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The ROI of Concurrent Design with CFD

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Research Brief

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Research from Aberdeen's Q1 2011 business review has found that the top strategy for manufacturers, reported by 46%, is to improve business execution. What does this mean for new product development? A look at Aberdeen's October 2010 *NPD - the 2011 Growth Imperative: Optimizing Speed and Cost in New Product Development* report reveals the top challenges that must be addressed to accomplish this:

- Development schedules have been reduced (72%)
- Development projects are understaffed (43%)

This means that those involved in new product development must get the most from their existing resources in order to improve efficiency. How can the design engineer contribute to this high level strategy of the organization? One area of focus is understanding product behavior during the development cycle. Assessing product behavior varies based on the product and its operating environment. As found in Aberdeen's April 2011 report, *Getting Product Design Right the First Time with CFD,* an area of growing interest is the impact of Computational Fluid Dynamics (CFD). Does arming design engineers with CFD tools help or slow down the development process? To understand this, Aberdeen studied the experiences of 279 design engineers in March and April 2011, through a survey and interviews. Those whose products were impacted by the criteria assessed in a CFD analysis were isolated for this analysis. This Research Brief provides an overview of the results.

Why CFD?

There has been a growing interest in CFD analysis. CFD has many applications. Some of the more obvious and traditional uses include assessing air flow around an automobile to understand the impact on fuel efficiency, predicting rotor thrust, or evaluating the pressure drop in a hydraulic line. CFD is also becoming increasingly important to high tech products, especially as more products incorporate electronics. Engineers who never before needed to worry about factors such as proper cooling now find it to be a critical aspect of their product design. While these are just examples, there are also many of areas where a CFD analysis provides value (see sidebar definition of CFD). However, before examining CFD practices, we first must understand the pressures companies are under to better understand product behavior.

Research Brief

Aberdeen's Research Briefs provide a detailed exploration of a key finding from a primary research study, including key performance indicators, Best-in-Class insight, and vendor insight.

Definition of CFD

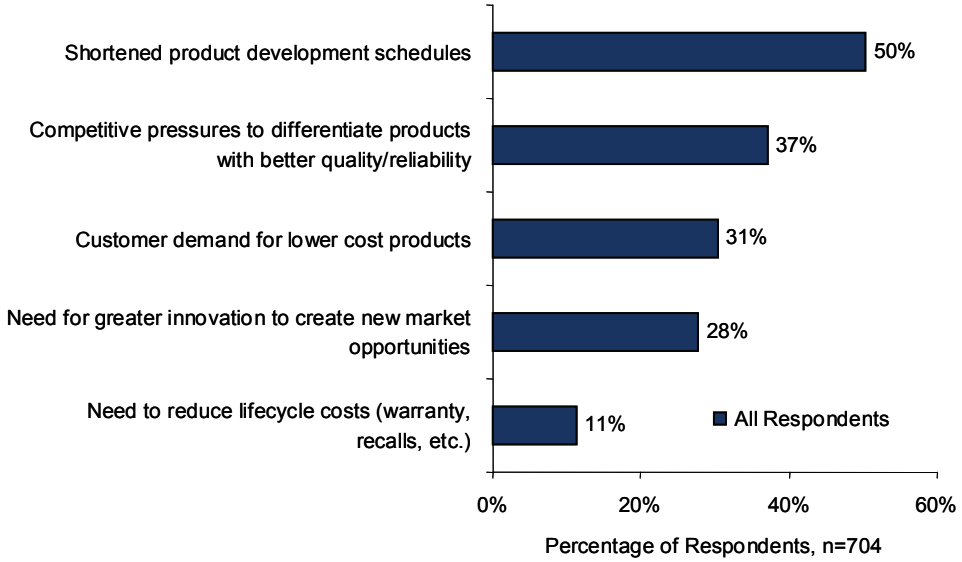
Computational Fluid Dynamics (CFD) is a specialized simulation that analyzes fluid flow. It can be used to assess both liquid and gas flows as well as their interactions. Depending on the application, CFD can be used to obtain better insight into:

- Air / Gas flow
- Fluid flow
- Heating / Cooling
- Chemical reactions /combustion
- Turbulence
- Other related physical phenomena

How Assessing Product Behavior Concurrently with Design Creates Business Value

To understand the external factors driving companies to better understand product behavior during the development process, survey respondents were asked to pick the top two external pressures impacting them the most. Figure 1 shows the top pressures of those whose products are impacted by the factors assessed by CFD analysis.

Figure 1: Top Business Pressures Driving a Better Understanding of Product Behavior



Source: Aberdeen Group, April 2011

"Our company has benefited considerably from implementing CFD. Previously, we used the same cooling system on every product. With CFD, we can actually optimize each system."

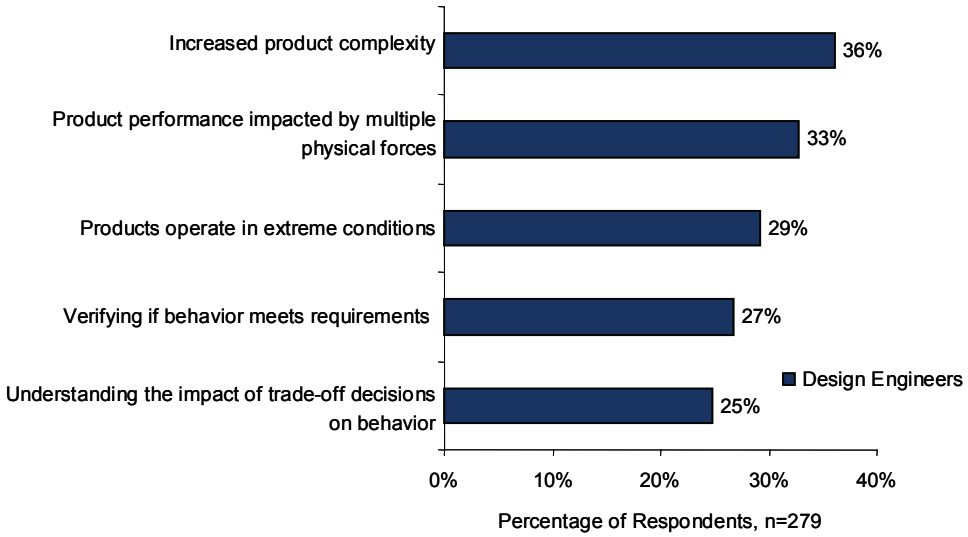
~ Engineer, Consumer Goods

The top pressure is shortened development schedules. Companies must get their products to market as quickly as possible so that they may beat their competitors and capture market share. In addition, they need to maximize the window of opportunity for higher profit margins to recoup development cost and improve profits. The impact of this on development teams is that schedules and resources have been reduced. There is no time to find problems at the end of the development cycle that will delay bringing the product to market. In addition, to capture market share, products must balance high quality and cost competitiveness. Given these pressures, it makes sense to provide design engineers with the tools needed to make better design decisions and this will ultimately lead to more profitable products.

The Design Engineer's Challenge

What obstacles must be addressed in order to help design engineers assess product behavior? The answer can be found in Figure 2 and can be boiled down to one thing: complexity.

Figure 2: Design Engineer's Top Challenges of Understanding Product Behavior



Source: Aberdeen Group, April 2011

The top challenge for design engineers is increasing product complexity. Factors such as a greater number of parts, miniaturization, globalization, and the involvement of multiple engineering disciplines all add to the complexity of products, making it difficult to predict how the components will interact. Further complicating things, the environments the products operate in are also complex, making it even harder to predict behavior. Products are impacted by a variety of physical factors and extreme environments that will impact product performance. All of this uncertainty makes it very difficult to determine if the product will even meet design requirements, not to mention understanding the impact of trade off decisions. Given all these factors, it is extremely challenging to ensure products are designed to meet customer demands for high quality, yet will still be economical.

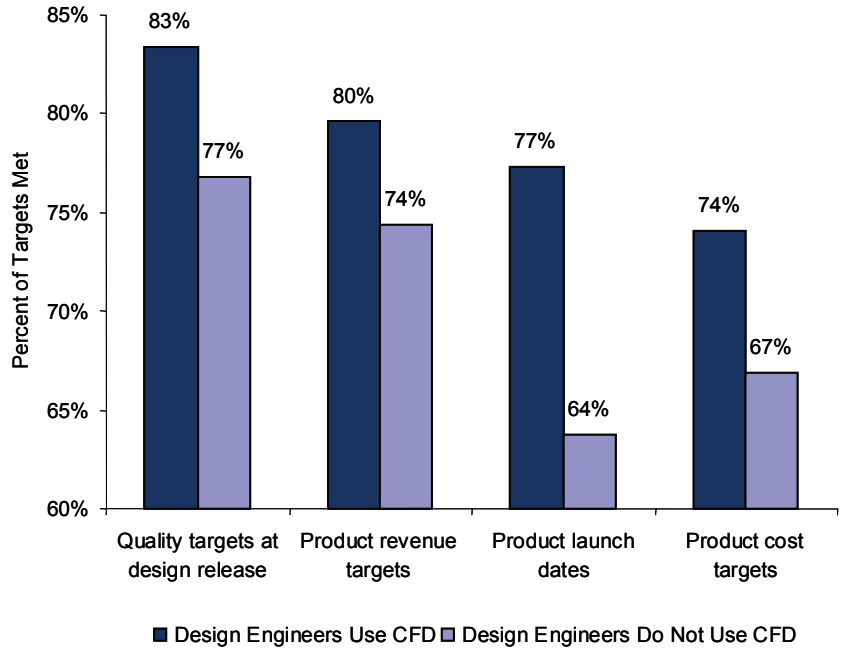
Clearly, design engineers need methods to address all of this complexity. With better insight into product behavior, especially understanding the impact of the variety of physical forces, engineers can make better design decisions that will make products more appealing to customers which will ultimately lead to greater profitability. However, given the time pressures on development, this must be accomplished without adding to the development cycle.

The Impact of Making CFD Available to Design Engineers

As seen in Figure 2, a top challenge for design engineers is that product performance is impacted by multiple physical forces. CFD analysis assesses forces such as fluid flow, air flow, and heat transfer which are often among the multiple physical forces impacting product performance. Understanding

the impact of these forces has become increasingly important in developing new products. Does making CFD tools available to design engineers help to address the design challenges identified in Figure 2? If so, is it possible to accomplish this while simultaneously supporting the company's objectives of addressing top market pressures? To understand this, the performance of companies whose design engineers conducted and had access to CFD results was compared to those who did not make CFD available to design engineers. The results can be found in Figure 3.

Figure 3: The ROI of Design Engineers Using CFD



Source: Aberdeen Group, April 2011

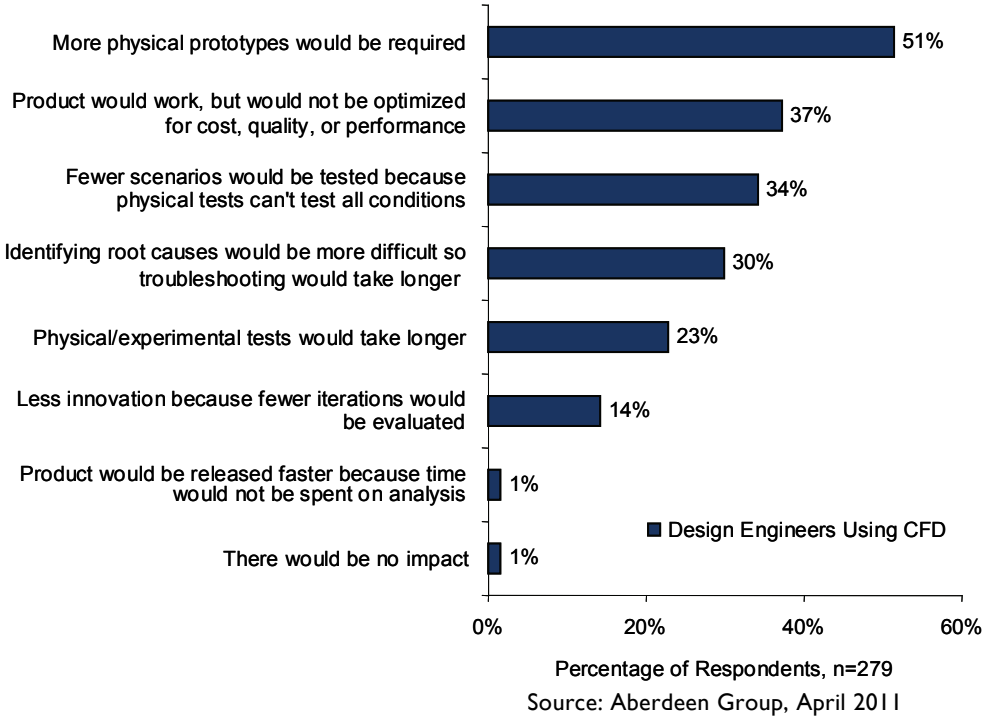
The most striking performance difference when design engineers use CFD is the ability to meet product launch dates. This may seem counterintuitive as it would seem adding CFD analysis to the design engineer's work would actually slow things down. However, by doing this analysis throughout the development process, design engineers are more easily able to manage product complexity and thus have the needed insight to make design decisions more efficiently. More importantly, they catch problems earlier when they are easier to address. Those who are not using CFD are more likely to not find problems until the very end which results in delays that make it harder to meet launch dates. This means that CFD is helping companies address the top pressure on product development, shortened development schedules, and provides a key ROI benefit.

By making CFD available to design engineers, they are also able to make better decisions to improve product quality. At the same time, greater insight helps them to avoid over engineering so they are able to do a better

job of meeting cost targets. Finally, by being more likely to get to market when expected, they are able to capture market share, making it easier to meet revenue targets. In addition, because the decision making process is more efficient, design engineers can put an even greater focus on more innovation which will drive customer demand and further contribute to the ability to meet revenue targets. All of these factors further contribute to the ROI of CFD.

Further reason for the performance advantages seen in Figure 3 is shown in Figure 4. Design engineers were asked the two biggest impacts if CFD was not used.

Figure 4: Biggest Impact if CFD Was Not Used by Design Engineers



Source: Aberdeen Group, April 2011

The vast majority of design engineers, 98%, report value in using CFD. Design engineers find that concurrent CFD during the design phase helps them with testing because they test more design ideas in a virtual environment. As a result, they can bring greater innovation to their products yet still be more likely to meet launch dates and quality targets. In addition, they find that concurrent analysis with CFD tools truly helps them optimize the product design because the results guide the engineer to make better design decisions during the design phase. Ultimately, this leads to greater product profitability.

Interestingly, design engineers do not find that conducting a CFD analysis slows them down. A way to ensure this is to make sure that their work

flow is not interrupted to conduct an analysis. One way to accomplish this is to embed the analysis tools directly into CAD.

What Design Engineers Find Useful

After establishing the ROI that CFD provides design engineers, it is helpful to understand what design engineers find most useful when conducting CFD analyses. To determine this, they were asked to rate the usefulness of various simulation technologies on a scale of 1 to 5 with 5 being the most useful and 1 being the least. The top five most useful functions, shown in Table 1, shows that not only do design engineers value both ease of use and the ability to integrate analysis with the design process, but they rate these features extremely useful.

"We needed to optimize the internal fluid-dynamic of an oven. Coupling CAD, CFD code and an optimization code we automatically tested more than 100 different solutions in a few weeks. The physical tests have been reduced to three major designs."

~ Manager, Consumer Products

Table 1: Top 5 Most Useful CFD Simulation Technologies for Design Engineers

Rank	CFD Simulation Technologies	Score
1	Mesh style flexibility	4.33
2	Integrated design exploration tools	4.17
3	Ability to integrate simulation and design	4.10
4	Knowledge capture through wizards and templates	4.05
5	Automatic Meshing	4.01

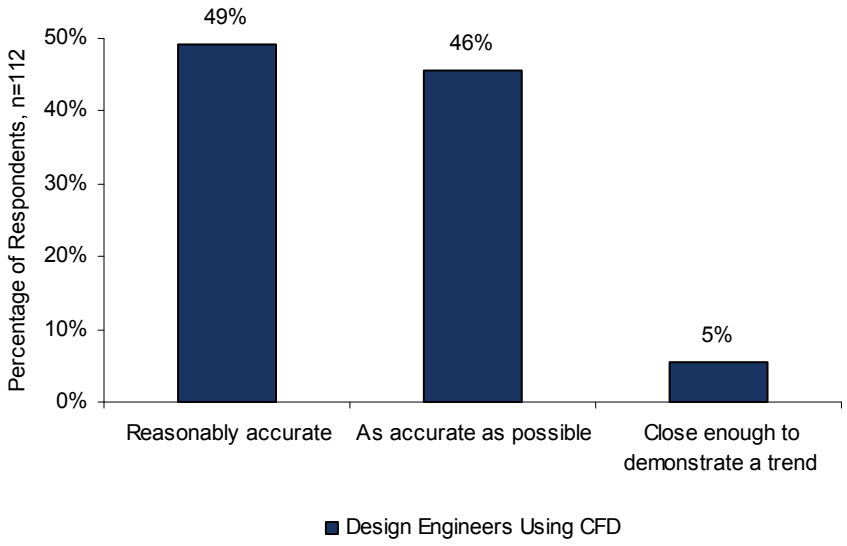
Source: Aberdeen Group, April 2011

Design engineers rate functions that enable them to use simulation results to make better design decisions very high on the usefulness scale. Design exploration tools support concurrent design and analysis by enabling design engineers to conduct what-if studies so that they can better understand the impact of given parameters as they work on the design. They rate integrating analysis with design as extremely useful. This integration is easily accomplished by embedding the analysis tools directly within CAD so that the simulation can be conducted throughout the design process without the need to switch applications or import data into another application. To support ease of use, design engineers find wizards that walk them through the analysis process very helpful. This function provides guidance to set up the analysis correctly and is especially useful to those who may not conduct an analysis every day and therefore, are less familiar with the company standards and process for analysis. Design engineers also appreciate automatic meshing that saves time preparing a CAD model for analysis, but when they have the knowledge or desire to change the mesh style, they find it very useful to have the flexibility to do that.

Another question is how much do design engineers value result accuracy? Is it more important to just understand a general trend or do they need accurate results? As seen in Figure 5, accuracy is very important. Design engineers were asked if they looked for results to be very accurate, reasonable accurate, or just close enough to identify a trend. Ninety-five

percent (95%) look for the results to be accurate and need more than results that provide a general trend.

Figure 5: Design Engineers Value Simulation Accuracy



Source: Aberdeen Group, April 2011

Key Takeaways

Design engineers are finding significant value in the ability to conduct CFD analyses while performing design work:

- Design engineers rate functions that enable them to tightly integrate CFD analysis with design as extremely useful as it enables them to make better decisions so that they can meet both quality and cost targets, while focusing on the innovations that will drive customer demand to meet revenue targets
- Increasing part complexity as well as the multiple physical properties impacting products creates a need for design engineers to have better methods for understanding product behavior
- Companies that provide design engineers with CFD tools to use during design are 21% more likely to meet launch dates than those who do not provide design engineers with these tools, making it a key part of the ROI of using CFD in a design environment

Companies that support their design engineers with CFD tools realize the ROI of CFD because they are better able to address the top market pressure to bring products to market sooner and are therefore at a competitive advantage.

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For more information on this or other research topics, please visit www.aberdeen.com.

Related Research	
Getting Product Design Right the First Time with CFD, April 2011 *Engineering Evolved: Getting Mechatronics Performance Right the First Time.* November 2008	*Cost Saving Strategies for Engineering: Using Simulation to Make Better Decisions*, April 2010

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