From Landfill to Building Block: Turning Drill Cuttings into Industrial Bricks

We Got Gas: Partnered with Chevron

Figure 1. The solidworks representation of the brick making process.

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Executive Summary:
This report outlines a current issue in Chevron’s hydraulic fracturing process and suggests a feasible solution for the company as to how to fix the issue. Methods of analysis include decision, scoring and AHP matrices, a systems diagram, and a design tree. Results of data analyzed shows that using the drill cuttings to make bricks is the best solution. Brick-manufacturing will greatly reduce costs and be much more environmentally-friendly.

This report finds that Chevron is spending much more money than is necessary on the drill cuttings. Along with that, burying the cuttings in a landfill is not a sustainable solution.

Introduction and Problem Statement:
'We Got Gas’ goal is to find a way to use drill cuttings as a resource instead of treating it as waste, as well as coming up with a cost efficient and long term solution for the use of the drill cuttings.

At this point Chevron is disposing of the drill cuttings in landfills without using them for any other purpose. This process is unsustainable, as available land for landfills will decrease in the future due to the amount of waste that is currently being produced, and will continue to be produced.

‘We got Gas’ plans on finding out what the drill cuttings are made of, what they are currently used for in other industries, and then coming up with a plan to utilize all the drill cuttings in an innovative way.

Definition of Sustainability:
‘We Got Gas’ defines sustainability as “an essential aspect of any design or process that allows for a more efficient, economic, and eco-friendly way to complete the task at hand.” In more specific terms, related to drill cuttings and Chevron, the definition can be explained as, “a better solution for waste management that can be used as viable alternative to the burial of drill cuttings in a landfill.”

Figure 2. The “Most sustainable Design Award” was presented to “We Got Gas” during the Chevron sponsored conference for the design that best embodied sustainability.
Background:

Chevron, like all fossil fuel companies, produce waste during the process of drilling. The two major types of waste are drill cuttings, and drill fluids. Drill cuttings are the crushed rocks produced by the drill heads during the drilling of the wells. These wells can produce thousands of tons of drill cuttings per 6 month period. These large quantities of drill cuttings pose significant issues to Chevron, forcing them to find ways to dispose of the cuttings and/or reuse them.

Some typical industry practices in terms of drill cutting management involves landfills, disposal in the ocean, treatment of drilling cuttings and reuse at the drill sites as roads; each method has its own drawbacks[3]. Dumping the drill cuttings in the ocean could have environmental costs, as well as high transportation costs, and poor public opinion of the method. Landfills has transportation costs, as well as cost of land and landfill planning and preparation. Also, with decreasing availability of land for landfills, this method becomes increasingly expensive. Using the drill cuttings to make roads at drill sites requires extensive cleaning of the drill cuttings to make sure no chemicals or residue runoff into groundwater or farm land.

Chevron's typical form of disposal of the drilling cuttings is through the use of landfills, which costs them currently around $100 per ton of drill cuttings to dispose of[1]. There are many measures taken for this process, as well as regulations to ensure that the waste has no negative effects on the surrounding environment. This requires ‘engineered landfills’, which are specially engineered to contain the waste and prevent contamination, as opposed to a typical landfills[3]. This costs significantly more, and requires a lot more effort on the part of chevron.

Customer Needs:

During this project, Chevron had several demands when it came to finding a drill cuttings solution. Being the large and fast-paced company that it is, Chevron doesn’t want a solution that isn’t going to take a huge commitment. Because of this fact, they need a product that can be easily manufactured in a short period of time. Another issue that they want this solution to address is the high costs of handling the cuttings. Their current means of disposal costs $100 per ton, so they want something that will greatly decrease these costs. While increasing profits is important to Chevron, they don’t want it to come at the expense of the environment. The solution needs to be environmentally friendly, as burying the cuttings in a landfill is neither healthy nor sustainable. Lastly, similar to being environmentally friendly, “We Got Gas” needs to come up with an idea that does not diminish the “Chevron” name. As a global company, Chevron wants to ensure that they maintain a good reputation with the people. After all of the needs were determined, they were put into an AHP matrix to determine their importance compared to others.
<table>
<thead>
<tr>
<th>AHP Matrix</th>
<th>Ease</th>
<th>Cost</th>
<th>Environment</th>
<th>Time</th>
<th>Considerate</th>
<th>Integrity</th>
<th>Total</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Manufacturing</td>
<td>1</td>
<td>.5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>10.5</td>
<td>.2</td>
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<tr>
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<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>.33</td>
<td>9.33</td>
<td>.18</td>
</tr>
<tr>
<td>Environmentally Friendly</td>
<td>.33</td>
<td>.5</td>
<td>1</td>
<td>1.5</td>
<td>1</td>
<td>.33</td>
<td>4.66</td>
<td>.09</td>
</tr>
<tr>
<td>Time Efficient</td>
<td>.5</td>
<td>.5</td>
<td>.67</td>
<td>1</td>
<td>.5</td>
<td>.25</td>
<td>3.42</td>
<td>.07</td>
</tr>
<tr>
<td>Considerate of Local Residents</td>
<td>.5</td>
<td>.5</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>.5</td>
<td>5.5</td>
<td>.11</td>
</tr>
<tr>
<td>Maintains Company Integrity</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>18</td>
<td>.35</td>
</tr>
</tbody>
</table>

**Grand Total:** 51.41 1

**Figure 3. AHP Matrix**

After running all of the needs through the matrix, it was determined that maintaining company integrity was the most important need. While all of the other needs are important, company integrity is the most important because of the impact it can have on business. Customers aren’t going to want to do business with a company that is untrustworthy. People like the feeling of security, and because of that fact, company integrity is most important towards the concept generation process.

Cost-efficiency was also rated highly because of the current high costs associated with drill cuttings disposal. Chevron is a profit-driven company, and if “We Got Gas” can come up with a solution that increases the margins, then they would be greatly satisfied.

**Concept Generation:**

During the concept Generation portion of the design process, it was important for “We Got Gas” to come up with as many creative and innovative ideas that could best satisfy Chevron’s needs. The group’s initial ideas included the production of paper weights, sand paper, chalk, bricks, and sandbags. Each of these ideas were chosen because of the benefits to sustainability that they bring to the table. Paper weights, for example, have only a few production requirements (ease of manufacturing) and could be sold potentially for a profit. Secondly, sandpaper was chosen for the consistent
market that exists for this product in addition to the fact that the materials required to manufacture sandpaper are cheap (cost efficient). Next, chalk was also chosen for its cost efficient materials and ease of manufacturing as chalk essentially only requires powdered limestone, water, and a mold to create sticks of chalk. In addition, shale brick manufacturing was a plausible idea because the majority of the drill cuttings composition is shale rock. Lastly, sandbag production was a viable option for the management of the fracking fragments because of how easy it is to mass produce sandbags. Although every brainstorming idea was generated for a multitude of benefits that each concept posses, the cons (which will be addressed later on) of the ideas are what helped “We Got Gas” decide to move forward with the brick manufacturing process.

Figure 4. These sketches represent the steps required to produce paper weights, sandpaper, chalk, and sandbags (the initial concepts which further research was not conducted).
Figure 5. Above is a concept sketch of the brick manufacturing process which was picked for further research as well as the final design idea chosen by “We Got Gas.”

Figure 6. This classification tree depicts multiple paths that Chevron could follow in order to better improve waste management.
Concept Development and Selection:

Once the group was able to narrow its ideas down to five final options, the choices needed to be evaluated through the scoring matrix. Using the weighted categories determined earlier, the options were scored as follows:

<table>
<thead>
<tr>
<th>Scoring Matrix</th>
<th>Reference</th>
<th>Paper Weights</th>
<th>Sand Paper</th>
<th>Chalk</th>
<th>Bricks</th>
<th>Sandbags</th>
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</thead>
<tbody>
<tr>
<td>Weight</td>
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<td>Score</td>
<td>Rating</td>
<td>Score</td>
<td>Rating</td>
<td>Score</td>
</tr>
<tr>
<td>Ease of Manufacturing</td>
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<td>1</td>
<td>4</td>
<td>0.8</td>
<td>3</td>
</tr>
<tr>
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<td>0.72</td>
<td>3</td>
<td>0.54</td>
<td>3</td>
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<tr>
<td>Time Efficient Considerate of Local Residents Maintains Company Integrity</td>
<td>0.09</td>
<td>1</td>
<td>0.09</td>
<td>3</td>
<td>0.27</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
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<td>1</td>
<td>0.11</td>
<td>3</td>
<td>0.33</td>
<td>3</td>
</tr>
</tbody>
</table>

Figure 7. Scoring Matrix (1-5 rating scale, 5 being the best)

After going through the scoring matrix, bricks turned out to be the best solution. Bricks scored well in every category, earning a three or higher in every one. The group believed that the cost-efficiency of brick-manufacturing was its strongest asset, as it earned a five in that category. Rather than having to pay to dispose of the cuttings, Chevron could sell the cuttings as a resource to brick manufacturing companies. Along with that, the cuttings would be used as a building material in local communities rather than just being buried in a landfill. This would only add to Chevron’s reputation, showing its involvement in the community.

The idea that was determined as the second best was chalk. Quite similar to bricks, the cuttings could be molded together to form chalk for use. However, the problem with this idea was the small market of chalk. As whiteboards replace more and more chalkboards in schools across the country, chalk is becoming irrelevant. Along with that, chalk is made primarily out of limestone, which is merely a secondary component of the drill cuttings. The drill cuttings are made up primarily of shale, with trace amounts of other rocks, including limestone. Because of this, the process to extract the limestone from the cuttings would be rather meticulous and not worth its time.

Another idea that was discounted due to its small market was paper table weights. Table weights are never a heavily demanded item, and due to that fact, it
would be difficult to introduce drill cutting table weights and expect large financial returns.

Sandpaper was deemed ineffective because of the texture of the rock cuttings. While initially the group believed that they would perform about as well as normal sandpaper, it was soon determined that the rocks are much softer. They would crumble much too easily and would not be effective.

The group’s last idea, sandbags, received the lowest score of the five ideas. Not only is there a small market for them, but they also don’t perform as well as normal sandbags. The rock cuttings would be much less absorbent than regular sand. Also, if used for military purposes. The rock cutting sandbags would not be able to stop bullets or other flying debris nearly as well. The regular sandbags do a much better job of absorbing the blow.

Through the initial design process, the group was able to figure out a general direction as to how the cuttings should be treated. By creating a single, tangible product out of many small rocks, something could be made out of nothing. The only problem the group faced was determining which idea would be best. With the help of the matrices, it was determined that bricks were the best way to go. Once the group was given its direction, the initial prototypes and designs needed to be created.

**Description of Prototype:**

The initial plan for the prototype was to create a brick. Although creating a brick would be simple, and is in fact what the final product would be, it did not accurately portray the necessary steps of how shale rock could be turned into bricks. So, the focus of the prototype moved towards the process of how a shale brick is made, and away from the the brick itself. In order to create an accurate representation of the brick making process, research was conducted to determine what needed to be added to the standard brick making process in order to incorporate shale rocks (see figure_). Because shale rocks vary in size anywhere from the size of a fingernail to a grain of salt, It was determined that a contraption was needed to smash the rocks to a fine powder before they could go through the brick making process. Many brick making companies already have a similar mechanism to smash quarry rocks for standard bricks, but not every company does. Therefore, it is possible that some brick making companies will have to develop one before purchasing the shale rocks from Chevron.

The primary goal of this proposition is to create a more eco friendly, economical, and efficient way for Chevron to dispose of their drill cuttings. By selling the cuttings to a brick manufacturer, Chevron is fueling the development of future schools, homes, and public buildings at half the cost of what they were doing previously, without hurting the environment. The prototype for the brick making process is specific, visually appealing,
as well as effectively demonstrates the possibilities for a better society through its primary goal.

Figure 8. Side view of the prototype built to tangibly show the brick manufacturing process.

Figure 9. Top view of the prototype.
Description of Final Design:

This process of selling the drilling cuttings to a brick manufacturer saves Chevron money right away. The costs involved are transportation, which is about $.15 per ton per mile, and assuming Chevron would only truck there cuttings a maximum of 360 miles, this would cost them $54 per ton[2]. Chevron could also sell the cuttings for a maximum $6.43 per ton, dropping the total cost per ton to about $47.57. This cost is half the current cost of dumping in the landfills, which is $100[1]. Selling the cuttings also reduces Chevrons total work and energy involved with the disposal or relocation of the cuttings, because they are simply shipping the cuttings, and leaving all the other costs involved in brick making to the brick manufactures. Also, selling the cuttings to be made into bricks has a lower environmental impact that landfill, because less land will have to be disturbed to create the landfills. Because Chevron is simply selling the shale rocks, there is no end to the cycle, and the only regulations they have to worry about are the shipping regulations(mostly the speed limit for their shipping trucks). In addition, Chevron can basically sell the shale rocks to brick companies forever, it is essentially sustainable for an endless number of years. Also, it meets all of Chevron’s requirements, which is why Chevron picked it as the best solution.

Figure 10. Solidworks model of prototype

Conclusion:

Through research and calculations, it was determined that the method of selling the drill cuttings to a brick manufacturer was more cost and time efficient than the current, landfill, solution Chevron uses. The main cost involved in selling the cuttings is the cost of shipping. In the current landfill method, Chevron’s cost includes the cost of shipping, as well as the cost of properly burying the drill cuttings. Through research and calculations it was found that Chevron could save about half its current cost of disposal.
Although the proposed process is still costing Chevron money, it is less than half the cost of putting the drill cuttings in landfills, which is about $100 per ton[1]. Taking into account that more than 1,412 tons of drill cuttings could be produced from one well in a given 6-month period, and that Chevron has multiple wells running at once, the process of selling the drill cuttings could save Chevron millions of dollars in long run[4]. Another long term benefit of selling the cuttings instead of burying them in a landfill is that in the future the cost of landfills and burying the cuttings is going to go up, do to the lack of available landfill space.

A possible issue with selling the drill cuttings to a brick manufacturer for use in making shale bricks is that although there are some companies that do make shale bricks as opposed to clay bricks, there are very few in the market because it is a relatively new concept. Also it might be difficult to convince the companies to purchase the drill cuttings instead of regular mined shale. One way that could be solved though is by lowering the price of the drill cuttings per ton below the market price of shale. This would only affects Chevrons savings per ton of drill cuttings by only a couple of dollars, and the savings would still be about $50 per ton of drill cuttings.

Besides the money Chevron would be saving, selling the cuttings to brick manufactures looks much better for their company then burying them in landfills. It’s more environmentally friendly, and the bricks made could beneficial to the community and those who use them. Bricks themselves can last over 100 years so they are a good, long-term building supply, and a much better alternative than landfills.
References:


Appendix 1A:

Figure ?: A picture taken of Dr. Ritter and her favorite students, “We got Gas,” (Who managed to steal the hearts of the judges and spectators alike) at the end of the Chevron sponsored sustainability competition which was held at the Bryce Jordan Center.