The New Locking Device for Ships and Ferries. A Story of How Good Ideas are Simple

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Abstract: The seven evaluation criteria of solutions are considered using a new locking device for gates as an example. The evaluation is compared with the results of experiments.

"How in the hell nobody has thought of this earlier."

These are often the first comments of the new locking mechanism for gates and hatches, invented by Mauno Lahtinen, an entrepreneur in machine building, and Paavo Holttä, an economist.

The story began from a great disaster. The passenger vessel ESTONIA capsized on 28 September 1994 in the Baltic Sea. Total 852 lives were lost.

The failure of the bow visor caused the disaster. A bow visor is a gate in the head of a ferry. It reminds the visor in the helmet of a motorcyclist.

The Incredibly Simple Invention

The Investigation Commission concluded that the locking devices in the gates should have been several times stronger [1]. Lahtinen and Hölttä went further. They proposed additionally a more reliable locking mechanism.

The locking mechanism includes a female part, a male part, and a pin securing the two parts. In the old construction the locking pin is a cylinder. The cylindrical form compels to make a clearance between the pin and other parts, to ensure that the gate can be closed and opened. The construction is not rigid. The parts can move, wear each another, and ultimately fracture.

The idea of the invention is simple: A conical pin is used instead of cylindrical one. For more details see "Simpified TRIZ" [2] and the patent description [3]. Actually, the old principle of the wedge is used in the new place.

Now parts form a rigid construction in every direction. An expert in the strength of metal materials Kari Immonen helped to calculate the proper angle of the cone. It was 15.4 degrees. That angle ensures that the parts are tightly locked and easily unlocked.

The Evaluation by the Criteria of the Final Ideal Result

The theory of Inventive Problem Solving (TRIZ) allows to give reliable criteria for the evaluation of ideas. They are based on the study of a large number of successful solutions. Let's apply seven criteria presented in "Simplified TRIZ" [2]:

1. Do the harmful features disappear?
Yes. There will be no wear, since the parts are tightly locked.

2. Are the useful features retained?
Will new benefits appear?
Yes. Simplicity is retained. The locking problem is solved.

3. Will new harmful features appear?
No. There are no new harmful features.

4. Does the system become more complex?
No. Actually it gets simpler.

5. Is the inherent, most important contradiction resolved?
Yes. There was a clear primary contradiction in the old construction. The pin should be tight or have no clearance and at the same time it should be loose or have a big clearance. The conical pin has no clearance when closed, and a big clearance is formed as the locking begins open.

6. Are idle, easily available, earlier ignored resources used?
Yes. The geometry of the pin is an idle resource used.

7. Are possible other criteria fulfilled?
Yes. Since only small changes are needed, a new mechanism fits well to the ship or ferry as a whole.

What did the experiments show?

The seven criteria allow to evaluate ideas before experiments and help to decide whether they are worth to be tested.

Let's now see the results of the experiments in the laboratory and the sea.

The device for a big ferry with real-life dimensions was tested in the Laboratory of strength of materials in Helsinki University of Technology, according the rules of the register (insurance) company Norske Veritas. The dynamic load to 200 kN was tested 100 000 times. No problems appeared. The results of the static load testing were also good. The static strength was in practice five times better than in the theoretical calculation, obviously thanks to the tight construction.

For the experiments on the sea the smaller device was installed in a small ferry. It was opened and closed 20 000 times. The number of openings and closings is approximately the same as during the lifetime of a big ferry. The construction worked excellently. An additional benefit was found: the new construction was actually noiseless. It is also worth to mention that there were no problems with thermal expansion in spite of tight construction.

During the experiments appeared small problems that were solved. The cylinder was strengthened.

An auxiliary device that locks the same locking device was designed.

Now the inventors and related companies are planning more thorough experiments with a large scale device.

To avoid the oversimplification one must say that there will be inevitably secondary problems that cannot be seen beforehand. The criteria of TRIZ say that the core idea is good and the problems in the implementation can be solved, and it is reasonable to invest in the invention.

An experienced naval architect Tuomo Karppinen who now works as the director of the Finnish center for accident investigations, has put it precisely: "It is a good basic construction that deserves to be elaborated further."

References:

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2. Rantanen, K., Domb, E. ***Simplified TRIZ: New Problem Solving Applications for Engineers & Manufacturing Professionals***, CRC St. Lucie Press, Boca Raton FL, USA, 2002

3. Lahtinen, M,, Holtta, P. Locking mechanism for gates and hatches. U. S. Patent 5,875,658, 1999.