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How to Hit Your Left Thumb: Designing a Better Hammer

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How to Hit Your Left Thumb: Designing a Better Hammer

HAMMERS ARE HAMMERS. What more can be said? Plenty, as John Grieves makes clear in this fascinating case study. His is a tale about designing the best hammer possible, about thoughtfully gathering all kinds of detailed user data to make subtle refinements to an age-old tool—changing how it works, how it feels, and how it looks. Notably, the outcome of this intimate customer encounter is a product that commands a premium price at the same time that it attracts a larger share of the market.

by John Grieves

Every designer knows that there are some designs that could never have been made without the help of end users. The problem is: What is the best way to involve prospective customers? Ergonomi Design Gruppen, based in Stockholm, Sweden, has cultivated a design method that engages groups of end users, asks them to test a range of existing designs, and uses the test results as a basis for prototypes. For example, we point with pride to our T-Block series of Hultafors engineers' hammers. Here's the story behind that product.

John Grieves studied at the Central School of Arts and Crafts, in London, before moving to Stockholm, Sweden, where he became a founding member of the Ergonomi Design Gruppen.

A New Range of Engineers' Hammers
In 1994, Ergonomi Design Gruppen was commissioned to develop a new design for engineers' hammers, in collaboration with Hultafors AB. The traditional suppliers of hammers to the Scandinavian market, Hultafors AB manufactures a whole range of hand tools, including hammers, crowbars, axes, and folding rules. Our brief was to develop a new range of hammers that would improve performance, increase user satisfaction, and significantly reduce the accident rate.

The Hultafors project was initiated by a Swedish study[1] of industrial accidents involving hand tools. Hammers figured in a surprising number of these

1. A. Kilbom and L. Sperling, *Forskning & Practic* (English edition), no. 3, 1993, National Institute of Occupational Health, Solna, Sweden.

accidents. In fact, with the exception of knives, no other hand tool came close. Detailed studies of the accident reports showed that the most frequent accidents fell into three categories:

1. Accidents in which the user loses control over the hammer when it recoils
2. Accidents in which the user misses the object aimed at and hits something else, often the fingers of his or her other hand
3. Accidents involving indirect damage in which, for example, the user falls and hurts himself or someone else with the hammer he is carrying

At Ergonomi Design Gruppen, we like to start a design project by investigating models that are currently in use. Accordingly, our first visits to manufacturing workshops were to investigate the hammers that were traditionally used there, the way in which they were used, and what the end users thought about them.

The First Encounters

The visits would, typically, start by the foreman of the workshop denying that they used hammers at all. We soon learned, however, that if we waited around long enough, somebody would start hammering somewhere. They would start hammering because something had gone wrong; something had stuck or needed bending. This gave us an opportunity to get to a hammer user and start our interview. We made video recordings of the way hammers were used, the workplace environments in which they were used, and how the hammers were stored when not in use (figure 1).

At this stage of a project, we like to review market developments—the way competitors in our area and related markets have improved their use of materials and manufacturing techniques. We collect user reactions to these new designs, which puts our design team in a good position to postulate new design ideas. Our assessment of recent developments in hammer design revealed a number of hammers with plastic handles, integrated heads, and reduced recoil. We brought these with us and tested them with our subjects, recording users' reactions in notes and on videotape (figure 2).

Our workshop visits revealed several interesting points.

1. On almost half (40 percent) the hammers in our subjects' workshops, the wooden handles had dried and shrunk so that the heads were loose, even if they were still attached to the handles. Plastic handles were preferable.
2. Every fourth hammer (23 percent) had a handle that was oily and slippery as a result of users' dirty hands. Moreover, hammers were typically stored in a drawer along with other oily and greasy tools.
3. Because most tasks required only one hammer blow to achieve the user's purpose, hammers with reduced recoil attracted attention and were appreciated.
4. Old hammers had very narrow handles; newer models, which had thicker handles, were preferred.
5. We found that plastic mallets were more frequently used than metal hammers.

Figure 1

Investigating users' attitudes about their hammers.

A Second Round of Encounters

This first round of customer encounters, as well as the above-mentioned accident reports, demonstrated a need for hammers with several new requirements.

We prepared ourselves for the next round of visits to the end users by designing and manufacturing a kit of models (figure 3) that illustrated various solutions. Sketches of possible solutions were augmented with readily available anthropometric data, as well as Ergonomi Design Gruppen's considerable previous experience designing and developing hand tools. The proposals were then drawn up and manufactured.

The models included a selection of shapes and sizes of hammerheads, several of them designed for reducing recoil. We manufactured handles of different thicknesses in order to investigate size preferences. We also produced a variety of handle shapes so that we could study their usefulness for performing different tasks. Handles that were longer than usual were included to ascertain which length was preferred. Some of the handles were made with an indented handgrip to study a competing design that had such a feature. Some were even set on an angle to the head in accordance with the findings of a study[2] that claimed significant advantages for reducing the ulnar adduction of the wrist in using a hammer.

Figure 2

Competitors' hammers with plastic handles and recoil reduction.

The kit of models allowed us to combine a variety of hammerheads with an equally wide selection of handles. All the heads fit all the handles. We painted the whole kit of models black so that no color discrimination entered into the evaluation of the various combinations. With the help of the kit, pictured in figure 3, we were able to interview a

2. R. W. Schoenmarklin and W. S. Marras, *Human Factors,* vol. 31, number 4, 1989.

Figure 3

The kit of prototype models demonstrates a range of solutions to user requirements.

wide selection of hammer users and to test their reactions to the designs.

For these interviews, we chose four industries engaged in the assembly of products of varying size and weight. A total of 11 hammer users were interviewed; three of them were female.[3]

We have found that giving users a practical choice of solutions and dimensions is a very efficient way to gather quick and reliable assessments. The user is able to gradually close in on his or her preferred solution, try it out, and compare it directly with other possible solutions. The user does not need to speculate or guess at which is best; instead, he or she can reduce the field to the best available solution. (The findings are, of course, confined to solutions included in the kit of models that has been designed and manufactured. The testers have to be aware that there may be other possibilities and that these might improve performance even further.)

We videotape the interviews and tests. This helps to reveal additional relevant information gleaned from working stance, grip, and position of grip on the handle.

Our observations showed us the following preferences:

1. *Reduced recoil.*
2. *Oval cross-section.* Our subjects preferred an elliptical handle, which offered an immediate indication of the hammer's direction. This shape also suited both left- and right-handed people and gave a good distribution of pressure in the hand.
3. *High-friction surface.* This reduced the need for strength of grip and also reduced the possibility of accident caused by an oily handle.

These specifications, together with preferences for length, cross-sectional sizes, and balance, gave us a good starting point from which to develop a design proposal. The interest in reduced recoil led us to perform a series of experiments that changed the balance of the hammers with a counterweight at the end of the handle. This dampened the rotational component of the recoil; the hammer rotated around its center of gravity, reducing the shock on the fingers. High-speed filming confirmed this hypothesis, and in our field tests we found that improved balance and reduced back rotation were appreciated.

Now we began work on a set of test hammers that offered four different weights and three alternative head ends—peen, ballpeen, and a nylon plastic cap (figure 4). The heads were drilled out and filled with steel shot, which significantly reduced recoil. The handles were made in four sizes, three cross-sectional sizes, and three lengths. These prototypes would be used in the third and last of our field tests.

Figure 4

Prototype of the design proposal.

Round Three

This round of customer encounters involved 10 more end users (seven males and three females) at three separate industries. All were given prototype hammers, and their responses were very positive ("Much easier to use." "Good—it is important how the handle feels in your hand." "Better grip on the handle.") Most of our subjects found the hammers well designed. They approved of the balance we had achieved with a small counterweight at the end of the handle. The variation in cross-sectional dimensions over the length of the handle met with approval. Two men thought the handles were too thick in the middle; the women chose the smallest and the medium thicknesses. The longest handle was generally regarded as too long. Eight out of 10 judged the face of the head to be too little. All our subjects appreciated the reduction in recoil and judged it to be neither too elastic nor too rigid. For those who liked to use a plastic mallet, we devised a combination head that offered a steel face and a plastic face on the same handle, and this was also well received.

Final Design

After this third round of consultations, we prepared a design proposal. With an eye to what we had learned, we made the heads stubbier and removed the longest handle from the selection. Then we turned to the forging process and studied its

3. The female population in the manufacturing industry has increased. This is especially noticeable in the automotive industry, in which up to one-third of assembly line workers may be female. The significant difference in anthropometric measurements, as well as physical strength of men and women, make this a necessary consideration in any tool design.

requirements. Finally, we were ready to propose a final hammer design, which was to be called the T-Block in acknowledgment of the shape of its head. As defined in our Intergraph EMS computer program, the series sported a system of interchangeable handles and heads that allowed four head weights, three alternative second faces, and three handle sizes (two lengths and three thicknesses).

We addressed the original problem of loose heads by designing the hammers to include a steel tube that goes through the plastic handle and connects the forged head and the counterweight. This assures a secure fastening of head to handle and eliminates the risks associated with loose heads.

Hammering Home Some Unique Selling Points

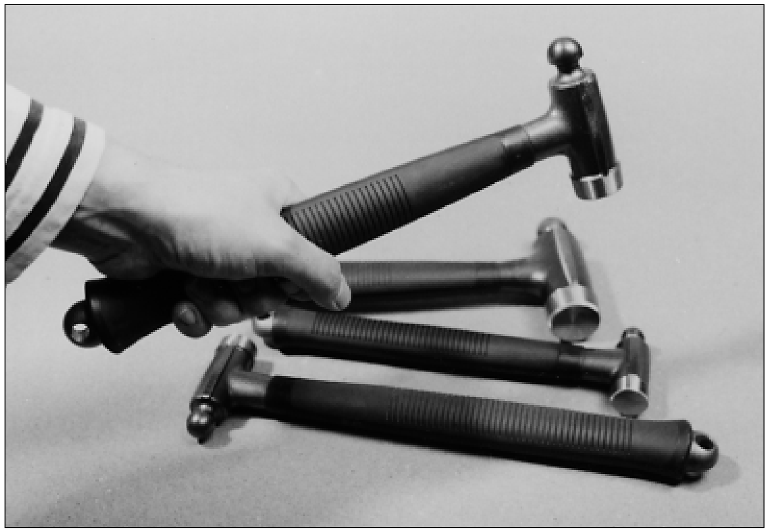
The T-Block series (figure 5) was deliberately made to differ from traditional hammer designs. Hammers are made in widely differing design traditions in Europe, and it was necessary not to associate the T-Block too closely with any of those traditions. We emphasized a modern style in materials, as well as the organic shapes used for the head and handle. The design gives expression to the efficiency of the new hammers.

We addressed all the concerns we had identified in our studies. The design dealt with the loose-head problem by making it clear that the heads are forged with a "neck" that meets the handle and thus offers a more secure attachment. The counterweight has the same finish as the head in order to assure the user that the two are connected in a secure manner. The hammers have a totally forged feeling that demands respect. The flash on the parting line for the forging of the head is emphasized and ridged so that grinding of flash does not disturb the forged surface. This gives the head an emphasis on its direction, together with a place for the text indicating weight and size.

We addressed the "grip" problem by first designing the handles for an optimum grip for tasks that demand both power and precision. The handle is made of polypropylene, with a covering of polypropylene elastomer, which provides a high-friction surface that reduces the need for tension in the grip. The elastomer is grooved, providing a good grip even for hands that are wet or oily. The handles offer a secure grip in the middle, as well, making it comfortable to carry the hammer in this way. Furthermore, the handle ends are thicker than the rest of the handle, making it harder for the handle to slip out of the hand. The counterweight has a hole in it by which the hammer can be hung, addressing the storage problem.

The heads and counterweights are varnished, accentuating the color and finish of the forged iron, and the elastomer of the handles is black on a red core. Its well-finished appearance and stylish color scheme makes it easily recognizable in hardware stores.

Figure 5



The T-Block hammer system, with 6-, 9-, 13-, and 21-ounce head weights.

Proof in the Pudding

Hammers in the T-Block series command a price that is 200 percent greater than that of their competitors, which makes them more attractive from a manufacturing point of view. Despite the price difference, T-Block hammers currently command 25 percent of the industrial-hammer market. And the design community likes them, too. Our hammers were finalists in the European Design Prize in 1997. They could not have been imagined without the help of our colleagues, our customers. ♦

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Suggested Readings

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