



# CONSTRAINT-DRIVEN INNOVATION

Technology developed for emerging markets can be competitive in the rich world, as well.

**M**ost cultures have an expression for solving difficult problems by using clever, elegant solutions made from locally available materials: Yankee ingenuity; MacGyvering; Jugaad; Gambiarra; Zizhu chuangxin; Système D.

The point is, when people face tough constraints, they tend to get pretty creative. Examples over the past century include the creation of penicillin and the polio vaccine in the 20th century, the technological advancements realized during WWII, and the increased focus on alternative energy solutions in the last 15 years. When our backs are against the wall due to an intractable technical problem, engineers and scientists become superheroes by devising solutions that literally change the world.

What about the developing world? According to Navi Radjou, Jaideep Prabhu, and Simone Ahuja in their book, *Jugaad Innovation* (Jossey-Bass, 2012), countries like India are full of jugaad innovators, who create something out of nothing to improve their own lives: pedal-powered rickshaws, clay pot evaporative cooling refrigerators, and tractors repurposed as people carriers, for example.

“Jugaad” is a Hindi word for “improvised solution” or “work-around.” But the term can also bring negative connotations such as low-quality, cobbled together, or unreliable—features of a technology that trained engineers try to mitigate.

Engineers should be excited about the challenges presented by developing and emerging markets. They represent a shift in

the “necessity” behind the mother of invention. Solutions that have been employed in the rich world are often too expensive, too complicated, or unreliable in these new contexts. To creative engineers, this situation should not make us throw up our hands, but rather put our pencils to paper and invent the high-performance, low-cost solutions that the world needs.

I love the idea of jugaad *engineering*. We should harness local innovation and add to it rigorous engineering that enables solutions to be optimized, scaled, and sustained. Our capacity to do this is what makes engineering a discipline, rather than a haphazard activity.

I use the term “constraint-driven innovation” to describe how the constraints posed by developing and emerging markets are going to drive a new industrial revolution. The technologies we create may be initially aimed at lower-value markets but will provide unique attributes that position them to be competitive in established markets. These products will offer performance comparable to their rich-world equivalents at a fraction of the price, making them globally relevant.

Multinational companies will tune features of these new technologies to meet the prices and consumer tastes in the developed and developing world alike.

Constraint-driven innovation can be pursued in a serial or parallel process. In the case of the Leveraged Freedom Chair, a project I worked on, our team’s initial focus was on creating an off-road wheelchair for the developing world. Cost and performance

constraints drove the innovation towards an embodiment that offers rough-terrain mobility comparable to rich-world wheelchairs costing 30 times as much. We are now tuning the technology for developed countries, improving features such as weight, transportability, and aesthetics—changes that will incur an increase in cost, but one that a

wealthier market can support.

The sweet spot for development engineers and companies who want their technology to make a multi-market impact is reached through parallel constraint-driven innovation. If we realize a disruptive innovation is required in the developing world, then we can concurrently project how the technology can be adapted to create a new niche in developed markets.

Knowing these design requirements up front enables engineers to use the same fundamental innovation for rich and poor, with small tweaks to match preferences and price for different markets. My research group is aggressively pursuing parallel constraint-driven innovation in areas such as prosthetics and irrigation. Multinationals like GE, Harman/Kardon, and Nokia have successfully done so by using common base platforms with regional customization in their electronic devices.

Everyone likes cheap and everyone likes quality. When these attributes become constraints, there is no reason they have to be mutually exclusive. **ME**

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CHALLENGES OF DEVELOPING AND EMERGING MARKETS REPRESENT A SHIFT IN THE “NECESSITY” BEHIND THE MOTHER OF INVENTION.