

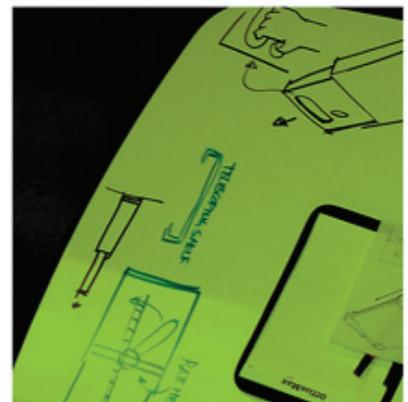
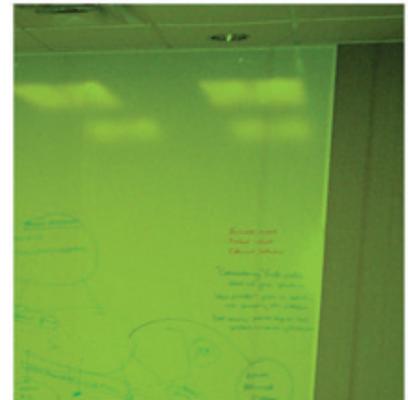
Effective Product Convergence through

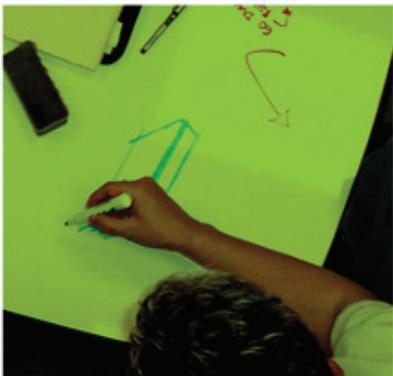
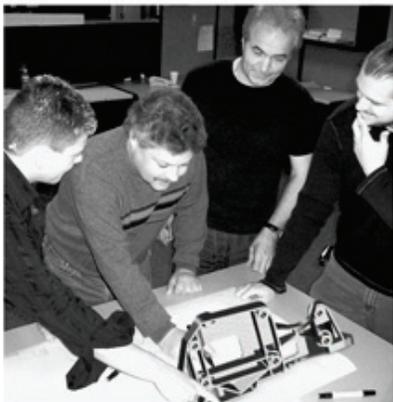
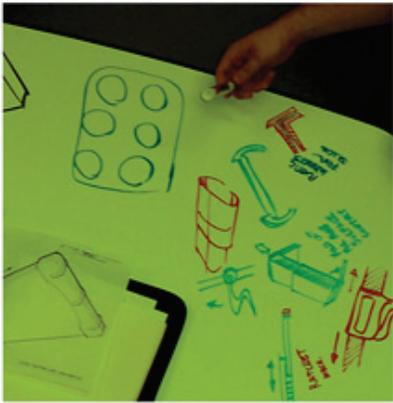
# Visual Brainstorming



When trying to reach consensus in new product development, **a picture (or two) is worth a thousand words.**

by Nance Halle,  
Allen Rubel and  
Dave Simon





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Managing the proper rate of product convergence on a large-scale systems engineering project is difficult – especially when significant innovation is required to make breakthroughs in functional and cost-benefit performance. A natural organizational tendency is to subdivide the innovation process too quickly into pre-set boundaries of the system, subsystem and component descriptions. Traditional product development methods have a tendency to follow along the lines of a premature subdivision.

A requirements-based design strategy incorporating the key elements of systems engineering (target setting, requirement definition, prioritization, etc.) with visual brainstorming methodologies can help prevent the premature effects of system division from occurring. Moreover, early-phase product development work encourages open thinking and participation from all members of a cross-functional working group.

## Setting the Direction

A requirements-based design strategy is a subset of an overall Quality Function Deployment (QFD) process, and it is intended to be used as a direction-setting requirements exercise early in the product development process. It is a tool based on the following two premises:

- ◆ Effective brainstorming requires a selective and specific list of questions on which to focus.
- ◆ The use of structural optimization and other advanced simulation techniques early in the design cycle requires careful assessment of design requirement parameters.

Discipline is required in early phase product concept work to avoid just coming up with broad-view ideas, or, conversely, from drilling very deep into a particular technical problem and solution set. This is particularly true in the two extremely opposite cases of group brainstorming and the efforts of an analytical specialist.

## Asking the Right Questions

The U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC) Family of Army Scalable Trailers (FAST) project is intended to provide a multi-purpose replacement for trailers that engage in cargo-hauling missions, including standard container transfer, heavy-tracked wheeled vehicles, equipment and miscellaneous cargo. Program goals include reduced part count, common

components and increased reliability, as well as increased compatibility with prime movers, better cargo protection and increased off-road capability.

As a result of the various requirements put forward by the trailer user groups and other customers to the project, the list of product specifications was extensive. There are two extreme approaches to developing the right set of questions: broad and narrow.

Distillation of a technical challenge down to a single all-encompassing question can be a very powerful tool for achieving innovative results. Once this question has been developed, however, it is usually necessary to focus on sub-questions, particularly in the context of trying to keep a group brainstorming session moving forward.

The one-question challenge for the TARDEC FAST project might be phrased as, "How can one trailer be effectively and efficiently used for all of the Army's cargo-hauling missions?" While there are times when this approach might have worked well, the project management team decided that more focused questions would be required in order to have effective brainstorming sessions.

From the list of technical requirements, it would have been easily possible to develop a comprehensive series of between 50 and 100 legitimate questions regarding the Army's trailers.

To run a brainstorming session on each of 50

questions – allowing a minimum of 15 minutes per question – would have required each session to be nearly 13 hours long. This was simply regarded as impractical.

Rather than targeting either extreme in terms of question development, the following five questions comprised the brainstorming list:

1. How can we decrease load/unload times?
2. How can we increase a trailer's off-road mobility?
3. How can we haul extreme cargo in terms of weight and volume within a defined envelope?
4. How can we reduce the terrain vibrations that the cargo will see at the extreme payload conditions?
5. How can we hook up with numerous prime movers with varying fifth-wheel locations?

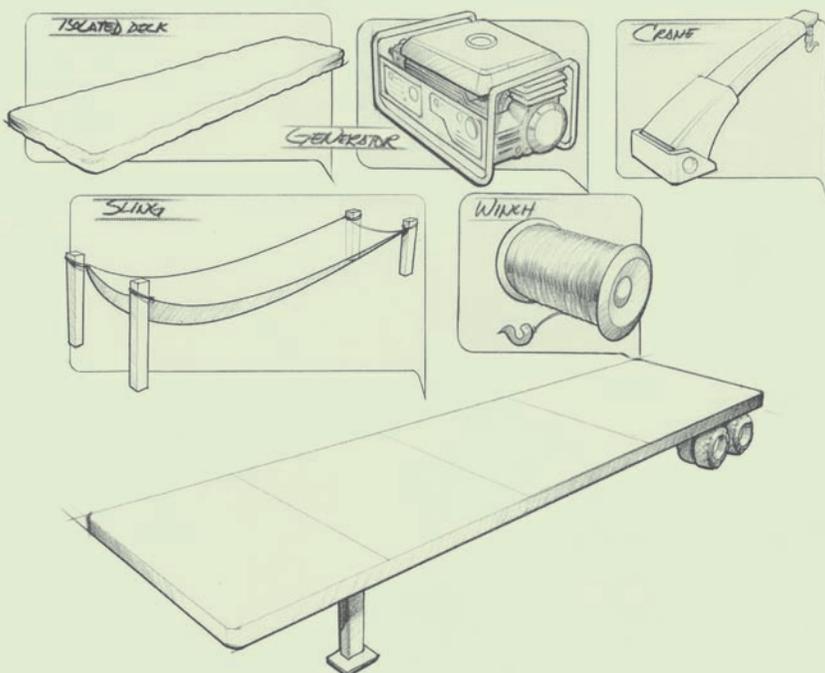
### The Traditional Approach

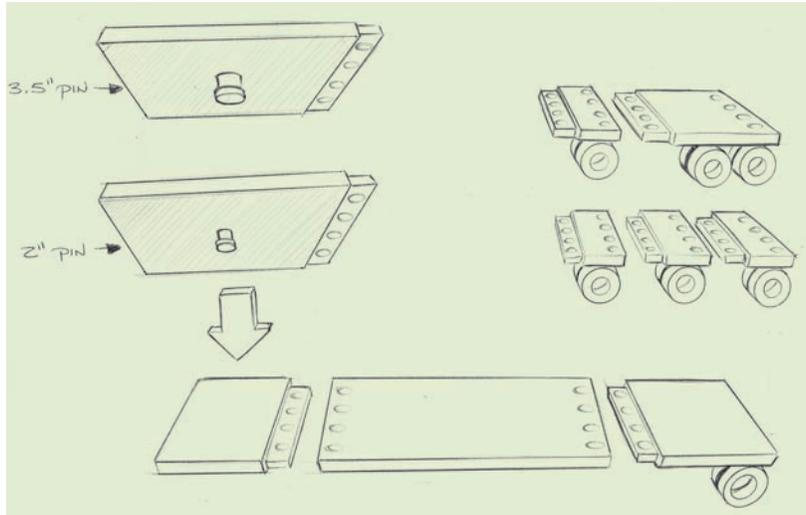
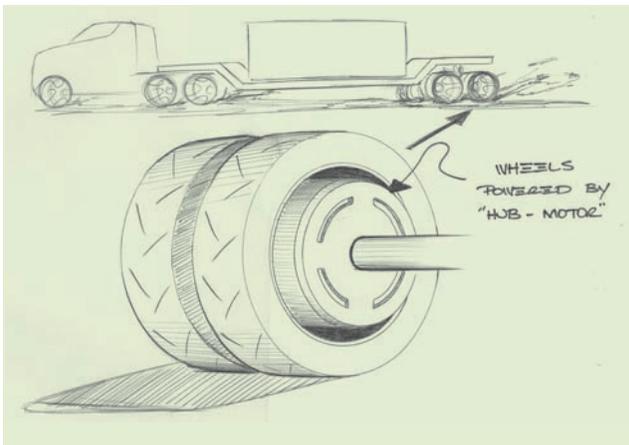
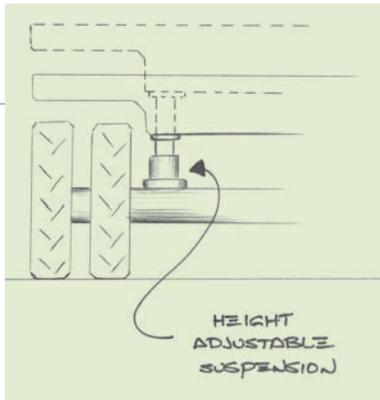
Brainstorming sessions are a successful tool for generating many possible solutions to a question or challenge. Traditional brainstorming sessions have evolved to commonly follow a well-agreed upon set of rules such as these:

- ◆ There is no such thing as a bad idea.
- ◆ Negative discussion regarding an idea is not allowed.
- ◆ Everyone must contribute at least one idea per question.

The output of traditional brainstorming sessions is usually an extensive list of ideas. When doing product development, however, the generation of the "possible solutions" list has the following weaknesses:

- ◆ Words mean different things to different people. When everyone in a brainstorming session is from the same organization and department, the use of words is not usually a problem because they share a common daily vocabulary. In the case of the FAST trailer project, however, each brainstorming session included a wide cross-section of people from different companies and organizations, each with different technical backgrounds. The word "gooseneck," for example, has a fairly specific component definition to a trailer manufacturer, while to a vehicle ride and handling specialist the word "gooseneck" might infer a larger system definition.
- ◆ The same idea gets restated in different ways. One idea might be stated as "modular bogeys,"





while another idea might be called “interchangeable rear suspension units,” when the two idea-generators might – or might not – mean the same thing.

- ◆ Ideas do not build on each other. In word-driven brainstorming sessions, it can be easy to generate lots of ideas but difficult to get people to improvise and add to the ideas of others.
- ◆ Clarification of “what I meant” is difficult. By definition, brainstorming generates a lot of ideas, and clarification of meaning can be regarded as time-consuming and unnecessary.
- ◆ System divisions are premature and non-obvious. Especially damaging in a systems engineering context, words, and the way in which ideas are ordered, can subtly lead groups down certain paths of system divisions. There is a tendency on the part of groups to try and find common ground and understanding. Thus, a subconscious effort to “give a little” to the group can come in the form of using common words and phrases.

As a result of these weaknesses, an engineer on the FAST program might go into a trailer brainstorming session referring to “isolation” and “suspension” as two different things. During the course of a session

the word “suspension” might become the common phrase in the room, with the unintentional effect of making it difficult for the group to later re-split the functions of the suspension function from other isolator functions.

### The Visual Approach

Visual brainstorming is a method that uses the natural human tendency to gather and interpret data visually as a means of counteracting the problems associated with traditional brainstorming. The process and rules for visual brainstorming are the same as those for traditional brainstorming, with one addition: Every idea must be expressed in a picture.

Note that the rule doesn’t say the picture must be nice or neat, or that the person generating the idea needs to be the one to draw the picture. It also doesn’t say that the pictures need to be generated as fast as the ideas.

Once the project managers have defined the brainstorming questions, the next step is to provide as much in the way of visual aids as possible for the session participants. For the FAST program, this pre-meeting preparation included the following:

- ◆ Large posters showing the current trailers.
- ◆ Large posters stating each of the five brainstorming questions.
- ◆ Basic outline templates of common-profile items, such as trailers, prime movers and cargo containers, as well as ground clearance and maximum height lines.

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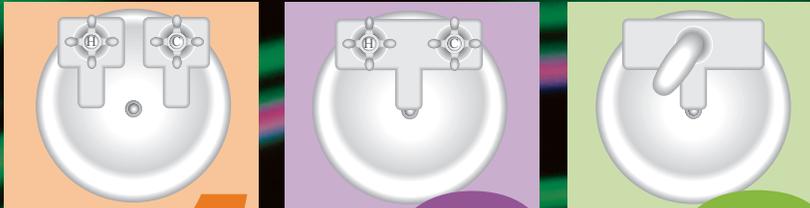
## Three Paths toward Product Convergence

**Project:** Design and engineer a water faucet

**Goal:** Warm water delivery to a kitchen sink

There is more than one way to approach a systems design and engineering project. This is a classic example that is often used in comparing single-purpose design to combined-function system design.

None of the solutions is inherently superior to the others. The example simply shows the clear relationship between system divisions and the resulting design, as well as demonstrating the importance of keeping all system-dividing options open until an appropriate time for convergence in the design cycle.



### Path One:

- ◆ Hot water delivery and control system
- ◆ Cold water delivery and control system

*The resulting product will tend to be two faucets and two control knobs, one each for hot water and one each for cold water.*

### Path Two:

If the system division is instead:

- ◆ Hot water control system
- ◆ Cold water control system
- ◆ Water delivery system

*The resulting product will likely be a single faucet with separate controls for hot and cold water.*

### Path Three:

- ◆ Water temperature control system
- ◆ Water delivery system

*The resulting product will evolve toward a design with a single control lever and a single faucet.*

continued from page 9

- ◆ Sketch paper.
- ◆ Clear acetate overlays of common-profile items.

For the FAST program, each brainstorming session included an overhead projector and a large screen. Two industrial designers especially skilled in rapid concept sketching sat in the front of the room. As ideas were generated, they either provided a quick sketch or helped clarify a participant-generated sketch.

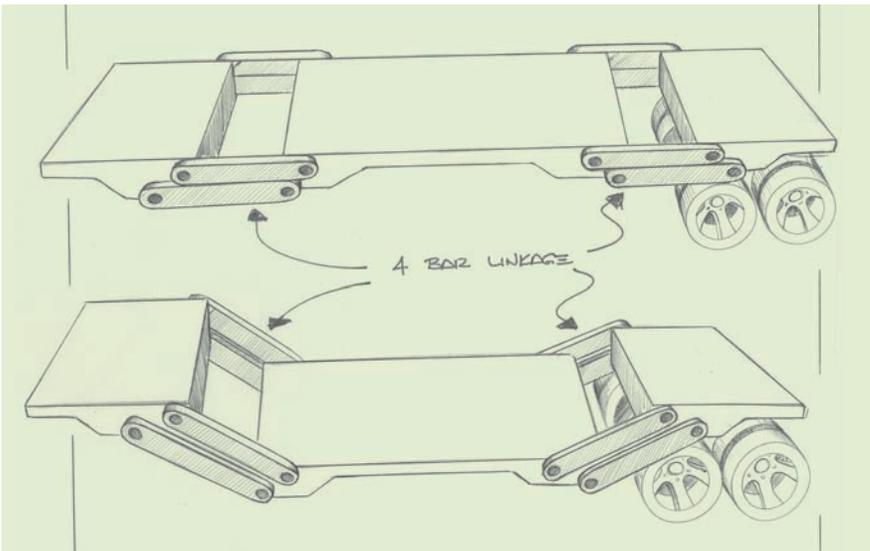
It should be noted that while many graphic artists, storyboard artists, etc. are able to draw ideas quickly, it is essential to the process that the people aiding the visual aspects of the process also understand the issues inherent with product development, systems design and engineering. The training and skills offered by industrial designers are especially suited to

help with visualizing product ideas.

As with any brainstorming session, it is the role of the facilitator to help the group generate as many ideas as possible. At the same time, the facilitator must ensure that everyone is heard, that the goals of the session are being met, and that the clock is being watched.

In addition, while using visual brainstorming techniques, the phrase “Is this what you meant?” is extremely valuable. It means that there must be some juggling of focus, as the sketch for ideas always seems to lag behind the words. However, the role of making sure that words and pictures correlate is key to the process’ success.

The group members must participate as they would in any brainstorming session, letting go of any negative barriers to idea generation and conveying their ideas as clearly as possible. In addition, it is the



job of the participant to see to it that their ideas are represented accurately – if not elegantly – with a picture. This can be represented by their own sketch or from one by the industrial designers or a combination of both.

Participants are strongly encouraged to use other people's sketches as the basis for their refining ideas. Tracing, copying, overlaying and other forms of manipulating images into new forms are highly recommended.

The results from a visual brainstorming session should be the same as with any brainstorming exercise. That is, there should be a great number of ideas generated. The differences between visual brainstorming and the traditional method should be apparent, however, in the following ways:

- ◆ Every group member should have a clear picture in his/her mind of what every other group member's ideas were, because the entire group witnessed the “here's-what-I-meant” moment as the sketch is shown.
- ◆ The physical act of drawing, tracing, cutting, etc. should have led to deliberate thought about which items were ordered into which sort of system configuration, thus helping to avoid “group think” regarding system divisions.

The output from the visual brainstorming sessions is used to organize the categories for theme development, the next phase in the project. Because all of the ideas are visual, the various ideas can be mixed and matched into various “picture stories” to see which makes sense to carry forward and combine.

### Developing a Theme

The second round of group sessions is intended to combine the brainstorming results into thematic

groups for the team to review. On the FAST program, two of the groupings were “prime mover attachments” and “load floor configurations.”

For each thematic grouping, a design decision matrix (DDM) is used to help rank-order the themes in order to determine which theme to carry forward into the design concept phase.

The third round of group sessions examines the results of the DDM sessions that have been sorted and refined into design concepts and determines which of the concepts to carry forward.

Once the concept development phase is passed, then the use of CAD and CAE tools is appropriate to simulate, visualize and begin optimizing the design. The FAST program held design reviews of the major concept themes in the National Automotive Center's CAVE Automatic Virtual Environment (CAVE).

### Getting the Picture

Surveying the needs of potential owners, maintainers and users of FAST trailer products is made much easier with the early-phase availability of illustrated concepts. Much in the same way that the availability of visual images helped the brainstorming sessions, the picture-based survey engendered good response and comments from the survey participants.

Once there is confidence in a design direction that is supported by the key trailer constituents, the FAST program will move into a simulation-intensive design and development process. Confidence in this process will be greatly bolstered by the shared understanding of system design and engineering parameters that was achieved by using highly visual methods early in the program.

The use of team brainstorming sessions as a precursor to product development efforts is generally acknowledged to be a powerful and appropriate tool. Particularly with complex systems engineering projects, the use of visual brainstorming techniques can significantly enhance participants' understanding, and speed the rate of idea refinement and sorting. **C2R**

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