

# Seven Habits of Highly Effective Product Development

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In product development today, one question that always seems to come up is “How are we going to get our products to market quicker and still not sacrifice quality?” At least I like to think everyone adds the second caveat.

In this paper I hope to present you with ideas and proven practices, that if you use them and make them habits, will get your products to market faster, make your products more reliable, keep your designers happy, and save you money. This paper will provide examples of how the seven habits fit into a generic product development process. This paper will also provide examples of how they were used in a real product development.

The seven habits of highly effective product development are:

- Concurrent Engineering with Multi Functional Teams
- Product Robustness Must Be Put In at the Design Stage
- Change The “Designer’s Mentality” to see Breaking Products as a Good Thing
- HALT the Prototype
- FMECA Is Needed to Disseminate Engineering’s Knowledge to the Rest of the Organization
- HALT the Final Solution
- Know When the Project Is Done and Celebrate

The following is a description of each of the seven habits with some reasoning for having them.

## Habit 1: Concurrent Engineering with Multi Functional Teams

Most design engineering groups are being asked to do their part by utilizing concurrent engineering techniques already. Most of the time these techniques are applied only toward the design engineering effort. So the electrical designers are creating control systems at the same time the mechanical designers are still building the first prototypes of the hardware. The software engineers are also busy designing code to link all the other groups together in a control program. This in turn speeds up the entire development process and gets products to market faster.

The real value in doing concurrent engineering comes from the documentation required by the process. Requirements documents must be generated early in the process and they must reflect the potential customer’s requirements. In order to do a thorough job on a requirements document requires a thorough understanding of the customer’s challenges. Which in turn will

mean less starting and stopping on a project do to the changing customer requirements. This is not to say that a new technology won't change requirements in the product. But hopefully some group within your company is keeping up on the latest technological developments in your industry.

### Habit 2: Product Robustness Must Be Put In at the Design Stage

"You cannot test quality into a product." We have all heard this before and it is true. We have also all heard that it is always cheaper to make design changes earlier in the process as opposed to later in the process. The reason for this Habit is to get developers used to thinking, as early as possible, about how much robustness, reliability, and quality do we want to put into this product.

### Habit 3: Change the "Designer's Mentality" to See Breaking Products as a Good Thing

Designers hate to break things. They are always trying to make things work. That is beat into their heads from the first day of school. Whereas good testers have been described as warped designers who take pride in breaking designs. When I was running the test group we had a saying "It's not a good day if nothing broke." Of course to simply break things is not enough. 'Breaks' need to be repeatable and we also must find the root cause of the defect so it can be fixed. I used to always tell my testers, "breaking a product is good, but your job isn't done until it can be repeated and the root cause can be found and eliminated."

Our challenge then is to help designers see defects as opportunities to improve the design. Defects are especially beneficial if found by the test group or even better if found by the design group before it gets to the test group. Defects are not so good when the customer finds them in the field. If the customer finds a defect in a product it is still an opportunity to improve. But to contradict another saying from a former QA group leader "Customers are NOT our best testers."

### Habit 4: HALT the Prototypes

As stated above, the sooner in the design that we can make changes to make a product more robust the better. I suggest taking the first prototypes and running a HALT on them. The HALT environment is so severe that many parts of the system can be exposed at one time. So in less than a week's time many design flaws can be discovered and resolved before the design is set in stone.

By utilizing HALT, or some other accelerated testing methodology, the designers can identify the weak points in the design much earlier in the development cycle. They can then easily make changes to the design to increase the robustness and even functionality of the design, long before the design is set in stone.

By definition HALT needs to be done with the first prototypes so the design can be affected before changes get too costly. Which means it could be done before all the bugs are worked

out of the code and the final bill of materials is decided. This will also provide additional data on how to complete the remaining development tasks.

Other advantages of using HALT in a Concurrent Engineering development include the time and money it takes to perform the testing. This doesn't even take into account the fact that HALT will uncover design problems that normally wouldn't be seen until the product reached the field. On the time and money side, a typical HALT takes about one week and \$12,000 to complete, using external facilities. A classical DVT sequence of tests take 3 months and costs \$70,000. For a HALT, you prefer to have prototype (but representative) hardware. The classical DVT usually requires the finished product to get valid results.

To summarize the differences between using HALT or the classical DVT process: HALT takes less test time, uncovers design issues sooner; costs less, and can be performed much earlier in the design process. So any issues that are discovered can have solutions implemented for far less money than those issues uncovered during a DVT.

On the first HALT I performed on a brand new product, we discovered some problems that we were also experiencing in the field with our legacy products. Some of these field failures we could not duplicate in the lab, but we were seeing them during the HALT of a totally different product. So we could take our results from HALT and apply them not only to the new product that we were developing but we also told our continuation engineer and he made design changes to the legacy product.

The following page shows a Gantt chart comparing the Classical Development Process versus an Accelerated Development Process incorporating HALT. Times listed are composites from actual measured times for multiple projects at multiple companies where I have worked.



### Habit 5: FMECA Is Needed to Disseminate Engineering's Knowledge to the Rest of the Organization

The main purpose of the FMECA data is to get information out of the designers' heads and into a format that is useful to the other groups that need this information. Groups such as manufacturing need to know how the design works so they can better plan their processes and tests on the line to make sure weak areas are thoroughly checked before the product gets to a customer. The service and repair groups need this same data to develop their own procedures for troubleshooting units that fail in the field.

A second reason for this activity is to free your designers up to design. They were hired to design and if you keep them around helping out in manufacturing and repair until someone gets trained well enough to let them get back to designing, then it is only a matter of time until they go someplace where they can design.

### Habit 6: HALT the Final Solution

This is to verify that all the changes made since the first HALT on the prototype units have not decreased the robustness of the final solution. By final solution I am referring to units built by manufacturing using parts procured by manufacturing and the manufacturing processes.

### Habit 7: Know When the Project Is Done and Celebrate

Some sort of closure must be brought to a project. This can then be marked with a celebration of some sort. If this is not done, then the team may be together for too long. The team was brought together to develop a product. People that do development are generally not the same people that do maintenance activities very well. Actually most people who do development hate maintenance activities. So set a milestone so everyone knows when the project is done and when that milestone is reached, make some type gesture to mark the occasion, so everyone understands that the project is done.

To understand the case study that I am about to present also requires knowledge of a product development process. This paper is not to discuss the different types of product development processes. The process we were using goes by many different names and the terminology is generally tailored to a specific company. The process I will be describing in the case study consists of a number of different phases with specific requirements for each phase of the process that must be met before the project can proceed to the next phase. At the end of each phase a sign-off of sorts must be made to allow the project to continue. The decision points are sometimes referred to as checkpoints or gates and there is usually some type of management review before a project is allowed to move to the next phase. The table below lists possible product development phases and the activities associated with each phase.

## Typical Product Development Phases and Activities

### Initial Concept Phase

Investigate market needs, potential and technology

Assess program viability

Plan system design phase

### System Design Phase

Team is formed, initial timelines and the team establishes budgets

Define and agree on customer requirements

Define and agree on solution

Plan the rest of the program

Prototyping of new technologies/processes

Developmental HALT on prototypes

Design verification testing

### Implementation Phase

Design, test and produce the final solution

System verification testing

Agency testing

FMECA

Developmental HALT on final solution

Q-HALT

Run Safety of HASS

### Product Acceptance Phase

Test and certify the solution works in the customer environment - Beta

Launch the product

### Manufacturing/Warranty Phase

Support the program warranty

Identify process improvements

Re-HALT to verify previous design margins

Periodically rerun Safety of HASS

If there are Design changes/additions, a Re-HALT must be done

Now we can apply these definitions and the seven habits to see how they have worked together in a real product development. The product is the  $E^N$ -Counter 4000™ Transaction Terminal (formerly known as Jigsaw), a credit card reader.

A Case Study:  $E^N$ -Counter 4000 Transaction Terminal

The first product to ever receive the  $Q_{HT}$  Certification

When this project was started, one of our goals was to make this product THE most reliable product we had ever sold. Our previous products were perceived to have a Quality / Reliability problem, but our company was also known as having excellent customer service. We were very attentive to our customers' problems. Our problem was that most of our customers' challenges were caused by our own poor practices. In other words, we were the firemen who would quickly put out the fire that we caused.

As with most new product developments, a key priority was being the first to market. So as we would learn about new things (technologies or processes) during this project we would evaluate them and act on them as quickly as possible. (HABIT #1)

After the project had been going for about 9 months, our group discovered HALT. From the first two-hour talk, we decided that this seemed to be one way to quickly increase the reliability and quality of our new product. (HABIT #2) Within two weeks of the first talk, I was sitting in a HALT course taught by Dr. Gregg Hobbs. Two months later I was in the Advanced HALT class. One month after that we completed the first developmental HALT on our prototype product. (HABIT #4) This is just an example of how quickly things would change and move with this development.

Prior to our first HALT, there was training for everyone involved to get buy-in for what we were trying to accomplish. The most difficult task was to get everyone to let go of the concept of "those energy levels are way out of spec." (HABIT #3) One of our arguments for using the HALT methodology was that we were the ones who 'made up' the specification numbers and we could change them if we wanted to, they were not etched in stone.

One interesting thing that happened during that first HALT had to do with our legacy products. During the testing one of the electrical engineers, that was up to assist in monitoring the test, was also functioning as the continuation engineer on our legacy products. Both the legacy and new product use similar software. One of the failure modes of the new product looked very

similar to an intermittent failure mode seen on the legacy product. So a month after our first HALT, we were back with three of our legacy products. In the HALT chamber we discovered numerous “intermittent” failures on the legacy products. Failures we could not recreate on the bench in the lab were easily recreated in the HALT chamber. We later correlated many of these intermittent failures with field failures.

Discussing the initial HALT results with people from Repair, Design Engineering, and Manufacturing, we quickly incorporated changes into the second prototype. By the time  $E^N$ -Counter 4000 was released to the public, this product experienced no major failures of the hardware or the operating system.

One thing that bothered some of us was when someone would ask us to prove that this product was more reliable than our previous products. So we were looking for a vehicle to show that we had made a more reliable product. We did a MIL-HDBK-217 calculation on both the legacy product and the new product. According to this, our legacy product had a MTBF of about 8 years and the new product had a similar number. We also knew from our field failure data on the legacy products, that the actual number was closer to 9-12 months. Thus we had very little confidence in the calculation method of determining reliability. So we continued to look for another method to prove we had built a quality product.

Eleven months after the initial release we were ready to re-HALT an upgraded version of the  $E^N$ -Counter 4000. (HABIT #6) This upgraded version consisted mainly of fewer parts and a large ASIC to increase the reliability and functionality of the product. We believed that with fewer parts and the knowledge we now had from the five HALTs that we had done in the preceding 11 months, that we should easily go to higher levels during this HALT.

About this same time we heard about a new certification called Q-HALT, being offered jointly by TUV Product Service and QualMark. A product having this mark would be regarded as having a “new level of quality.” It was actually a method of testing where products could be compared at 5 different levels. After doing some research we discovered that no other products had this marking and that ours could be the first to get it.

$E^N$ -Counter 4000 was given the first Q-HALT license ever issued on November 25, 1997. Now when we were asked whether we did our job and created a robust, reliable, quality product, we simply pointed to the certification and asked, “Where’s yours?”

A brief description of Q-HALT direct from a QualMark brochure:

Q-HALT Certification is a pass / fail test of a product’s design ruggedization using temperature, vibration, and combined temperature and vibration environment. The testing (QualMark) and certification (TUV Product Service) are performed and confirmed by these two 3<sup>rd</sup> party inde-

pendent organizations. Products are certified to an XY combination of five thermal and vibration categories. These categories thermal (X) and vibration (Y) are defined below.

*Examples: Category A1 = -100°C to 170°C at 80 G rms or Category D2 = -40°C to 90°C at 55 G rms*

#### Q-HALT Certification Categories

Thermal Category (X)	Stress Level (°C)		Vibration Category (Y)	Stress Level (G rms)*
A	-100 to +170		1	80
B	-80 to +140		2	55
C	-60 to +110		3	35
D	-40 to +90		4	20
E	-20 to +70		5	10

*\*2 to 10KHz bandwidth*

For additional information on the Q-HALT program, contact either TUV Product Service ([www.tuvps.com](http://www.tuvps.com)) or QualMark ([www.qualmark.com](http://www.qualmark.com)).

Shortly after the HALT of the ASIC version of  $E^N$ -Counter 4000 took place, all the design engineers started the FMECA process on  $E^N$ -Counter 4000. (HABIT #5) We realized that there was a lot of data in the engineers' heads that would be very beneficial to our Repair, Manufacturing, and Service groups. By providing these data we believed that the design engineers could then go about the tasks of designing instead of all of them supporting the product.

About this same time as the FMECA, our sales group was having a training session for all the salespeople. One of the presentations was on Q-HALT and why it was important that we have this and how they might use it to help their sales. I did the presentation and the salespeople looking for a new angle to boost sales received it very well.

A couple of months after this training I was called into the General Manager's office to listen in on a Sales call. The sales call was taking place at a potential customer's office and our competition's sales rep would be present. Basically we were going head to head in front of a customer. The reason I was invited to listen was to hear our sales pitch. Our sales rep gave almost verbatim the same talk I had given him on why it is important for a product to be able to prove they are reliable and not just rely on a calculation. The best part was after both reps gave their speeches, the customer then asked our competition why they didn't have the Q-HALT mark on their product. The competition's rep didn't even know what Q-HALT was. Our GM had the biggest smile I have ever seen on his face and that is when I knew I had done my job and could also prove it. (HABIT #7)

After the second release of the product, the manufacturing group decided to start using HASS in the production line and purchased their own chamber. At this point we had to re-HALT to get

current numbers and from there we developed the HASS profile. We then ran Safety of HASS to verify that we could discover faults but not do too much damage to the product in the process. Since then there have been a number of additional Safety of HASS runs to insure we still have a valid HASS process.

### Conclusions

The seven habits of highly effective product development are:

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With this paper I have provided you with ideas and proven practices, that when used the way I have described them will:

- Get your products to market faster,
- Make your products more reliable,
- Keep your designers happy, and,
- Save you money by speeding up the entire development process.

### Biography

John’s current position is the Manager, Electronic Components Sustaining and Value Engineering at Thermo King in Bloomington, Minnesota.

Prior to coming to Thermo King, John’s positions were mainly in quality, reliability, engineering, and new product development. He has held the titles of Reliability Manager, Quality Manager, Principal Software Engineer, Test Manager, and Operations Manager.

John was responsible for the overall quality and reliability of the first product to ever receive the Q-HALT certification. TUV Product Services and QualMark Corporation issue the Q-HALT certification jointly. The Q-HALT certification is a voluntary certification mark, which shows the level of quality and ruggedization achieved by a product.

John is a Senior Member of the American Society for Quality (ASQ) and holds two certifications from the society: Certified Quality Manager (CQM) and Certified Software Quality Engineer (CSQE). John also teaches a refresher course for the ASQ for people preparing for the CSQE exam.