounds formed or introduced during the Bayer cycle. It is disposed as a slurry having a solid concentration in the range of 10-30%, pH in the range of 13 and high ionic strength.

A chemical analysis would reveal that red mud contains silica, aluminum, iron, calcium, titanium, as well as an array of minor constituents, namely: Na, K, Cr, V, Ni, Ba, Cu, Mn, Pb, Zn etc. The variation in chemical composition between different red muds worldwide is high. Typical values would account:

Fe_2O_3	30-60wt%
Al_2O_3	10-20wt%
SiO_2	3-50wt%
Na_2O	2-10wt%
CaO	2-8wt%
TiO_2	trace-25wt%

Table 6 - Chemical Composition

(Source: The International Aluminum Institute, modified for the TiO2 content)
Organic Technologies Corp has developed a chemical process to convert and stabilize the Red Mud compound. The result is the production of Fe3O4 industrial pigment, and Al and Ti minerals at high concentrations – to be utilized for the production of aluminum and titanium metals.

The initial material we tested came from the MAL aluminum plant spill in Ajka, Hungary. The material was collected at the mouth of the spill, and contained some additional contaminants. The material tested had a Fe2O3 content of around 24-27%.

Bench scale testing has shown that the processed Fe_2O_3 material collected from the MAL plant produced Fe_3O_4 with a purity of over 63%. This type of material can processed and recycled for use as various grades of high quality Iron Ore and/or Black Pigment.

From these results, we estimate that a 100 pound input of Red Mud (Fe_2O_3) of this quality would yield approximately 40 pounds of industrial grade Fe_3O_4 (60% - 65% purity), 20 pounds of Al Ore (at a 30% purity), 10 pounds of Ti Ore (with a 15% purity), and about 30 pounds of Mine Tailings.

The analysis of the Fe_3O_4, using an ICP-MS, showed that the Organic Technologies Corp processed material was directly comparable to industrial grade Black Pigment.

A summary of the following estimates are based upon third party analysis of the actual Bench Scale results obtained using the Organic Technologies Corp process:

Inputs	***Amount (Pounds)***	***Purity***	***Outputs***	***Amount (Pounds)***	***Purity***
Red Mud	100	24-27% Fe_2O_3	Fe Ore (Fe_3O_4)	40	60%-65%
			Al Fines	20	30%
			Ti Fines	10	15%
			Mine Tailings	30	

Table 7 - Percent purity

Further mass balance and purity of each item will be determined in the pilot process. An additional goal of the pilot process will be to further segregate and refine the purity of the Fe_3O_4 through grain size segregation.

Fe_2O_3 inputs with a higher concentration (as tested from the Ajka site) would yield Fe_3O_4 with purity levels over 65%. Compared to standard grades of Iron Fines, silicate in Fe_3O_4 used as steel inputs from this process would reduce quicker, using less energy and fewer inputs.

5.0 The Model

The model used for the purposes of simulating the future cash flow for ABC Corp. can be broken into seven sectors. These are as follows: the production sector, the inventory sector, the pricing sector, the misc. costs sector, the labor sector, the chemical ordering sector, and the accounting sector.

5.1 Production Sector

The production sector is designed to scale up the rate at which red mud can be processed, based on several factors. The first is that ABC will build a plant containing two production lines, but will only utilize one for approximately the first year. The reasoning behind this is so that the process and machinery can be vetted; the engineers can learn how often certain parts need to be replaced, and which ones, in order to prevent downtime in the future and maximize revenue. When a machine inevitably needs repair in this first year, the crew can use the other machine while the first one is being fixed, thus virtually eliminating downtime until a preventative maintenance schedule can be determined. The second cause for the scaling up in production is the ability to physically handle and transport the amount of red mud needed to run at maximum capacity, which will take time to perfect as ABC will be moving hundreds of tons of material per hour. It will take time to learn how to move the red mud fast enough to keep up with the maximum capacity of the machinery, so this is accounted for in the model. It will also take time to be able to maximize the metals that ABC recovers from red mud, and this is also taken into account.

In addition, the amount of red mud that can be processed is determined by a Leontief production function. That is, there are two factors that determine the rate of processing red mud. The first is the number of laborers (and their productivity), and the second is the amount of chemicals on hand. Simply put, production is equal to the lesser value of the two, which acts as a limit. If there are not enough workers, it doesn't matter how many chemicals are on hand, and vice versa.

Once the production level for the current time is calculated, it is discounted by the percentage of estimated metals that will likely not be recovered, as well as any theoretical shock to production which can be programmed to trigger at any time. This gives us the amount of production at a given time in the simulation, which allows us to determine the potential revenue and costs associated with the given market conditions.

5.2 Inventory Sector

The inventory sector takes the red mud that is actually processed and extracts the amount of each metal that is recovered. The result is the processing rate for each of the metals that are to be recovered. These feed into a stock of inventory, as there will likely be some build-up of metals before they are sold and/or shipped. The flow out of this stock is the rate at which ABC sells the metals it produces. Once multiplied by the respective prices these metals sell for, we can determine ABC's revenue stream for the given scenario.

5.3 Pricing Sector

The pricing sector determines the price each metal is sold at. For purposes of this project, we created four different pricing scenarios that may unfold. Each of these begin the simulation at a conservative price based on present market conditions, and either remain constant, increase or decrease at a percentage rate that can be programmed as needed. The model also includes the ability to add a price floor or ceiling if so desired, as was the case when it was determined that iron ore would likely not fall below $80 per ton by the end of the simulation.

5.4 Labor Sector

The labor sector includes two identical structures for both laborers and engineers. This structure incorporates the desired number of employees, which is based on production, and hires more as needed, but with a delay. There are stocks for the number of employees, with the inflows being the hire rate and the outflows being the quit rate.

5.5 Chemical Ordering Sector

The chemical ordering sector is a structure that takes into account the rate at which chemicals are needed (as determined by the red mud processing rate), forms expectations of that rate, and orders chemicals as needed. Additional structure takes into account the time needed to receive the chemicals, as well as adjusting orders for the amount already on order but not yet received. From this sector we can determine if there is a bottleneck at different levels of inventory coverage, or if a significant increase in time to receive chemicals results in a production slowdown.

5.6 Miscellaneous Costs Sector

The costs sector takes the required quantity of variable expenses such as chemicals, shipping, discard costs, utilities, and royalties, and determines the total costs associated with these items, to be used in the accounting sector.

5.7 Accounting Sector

The accounting sector takes the given revenue stream and costs associated with the simulation and generates a cash flow. This is then either added or subtracted from demand deposits, which determines the scheduling of loan repayments. The accounting sector also presents certain calculations, such as cost of goods sold, net present value, shareholder equity, and retained earnings.

6.0 Aluminum Sector

Big aluminum companies, such as Alcoa in the United States and Rio Tinto down in Australia, have enormous controlling power of the aluminum market. They are able to shut down some of their plants, no matter if they are old or just not producing enough profit or if they cost too much, in order to control how much aluminum is actually on the market. This in turn affects the price and drives it up. Business decisions like this are made upon the current economic situation. Like we saw in some of the analysis in the business plan China has been the major demand for aluminum recently. Production in aerospace, automotive, trucks and trailers markets have all gone up as well[31]. With all of its expanding economy in China and the new buildings going up it did not seem like it would stop anytime soon. The future predictions state that China's economic growth will actually slow down with the next few years. This means that the demand will go down and with that the price. Companies like Alcoa will have to close more of their sites in order to stay operational.

The entire dynamic of how these big bauxite reducing companies run their businesses will soon change as they know what ABC is capable of doing. This is because instead of having to open or re-open a whole other site these companies would have the ability to go to their red mud reservoirs and produce alumina from that, at a severely reduced cost. This will allow these companies to shut down even more sites simply because there is so much red mud that can be mined.

[31] (Elmquist 2012)

7.0 Conclusion

Red mud has been a source of many problems throughout the world. Catastrophic incidents involving the substance have uprooted families, killed businesses, and destroyed ecosystems. While numerous solutions to the problem have been proposed, they all suffer from high costs that eat away at the bottom line of aluminum producers and offer very little, if any, economic value. ABC is able to take these huge liabilities and turn them into assets, offering something that no other company or process ever has.

By recovering the metals that make up red mud, ABC is able to then sell these raw materials to companies that use them to make a number of products, while rendering the remainder of the red mud inert topsoil. The prices it can expect to receive for the metals it plans to extract can get quite high, offering substantial benefit to potential investors, while at the same time providing a critical service in ridding the environment of red mud.

The business plan in this report covers every aspect of the newly proposed business. It effectively incorporates a system dynamics model used to simulate several different scenarios that would be of interest to investors, providing a dynamic business model from which to base investment decisions. The results of these simulations show that ABC Corp. is poised to make huge sums of money by converting liabilities associated with red mud into assets, while at the same time cleaning up the environment and working to prevent another disaster like the recent one in Hungary.

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Model Equations

RM Raw Processing=

Red Mud Processing Rate

Red Mud Processed Stock= INTEG (

RM Raw Processing,

0)

Labor Production Function=

Min(Engineers/ Normal Engineer productivity, Workers/ Normal worker productivity)

Normal worker productivity=

Workers/ Max Red Mud Production Rate

Normal Engineer productivity=

Engineers/ Max Red Mud Production Rate

~ Tons/ Engineer/ Month

Rate of Processing=

Material Production Rate

Annual Revenue= INTEG (

Chg in Annual Revenue,

0)

Total Tonnage Processed= INTEG (

Rate of Processing,

0)

Chg in Annual Revenue=

Monthly Revenue

Desired Workers=

Workers per Production Line*Lines in Operation

~ Ppl

Rate of Line Addition=

(Desired Lines in Operation - Lines in Operation) / Time to Bring Lines Online

Desired Engineer Hiring Rate=

Expected Eng Attrition Rate + Adjustment for Engineers

Lines in Operation= INTEG (

Rate of Line Addition,

Initial Lines in Operation)

Production Shock=

0 * PULSE(24 , 6)

Max Production Rate=

Lines in Operation * 100

Time to Bring Lines Online=

0.25

Initial Lines in Operation=

1

Monthly High Skill Payments Due=

Monthly High Skill Wage * Engineers

Desired Lines in Operation=

1 + STEP(1 , 12)

Material Production Rate=

IF THEN ELSE(Production Shock = 1 , 0 , Efficiency of Separation * Red Mud Processing Rate\

)

Desired Engineers=

Engineers per Production Line*Lines in Operation

~ Ppl

Max Red Mud Production Rate=

IF THEN ELSE(Lines in Operation = 1 , Hours per Month * Tons per Hour * Max Op Eff \

, Operations Efficiency * Hours per Month *

Tons per Hour)

Utilities=

83333 * Lines in Operation

Workers= INTEG (

Worker Net Hire Rate-Quit Rate,

Desired Workers)

~ Ppl

Adjustment for Labor=

(Desired Workers - Workers) / Labor Adjustment Time

Adjustment for Engineers=

(Desired Engineers - Engineers) / Engineer Adjustment Time

Adjustment for Vacancies=

(Desired Vacancies - Worker Vacancies) / Vacancy Adjustment Time

Vacancy Adjustment Time=

0.25

Expected Attrition Rate=

Quit Rate

Expected Eng Attrition Rate=

Engineer Quit Rate

Quit Rate=

Workers/ Avg Duration of Worker Employment

Engineers per Production Line=

5

~ Workers

Vacancy Creation Rate=

MAX(0,Desired Vacancy Creation Rate)

Avg Duration of Eng Employment=

24

Adjustment for Eng Vacancies=

(Desired Eng Vacancies - Engineer Vacancies) / Eng Vacancy Adjustment Time

Engineers= INTEG (

Engineer Net Hire Rate-Engineer Quit Rate,

Desired Engineers)

~ Ppl

Desired Worker Hiring Rate=

Expected Attrition Rate + Adjustment for Labor

Engineer Vacancies= INTEG (

Engineer Vacancy Creation Rate-Eng Vacancy Closure Rate,

0)

Desired Eng Vacancy Creation Rate=

Desired Engineer Hiring Rate + Adjustment for Eng Vacancies

Eng Vacancy Closure Rate=

Engineer Net Hire Rate

Avg Duration of Worker Employment=

12

Desired Vacancy Creation Rate=

Desired Worker Hiring Rate + Adjustment for Vacancies

Avg Time to Fill Eng Vacancies=

0.25

~ Months

Worker Vacancies= INTEG (

Vacancy Creation Rate-Vacancy Closure Rate,

0)

Engineer Adjustment Time=

0.25

Eng Vacancy Adjustment Time=

0.25

Labor Adjustment Time=

0.25

Vacancy Closure Rate=

Worker Net Hire Rate

Expected Time to Fill Vacancies=

Avg Time to Fill Vacancies

Expected Time to Fill Eng Vacancies=

Avg Time to Fill Eng Vacancies

Engineer Quit Rate=

Engineers/ Avg Duration of Eng Employment

Desired Eng Vacancies=

MAX(0, Expected Time to Fill Eng Vacancies * Desired Engineer Hiring Rate)

Worker Net Hire Rate=

Worker Vacancies/ Avg Time to Fill Vacancies

~ Ppl/Time

Engineer Vacancy Creation Rate=

MAX(0,Desired Eng Vacancy Creation Rate)

Desired Vacancies=

MAX(0, Expected Time to Fill Vacancies * Desired Worker Hiring Rate)

Engineer Net Hire Rate=

Engineer Vacancies/ Avg Time to Fill Eng Vacancies

~ Ppl/Time

Black Oxide Spot Price=

1100

Iron Ore Floor=

80

Change in Blk Ox Price=

Average Black Oxide Price * "% Change in Black Oxide Price"

"% Change in Black Oxide Price"=

-2 * 0.0041

Change in Alumina Price=

Average Alumina Price * "% Change in Alumina Price"

Current Iron Ore Price=

0 * MAX(Average Iron Ore Price, Iron Ore Floor) + (1 * Average Iron Ore Price)

Monthly Revenue From Iron Ore=

Iron Oxide Sales Rate * Current Iron Ore Price

Monthly Revenue From Titanium Dioxide=

Average Titanium Dioxide Price * Tite Ox Sales Rate

Iron Oxide Production Rate=

Iron Oxide Produced * (1 - "Black Oxide Allocation %")

Current Alumina Price=

0 * MAX(Average Alumina Price, Alumina Floor) + (1 * Average Alumina Price)

Alumina Floor=

150

"Black Oxide Allocation %"=

0

Black Oxide Production Rate=

Iron Oxide Produced * "Black Oxide Allocation %"

Black Oxide Sales Rate=

Black Oxide Production Rate

Average Black Oxide Price= INTEG (

Change in Blk Ox Price,

Black Oxide Spot Price)

Iron Oxide Produced=

"% Iron Oxide" * Material Production Rate

Black Oxide Inventory Stock= INTEG (

Black Oxide Production Rate-Black Oxide Sales Rate,

0)

Monthly Revenue From Black Oxide=

Black Oxide Sales Rate * Average Black Oxide Price

Monthly Revenue=

Monthly Revenue From Alumina + Monthly Revenue From Iron Ore + Monthly Revenue From Titanium Dioxide\

+ Monthly Revenue From Black Oxide

Monthly Revenue From Alumina=

Alumina Sales Rate * Current Alumina Price

Chemical Useage Rate=

Red Mud Processing Rate

~ Tons/Month

"% Change in Alumina Price"=

-2 * 0.0041

"% Change in Iron Price"=

-2 * 0.0041

"% Change in TiO2 Price"=

-2 * 0.0041

"Misc. Operating Expenses"=

Discard Cost + Insurance + Legal Expenses + Office Rent + Royalties + Shipping + Travel\

+ Utilities + Chemical Expenses + Equipment Maintainence + Red Mud Cost

Price of Red Mud=

Original Red Mud Price + Shock to Red Mud Price

Accounts Receivable= INTEG (

New Accounts Receivable-Clearing Rate Accounts Receivable,

Initial Accounts Receivable)

~ $

Monthly High Skill Wage=

(High Skill Salary / 12)

Monthly Low Skill Wage=

(Low Skill Salary / 12)

Red Mud Cost=

Price of Red Mud * Red Mud Processing Rate

Monthly Manager Wage=

(Manager Salary / 12)

Change in Iron Ore Price=

Average Iron Ore Price * "% Change in Iron Price"

Change in TiO2 Price=

Average Titanium Dioxide Price * "% Change in TiO2 Price"

Nrm Receiving Time=

0.5 + Shock to Receiving Time

~ Months

Original Red Mud Price=

0

Shock to Red Mud Price=

0 * STEP(50 , 24)

Clearing Rate Accounts Receivable=

Accounts Receivable / Avg Time to Pay

~ $/Month

Avg Time to Pay=

1

COGS=

("Misc. Operating Expenses" + Labor Payments Due) / Max Red Mud Production Rate

Cost of Goods Sold=

Labor Payments Due + "Misc. Operating Expenses"

~ $/Month

Required Payments=

Labor Payments Due + Scheduled Interest Payment + "Misc. Operating Expenses"

~ $/Month

Borrowing=

(Expected Revenue Shortfall * Fraction of Shortfall From Borrowing * Effect of Current Ratio on Borowing\

)

~ $/Month

Monthly Payments=

Debt Retirement Rate + Interest Payment + "Misc. Operating Expenses" + Labor Payments Due

~ $/Month

Current Liabilities=

Labor Payments Due + "Misc. Operating Expenses"

~ $

Leverage=

Debt / Total Net Worth

~ Dmnl

Red Mud Processing Rate=

Min((1 * Chemicals In Stock), Labor Production Function)

Net Profits Before Taxes=

Earnings Before Interest and Taxes - Interest Payment

~ $/Month

Total Net Worth=

Equity + Retained Earnings

~ $

Sales=

New Accounts Receivable

~ $/Month

Effect of Liquidity on Dividends=

IF THEN ELSE(Liquidity < 1, 0 , 1)

~ Dmnl

Equipment Maintainence=

125000

Chemical Expenses=

Chemical Useage Rate * Chemical Price

Chemical Nrm Useage Rate=

Max Red Mud Production Rate

~ Tons/Month

Desired Managers=

2

~ Ppl

Chemical Initial Expected Useage Rate= INITIAL(

Chemical Nrm Useage Rate)

~ Tons/Month

Chemical Initial Inventory= INITIAL(

Desired Chemical Inventory)

~ Tons

Chemical Initial Useage Rate= INITIAL(

Chemicals In Stock/Chemical Inventory Coverage)

~ Tons/Month

Chemical Inventory Coverage=

ZIDZ(Chemicals In Stock, Chemical Useage Rate)

~ Months

Desired Chemical Inventory=

Chemical Expected Useage Rate*Chemicals Nrm Inventory Coverage

~ Tons

Desired Chemicals On Order=

Chemical Expected Useage Rate*Nrm Receiving Time

~ Tons

Chemicals In Stock= INTEG (

Chemicals Receiving-Chemical Useage Rate,

Chemical Initial Inventory)

~ Tons

Chemicals Nrm Inventory Coverage=

2

~ Months

Chemicals On Order= INTEG (

Chemical Orders-Chemicals Receiving,

Initial Supply Line)

~ Tons

Chemicals Receiving=

Chemicals On Order/Nrm Receiving Time

~ Tons/Month

Chemicals Time To Chg Expected Useage Rate=

2

~ Months

Chemicals Time To Correct Inventory=

2

~ Months

Chemical Arrival Time=

ZIDZ(Chemicals On Order, Chemicals Receiving)

~ Months

Chemical Chg to Expected Useage Rate=

(Chemical Useage Rate-Chemical Expected Useage Rate)/Chemicals Time To Chg Expected Useage Rate

~ Tons

Correction For Chemicals On Order=

(Desired Chemicals On Order-Chemicals On Order)/Chemical Time To Correct Orders

~ Tons/Month

Correction for Inventory=

(Desired Chemical Inventory-Chemicals In Stock)/Chemicals Time To Correct Inventory

~ Tons/Month

Chemical Expected Useage Rate= INTEG (

Chemical Chg to Expected Useage Rate,

Chemical Initial Expected Useage Rate)

~ Tons/Month

Chemical Orders=

MAX(0, Correction For Chemicals On Order+Correction for Inventory+Chemical Expected Useage Rate\

)

~ Tons/Month

Shock to Receiving Time=

0 * PULSE(12 , 12)

~ Tons/Month

Chemical Time To Correct Orders=

2

~ Months

Initial Supply Line= INITIAL(

Desired Chemicals On Order)

~ Tons

Chemical Price=

20

~ $/ ton

Time to Chg Traditional Gross Profits=

15

~ Months

Chg Traditional Gross Profits=

(Gross Profits - Traditional Gross Profits) / Time to Chg Traditional Gross Profits

~ $/Month/Month

Dividend Payout Ratio=

ZIDZ(Dividends, Net Profits After Taxes)

~ Dmnl

Dividends=

Effect of Liquidity on Dividends * Indicated Dividends

~ $/Month

Earnings Before Interest and Taxes=

Operating Income + Interest Income

~ $/Month

Indicated Dividends=

Net Profits After Taxes for Dividends * Nrm Dividend Payout Ratio

~ $/Month

General Operating Expenses=

0

~ $/Year

Chg Traditional Net Profits After Taxes=

(Net Profits After Taxes - Traditional Net Profits After Taxes) / Time to Chg Traditional Net Profits After Taxes

~ $/Month/Month

Traditional Net Profits After Taxes= INTEG (

Chg Traditional Net Profits After Taxes,

Net Profits After Taxes)

~ $/Month

Depreciation Retailer=

0

~ $/Year

Operating Income=

Gross Profits - General Operating Expenses - Depreciation Retailer

~ $/Month

Fiscal Authority Tax Rate on Corporate Income=

0.3

~ Dmnl

Gross Profit Ratio=

IF THEN ELSE(Gross Profits / Traditional Gross Profits < 1, Gross Profits / Traditional Gross Profits\

, 1)

~ Dmnl

Gross Profits=

Sales - Cost of Goods Sold

~ $/Month

Net Profits After Taxes=

Net Profits Before Taxes - Corporate Tax Bill

~ $/Month

Corporate Tax Bill=

Fiscal Authority Tax Rate on Corporate Income * Taxable Income

~ $/Month

Nrm Dividend Payout Ratio=

0

~ Dmnl

Interest Income=

0

~ $/Year

Net Profits After Taxes for Dividends=

MAX(0, Traditional Net Profits After Taxes)

~ $/Month

Time to Chg Traditional Net Profits After Taxes=

3

~ Months

Retained Earnings=

Net Profits After Taxes - Dividends

~ $/Month

Traditional Gross Profits= INTEG (

Chg Traditional Gross Profits,

Gross Profits)

~ $/Month

Taxable Income=

MAX(0, Net Profits Before Taxes)

~ $/Month

Workers per Production Line=

15

~ Workers

Labor Payments Due=

Monthly High Skill Payments Due + Monthly Low Skill Payments Due + Monthly Manager Payments Due

Discount Rate=

0.1

Starting Capital=

Equity Investment + Financing Investment + Gov't Subsidy

Low Skill Salary=

21000

Manager Net Hire Rate=

(Desired Managers-Managers)/Time to Hire Managers

~ Ppl/Time

Manager Salary=

150000

Managers= INTEG (

Manager Net Hire Rate,

Desired Managers)

~ Ppl

Managers per Workforce=

0.2

NPV Stock= INTEG (

NPV Flow,

0)

Equity Investment=

5e+006

Avg Time to Fill Vacancies=

0.25

~ Months

Debt Taken On= INTEG (

Rate of Taking Debt,

Borrowing)

Book Value of Inventory=

(Iron Oxide Spot Price * Iron Oxide Inventory Stock) + (Alumina Spot Price * Alumina Inventory Stock\

) + (TiO2 Spot Price

* Titanium Dioxide Inventory Stock)

Monthly Low Skill Payments Due=

Monthly Low Skill Wage * Workers

Monthly Manager Payments Due=

Managers * Monthly Manager Wage

High Skill Salary=

35000

Time to Hire Managers=

1

~ Months

NPV Flow=

"Present Value of Future Cash Flows (NPV)"

Gov't Subsidy=

1.2e+007

"Present Value of Future Cash Flows (NPV)"=

Demand Deposits/ ((1+Discount Rate) ^ Time)

Rate of Taking Debt=

Borrowing

Financing Investment=

1e+007

Tailings=

0.3 * Material Production Rate

Shipping=

((Material Production Rate * 0.7) / 30) * 1000

Office Rent=

3000

Royalties=

2 * Material Production Rate

Travel=

833

Legal Expenses=

125000

Discard Cost=

30 * Tailings

Insurance=

50000

Current Assets=

Accounts Receivable + Book Value of Inventory + Demand Deposits

~ $

Interest Payment=

Scheduled Interest Payment * Effect of Liquidity on Interest Payment

~ $/Month

Current Ratio=

Current Assets / Current Liabilities

~ Dmnl

Book Value of Capital=

Starting Capital - (Starting Capital * Depreciation Rate)

~ $

Debt Retirement Rate=

Scheduled Debt Retirement Rate * Effect of Liquidity on Debt Retirement

~ $/Month

Demand Deposits= INTEG (

Revenue-Monthly Payments,

Initial Demand Deposits)

~ $

Liabilities=

Current Liabilities + Debt

~ $

Liquidity=

ZIDZ(Demand Deposits, Desired Demand Deposits)

~ Dmnl

Assets=

Book Value of Capital + Current Assets

~ $

Effect of Liquidity on Interest Payment= WITH LOOKUP (

Liquidity,

([(0,0)-(1,1)],(0,0),(0.2,0.05),(0.4,0.1),(0.6,0.15),(0.8,0.3),(1,1)))

~ Dmnl

Equity=

Assets - Liabilities

~ $

Average Required Payments= INTEG (

Chg Average Required Payments,

Initial Average Required Payments)

~ $/Month

Expected Revenue Shortfall=

MAX(0, Average Required Payments - Expected Revenue)

Initial Accounts Receivable=

0

New Accounts Receivable=

Monthly Revenue

~ $

Nrm Coverage Demand Deposits=

3

Chg Average Required Payments=

(Required Payments - Average Required Payments) / Time Chg Average Required Payments

~ $/Month/Month

Coverage Demand Deposits=

ZIDZ(Demand Deposits, Monthly Payments)

~ Months

UnPaid Interest Accumulation Rate=

Scheduled Interest Payment - Interest Payment

~ $/Month

Fraction of Shortfall From Borrowing=

1

~ Dmnl

Debt= INTEG (

Borrowing+UnPaid Interest Accumulation Rate-Debt Retirement Rate,

Initial Debt)

~ $

Nrm Time to Pay Debt=

1

~ Months

Revenue=

Clearing Rate Accounts Receivable

~ $/Month

Depreciation Rate=

Time/ 120

Desired Demand Deposits=

Average Required Payments * Nrm Coverage Demand Deposits

~ $

Effect of Current Ratio on Borowing= WITH LOOKUP (

Current Ratio,

([(0,0)-(1,1)],(0,0),(0.25,0.5),(0.5,0.75),(0.75,0.9),(1,1)))

Effect of Liquidity on Debt Retirement= WITH LOOKUP (

Liquidity,

([(0,0)-(1,1)],(0,0),(0.2,0.4),(0.4,0.68),(0.6,0.85),(0.8,0.98),(1,1)))

~ Dmnl

Short Term Interest Rate=

0.02

~ $/$/Month

Expected Revenue=

Monthly Revenue

~ $/Month

Initial Average Required Payments= INITIAL(

Required Payments)

~ $/Month

Scheduled Debt Retirement Rate=

Debt / Nrm Time to Pay Debt

~ $/ Month

Initial Debt= INITIAL(

1e+007)

~ $

Time to Repay Debt=

ZIDZ(Debt, Debt Retirement Rate)

~ Months

Scheduled Interest Payment=

Debt * Short Term Interest Rate

~ $/Month

Initial Demand Deposits=

Desired Demand Deposits

~ $

Time Chg Average Required Payments=

3

~ Months

"% Alumina"=

0.2

"% Iron Oxide"=

0.4

"% Titanium Dioxide"=

0.1

Alumina Inventory Stock= INTEG (

Alumina Production Rate-Alumina Sales Rate,

Initial Alumina Inventory)

Alumina Produced=

"% Alumina" * Material Production Rate

Alumina Production Rate=

Alumina Produced

Alumina Sales Rate=

Alumina Production Rate

Alumina Spot Price=

175 + Shock to Alumina Price

Average Alumina Price= INTEG (

Change in Alumina Price,

Alumina Spot Price)

Average Iron Ore Price= INTEG (

Change in Iron Ore Price,

Iron Oxide Spot Price)

Average Titanium Dioxide Price= INTEG (

Change in TiO2 Price,

TiO2 Spot Price)

Days per Month=

20

Hours per Day=

16

Hours per Month=

Days per Month * Hours per Day

Initial Alumina Inventory=

0

Initial Iron Oxide Inventory=

0

Initial Operations Efficiency=

0.975

Initial Titanium Dioxide Inventory=

0

Initial Tons per Hour=

60

~ Tons/ Hour

Iron Oxide Inventory Stock= INTEG (

Iron Oxide Production Rate - Iron Oxide Sales Rate,

Initial Iron Oxide Inventory)

Iron Oxide Sales Rate=

Iron Oxide Production Rate

Iron Oxide Spot Price=

130 + Shock to Iron Price

Max Op Eff=

0.975

Efficiency of Separation=

0.85

Operations Efficiency= INTEG (

"Rate of Op. Eff Improvement",

Initial Operations Efficiency)

Rate of Improvement=

(Max Production Rate - Tons per Hour) / Time to Reach Full Capacity

"Rate of Op. Eff Improvement"=

(Max Op Eff - Operations Efficiency) / Time to Improve Operations Eff

Shock to Alumina Price=

0 * RAMP(-10 , 12 , 12)

Shock to Iron Price=

0 * RAMP(-10 , 12 , 12)

Shock to TiO2 Price=

0 * RAMP(-20 , 12 , 12)

Time to Average Price=

2

Time to Improve Operations Eff=

1e+006

Time to Reach Full Capacity=

24

~ Months

TiO2 Spot Price=

2750 + Shock to TiO2 Price

Titanium Dioxide Inventory Stock= INTEG (

Tite Ox Production Rate - Tite Ox Sales Rate,

Initial Titanium Dioxide Inventory)

Titanium Dioxide Produced=

"% Titanium Dioxide" * Material Production Rate

Tite Ox Production Rate=

Titanium Dioxide Produced

Tite Ox Sales Rate=

Tite Ox Production Rate

Tons per Hour= INTEG (

Rate of Improvement,

Initial Tons per Hour)

****

.Control

**~

Simulation Control Parameters

FINAL TIME = 60

~ Month

~ The final time for the simulation.

INITIAL TIME = 0

~ Month

~ The initial time for the simulation.

SAVEPER =

TIME STEP

~ Month [0,?]

~ The frequency with which output is stored.

TIME STEP = 0.0625

~ Month [0,?]

~ The time step for the simulation.