CASE STUDY | The Case of the Containers

You may have noticed or heard about a new product called a self-heating container, made by a company called OnTech and sold under Wolfgang Puck and other brands. The container was featured by Fortune magazine as one of the most innovative new products of the year. Over the next several pages, we highlight just three of more than 400 technical problems that were solved with TRIZ to make the can a market success.

As shown by the figure to the right, by triggering an exothermic reaction inside, an OnTech beverage container safely heats its liquid content to a desirable temperature so consumers can enjoy coffee while camping, or hot chocolate at a child's soccer game on a cold day. Of course the challenge for OnTech was to make all of its containers commercially feasible, while providing the required functionality at a reasonable cost.

Here's how the OnTech container works: A button is pressed on the bottom of the can, which breaks a barrier between calcium oxide and water, which combine to create an exothermic reaction, which releases energy into the internal container, which heats the beverage that sits in an external compartment separate from the chemistry. Nothing about making an exothermic reaction is all that complicated—but making one that heats sterile beverages consistently is complicated enough to present many engineering and cost challenges.

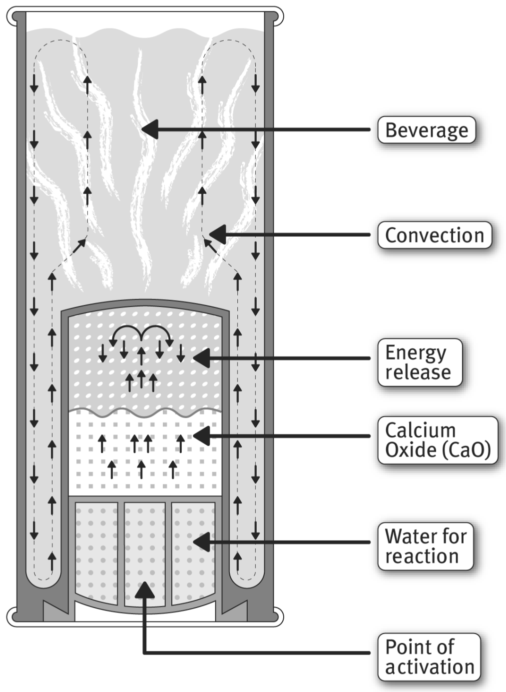
As with most all engineering challenges, you have a system to optimize, a set of objectives to meet. Customer needs are transformed into functional requirements, which are transformed into design parameters, which comprise the necessity space from which you identify system elements, both useful and harmful to your objectives.

All of this is organized into a model of Ideality that maximizes the useful functions and minimizes the harmful functions, and you use various modeling and other techniques to work backward from this vision of perfection toward the best possible solution.

Innovation expert Dr. George Land of the Farside Group coined the phrase "backward from perfect," which asserts that it's better to start with the ideal end in mind than to start from where you are and try to advance from there. This is very similar to the concept of the Ideal Final Result, which says that the ultimate imagined outcome of the problem-solving process provides all benefit, no harm, and no cost.

The TRIZ process accepts that perfection of this sort is not attainable but, at the same time, it does not accept limitations imposed by lack of knowledge or creativity.

THE ONTECH SELF-HEATING CONTAINER



OnTech used TRIZ to solve more than 400 technical problems associated with the commercialization of its self-heating container. The can's chemistry is activated by depressing a button on the bottom of the can. In a matter of minutes, the beverage in the container is heated to 140 degrees, perfect for drinking.

With TRIZ, most, if not all, physical and technical contradictions can be solved, as long as you can separate the constraints of an innovation problem that are legitimate from those that are imposed by psychological inertia.

TRIZ does not accept trade-offs for contradictions where the improvement of certain functional requirements causes the deterioration of others. If this is the case, and your solutions represent compromise, you simply haven't found the best way to resolve your problem. Dr. Land says this is when you need true innovation, which he says is "an idea to resolve a problem that has not succumbed to ordinary means."

That seems a fitting definition of innovation and a fitting way to describe the nature of OnTech's journey into the self-heating container. In achieving its goal of designing a can that heats its own contents, some solutions were ordinary, others less ordinary, and a couple not ordinary at all.

Work on the container project began where many TRIZ projects do: utilizing substance-field modeling, mathematical modeling, and Taguchi design of experiments to set up the basic structure of the design and to optimize several of its design parameters. One such parameter for the OnTech project was to make the outside layer of the container strong enough to resist expansion caused by the energy created during the exothermic reaction.

But after this work, several barriers to commercial viability remained, one of which was a physical contradiction related to thermal energy exposure during “retort.” This is the process of heating the beverage for a set amount of time at a certain temperature to kill all pathogens and spoilagens.

The problem for OnTech was that certain materials are more able to withstand the retort process than others. As the temperature inside a container rises, as it does during retort, pressure is exerted on the walls of that container, and too much pressure will cause those walls to become misshapen or deformed. At the same time, the cooling cycle creates an internal vacuum that can distort the walls as well.

For the Sake of Sake

As far as we know, the self-heating can was first used in Japan for warming Sake. The drinker would poke a hole in the bottom of the can with a metal spike, which would rupture a barrier between water and calcium oxide.

The can was pretty good, but it was expensive, not recyclable, and stayed hot to the touch of the drinker. The OnTech can is cheaper, safer, potentially recyclable, not hot to the hand–and it can be molded into any proprietary shape.

Metal, for instance, withstands retort very well. But metal is also very conductive, which means if you’re holding it in your hand, and the beverage inside is 140 degrees, you’ll probably feel it. Therefore, metal wouldn’t work for the OnTech application, and the best known alternative was a form of polymer, or plastic, called polypropylene. The very top and bottom of OnTech’s drinking can could be made of metal, but the sides where you hold the can had to be less conductive.

But the problem didn’t end there, as it became further confounded by the fact that there are two internal chambers that are subjected to the retort process, as well as one external chamber, the outside of the can (see figure on former page). Moreover, the seams that separate each of these chambers from their adjoining elements are of different natures, utilizing different materials and processes.

If too much heat resides in any chamber for too long, there is deformity and compromised integrity of function. The reason is because heat creates steam, which increases pressure. When pressure increases, it can cause various deformities in the walls of a chamber as it is built up and released. In turn, these deformities can then interfere with proper system functioning. Therefore, you need steam to do its job in the thermal warming cycle, but its job is bi-polar: It has to collapse at some time in the retort process, but it can’t collapse and create unwanted deformities.

This is what you might call a conundrum, or, in TRIZ terms, a physical contradiction. It was definitely both for the OnTech team, which had to control the heating/cooling cycle within each of the three can chambers, while also equalizing the pressure in all chambers, so the device could survive the retort process.

Remember that you can address a physical contradiction when a system element conflicts with itself or with one or more of the four separation principles (Time, Space, Scale, Condition). The OnTech team used the separation principle of Time to resolve its dilemma. By sequencing the cooling processes for each chamber at precise intervals, the strength of each successive chamber wall could recover before their various pressure vacuums are maximized. Therefore, no structural deformities. Problem solved.

Feeding an Army

OnTech has technology for several applications. One is the ability to heat an air-dropped, 32-pound package of food with meats, vegetables, potatoes, and desserts. Another is a self-heating tray for TV-dinner-type food.

Still, the team had more to do in resolving two technical contradictions, the first of which was a conflict between the complexity of the materials used in the container wall and the cost of manufacturing. We’ve already talked about why the outside of the can had to be made of plastic, a much less conductive and less expensive material than metal—and a material that allows a manufacturer to mold the container into any number of proprietary shapes that can be trademarked.

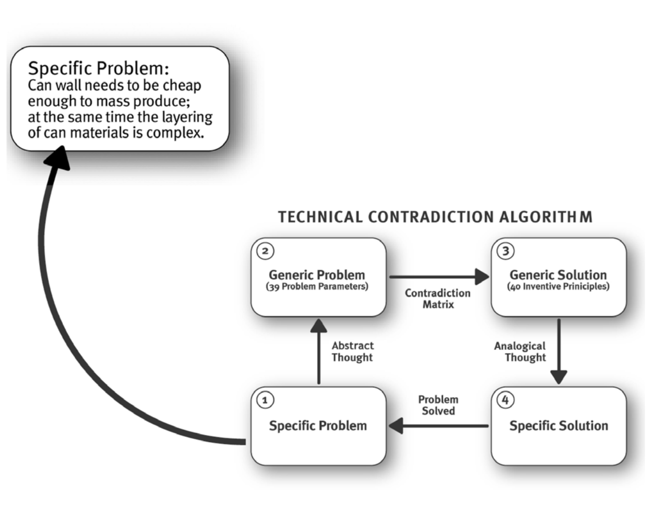
However, this doesn’t talk specifically about oxygen ingress, or the tendency for oxygen to seep through certain materials, like plastic, during retort or storage. That’s why the plastic outside of an OnTech container is really a composite of six layers of material, even though it doesn’t feel that way in your hand.

You have a smooth plastic material on the very outside of the can; then you have a recycled plastic material attached to that layer; then you have a layer of adhesive that binds the recycled plastic to a very thin layer of ethyl vinyl alcohol (EVOH). Traveling further inward, you have another layer of adhesive, which bonds the EVOH to a final layer of smooth plastic.

The problem is that you have to take this composite and attach it to the top and bottom of the can, which is accomplished with a technique called doubleseaming. We’re talking about how that little rim on the top of a soda can is formed.

Even though the OnTech team had optimized the design for the can parts, it hadn't optimized the way in which the can shell was attached to the can lid. They needed the can itself to be lower cost, but the can had to have all those layers also. (See Figure below)

SOLVING THE PROBLEM OF COST VS. COMPLEXITY



The challenge for OnTech was to find a solution to more than 400 technical problems, or contradictions. Just one of these problems is highlighted here.

In this case, there was a technical contradiction at play: The useful feature of low-cost manufacturing was in conflict with the harmful feature of high product complexity, relative to its purpose and nature. With this defined, the technical team could now match the nature of its specific problem with generic problem parameters, which it did, like this:

	OnTech's Specific Problem	Generic Problem Parameter
Useful Feature	Has to be cheap enough to mass produce	Ease of manufacturing (#32)
Harmful Feature	Layering of materials is complex	Complexity of device (#36)

The next step was using the contradiction matrix to locate the inventive principles that correspond to the generic parameters of the problem. Cross-referencing ease of manufacturing (#32) with complexity of device (#36) yields the following inventive principles: Inexpensive short-life object (#27), use of copies (#26), and segmentation (#1), as shown like this:

Harmful Feature / Useful Feature	Complexity of Device (#36)
Ease of Manufacturing (#32)	27, 26, 1

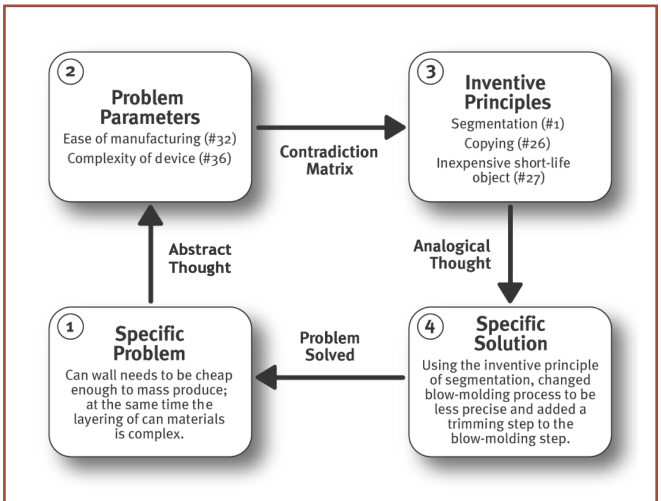
APPLICABLE INVENTIVE PRINCIPLE

Number one, Segmentation, was the principle that focused the team on an appropriate solution to its technical problem. By further segmenting a step in the manufacturing process, the complexity of the material would stay the same, but the cost would go down.

No longer would OnTech use precision blow-molding to attach the sides and ends of the can; it would use a more imprecise method that's much cheaper, and then use die stamps to cut the rough material into perfect shape. The process added a step, cost went down, and complexity remained constant. (See Figure below)

TECHNICAL CONTRADICTION ALGORITHM

Example #1: The problem of the outside can wall



OnTech moved from a specific problem to a specific solution by working through the four steps of the innovation algorithm in this manner.

Another contradiction that had to be solved brings you to the core of the can where the energy reaction happens. Inasmuch as the outside of the can *should not* be conductive, the inside part that houses the reaction *should* be conductive. You want as much energy to pass through the inside wall as possible to heat your drink. But at the same time, you have to protect the drink and the chemistry (calcium oxide) from oxygen ingress.

Therefore, the team had the same problem it had before about oxygen ingress, but this time it was different. This time, the team had to keep oxygen out of the product with a barrier that was energy conductive, not resistant, as is the outside wall of the can. Here's how it broke down:

	OnTech's Specific Problem	Generic Problem Parameter
Useful Feature	Inside wall has to be strong enough to survive retort	Strength (#14)
Harmful Feature	Inside wall has to be energy conductive while keeping oxygen out too	Temperature (#17)

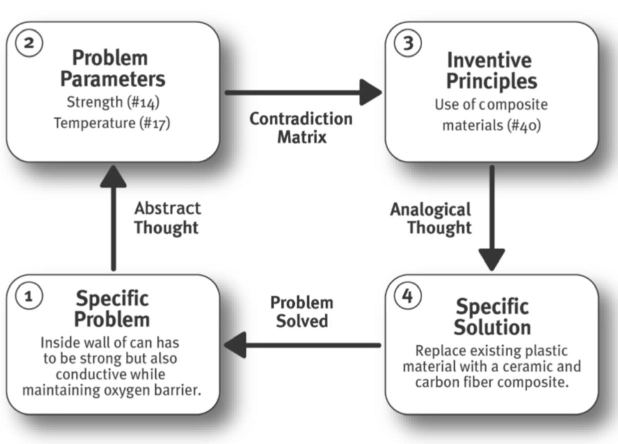
Verily, this lead to the following inventive principles: flexible shells and thin films (#30), preliminary action (#10), and use of composite materials (#40). The last, use of composite materials, proved to hold the key, as shown in the graphic:

Useful Feature \ Harmful Feature	Temperature (#17)
Strength (#14)	30, 10, 40

APPLICABLE INVENTIVE PRINCIPLE

Knowing what they know, the tech team hypothesized that maybe certain combinations of materials could be conductive while also blocking oxygen ingress. One idea, which turned out to be a good one, was to combine ceramic and carbon fiber with plastic, and to take out the EVOH oxygen barrier. It turned out that these elements were in fact strong enough to survive retort, conductive enough to heat the beverage, and oxygen proof too. The composite was implemented and OnTech had its can. (See Figure below)

TECHNICAL CONTRADICTION ALGORITHM
Example #2: The problem of the outside can wall



OnTech moved from a specific problem to a specific solution by working through the four steps of the innovation algorithm in this manner.

As simplistic as we've made the OnTech case seem, its innovation accomplishment was no small task, and TRIZ provided an engine for acceleration on a number of fronts. In fact, years before it was doing its research and development, American National Can (ANC) had completed work on its Omni-Bowl project, which addressed certain of the same issues that OnTech addressed with its product—but not the innovative self-heating aspects.

ANC is a large flexible-packaging company with about 2,000 different products, and tens of millions of investment later, its Omni-Bowl project yielded some important breakthroughs. One such breakthrough was figuring out how to bind metal and plastic into a container seam that would survive retort. None, however, were as technically demanding or as innovative as the ones the OnTech team came up with in their labs at a cost of a small fraction of the ANC solution.

The biggest reason for this was because TRIZ gave the OnTech inventors a small handful of paths to travel, rather than an infinite number of possible paths. We've already discussed what happens when you trade rationally targeted convergence for limitless divergence. Basically you end up in the weeds.

Although it might seem good at first to diverge all over the place, its better to Define the course, Model the variables, Abstract the problem, Solve it with analogical thought, and Implement your solution (TRIZ methodology). With this roadmap, a TRIZ problem-solver or team can make the course of convergence a valuable reality.

This case study was excerpted with permission from Insourcing Innovation, an Auerbach Publications book, the lead author of which is BMGI's CEO David Silverstein.