

Design for Maintainability

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This article describes an example of where systems thinking led to a much more practical solution to a common problem. For additional information, refer to Systems Thinking.

This article is excerpted and condensed from Johnson, S. 2010. *Where Good Ideas Come From: The Natural History of Innovation*. New York, NY, USA: Riverhead Books. pp. 25-28.



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Background

In the late 1870s, a Parisian obstetrician named Stephane Tarnier was visiting the Paris Zoo where they had farm animals. While there, he conceived the idea of

adapting a chicken incubator to use for human newborns, and he hired “the zoo’s poultry raiser to construct a device that would perform a similar function for human newborns.” At the time infant mortality was staggeringly high “even in a city as sophisticated as Paris. One in five babies died before learning to crawl, and the odds were far worse for premature babies born with low birth weights.” Tarnier installed his incubator for newborns at Maternité de Paris and embarked on a quick study of five hundred babies. “The results shocked the Parisian medical establishment: while 66 percent of low-weight babies died within weeks of birth, only 38 percent died if they were housed in Tarnier’s incubating box. ... Tarnier’s statistical analysis gave newborn incubation the push that it needed: within a few years the Paris municipal board required that incubators be installed in all the city’s maternity hospitals.” ...

Purpose

“Modern incubators, supplemented with high-oxygen therapy and other advances, became standard equipment in all American hospitals after the end of World War II, triggering a spectacular 75 percent decline in infant mortality rates between 1950 and 1998.”... “In the developing world, however, the infant mortality story remains bleak. Whereas infant deaths are below ten per thousand births throughout Europe and the United States, over a hundred infants die per thousand (births) in countries like Liberia and Ethiopia, many of them premature babies that would have survived with access to incubators.

Challenges

But modern incubators are complex, expensive things. A standard incubator in an American hospital might cost more than \$40,000 [about €30,000]. But the expense is arguably the smaller hurdle to overcome. Complex equipment breaks and when it breaks you need both the technical expertise to fix it and replacement parts. In the year that followed the 2004 Indian Ocean tsunami, the Indonesian city of Meulaboh received eight incubators from a range of international relief organizations. By late 2008, when an MIT professor named Timothy Prester visited the hospital, all eight were out of order, the victims of power surges and tropical humidity, along with the hospital staff’s inability to read the English repair manual. The Meulaboh incubators were a representative sample: some studies suggest that as much as 95 percent of medical technology donated to

developing countries breaks within the first five years of use.

Systems Engineering Practices

“Prestero had a vested interest in those broken incubators, because the organization he founded, Design that Matters, had been working for several years on a scheme for a more reliable, and less expensive, incubator, one that recognized complex medical technology was likely to have a very different tenure in a developing world context than it would in an American or European hospital. Designing an incubator for a developing country wasn’t just a matter of creating something that worked; it was also a matter of designing something that would break in a non-catastrophic way. You couldn’t guarantee a steady supply of spare parts, or trained repair technicians. So instead, Prestero and his team decided to build an incubator out of parts that were already abundant in the developing world. The idea had originated with a Boston doctor named Jonathan Rosen, who had observed that even the smaller towns of the developing world seemed to be able to keep automobiles in working order. The towns might lack air conditioning and laptops and cable television, but they managed to keep their Toyota 4Runners on the road. So Rosen approached Prestero with an idea: What if you made an incubator out of automobile parts?”

Lessons Learned

“Three years after Rosen suggested the idea, the Design that Matters team introduced a prototype device called NeoNurture. From the outside, it looked like a streamlined modern incubator, but its guts were automotive. Sealed-beam headlights supplied the crucial warmth; dashboard fans provided filtered air circulation; door chimes sounded alarms. You could power the device via an adapted cigarette lighter, or a standard-issue motorcycle battery. Building the NeoNurture out of car parts was doubly efficient, because it tapped both the local supply of parts themselves and the local knowledge of automobile repair. These were both abundant resources in the developing world context, as Rosen liked to say. You didn’t have to be a trained medical technician to fix the NeoNurture; you didn’t even have to read the manual. You just needed to know how to replace a broken headlight.”

References

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Johnson, S. 2010. *Where Good Ideas Come From: The Natural History of Innovation*. New York, NY, USA: Riverhead Books. pp. 25-28.

Primary References

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Additional References

None.

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