

# Frugal innovations and COVID-19



**1. MY UNDERSTANDING  
OF FRUGAL INNOVATION**



**2. LESSONS FROM COVID-  
19 FRUGAL INNOVATIONS**



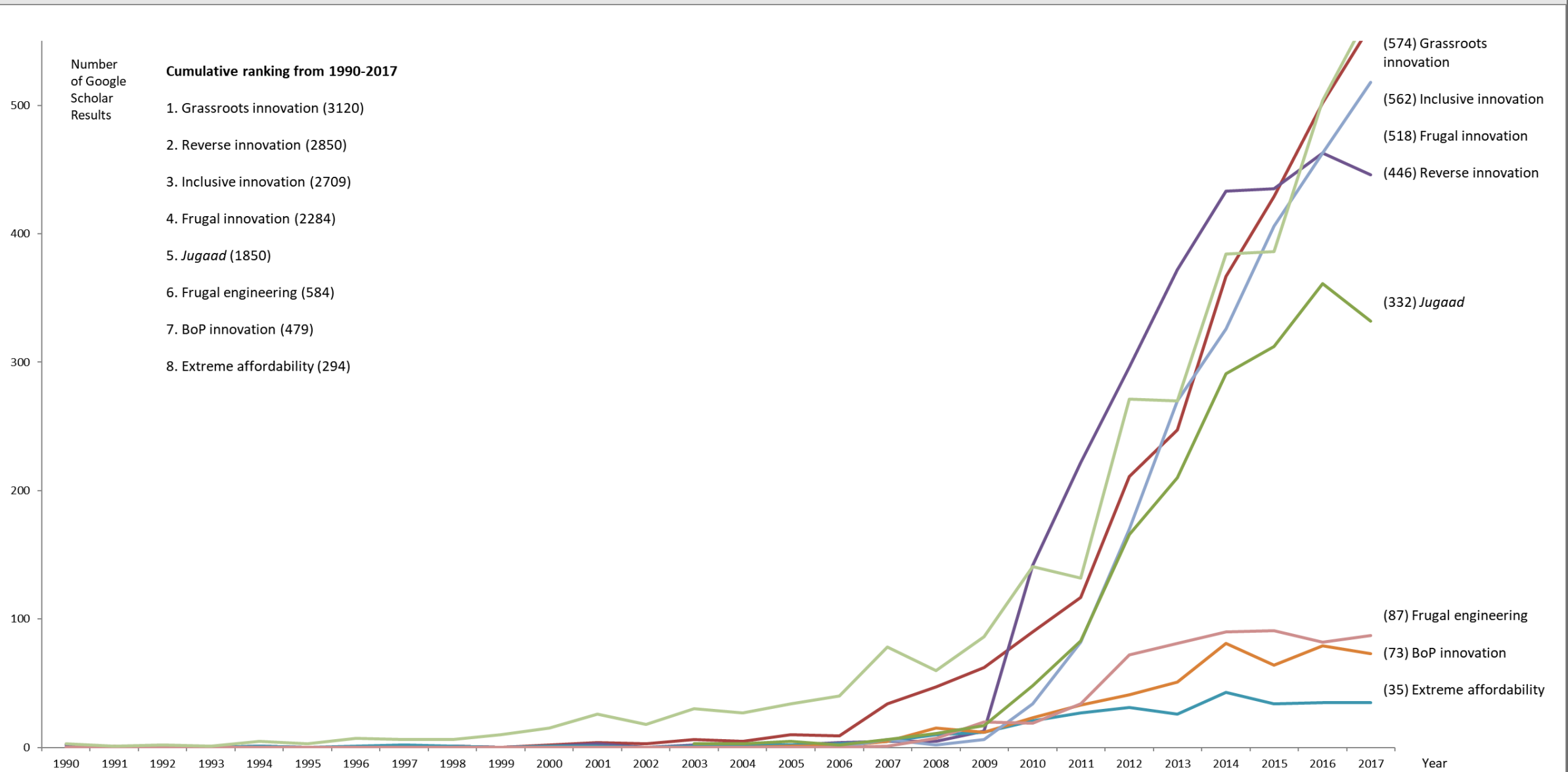
**3. YOUR EXAMPLES AND  
THOUGHTS**

# What do I do ?

- **2018-Current: Honorary Senior Lecturer at Imperial, Senior Lecturer at Queen Mary and Associate Scholar at Oxford**
- **2014-7: Ex-Research Fellow in Frugal Innovation at the Institute for Global Health Innovation.**
- **2009-14: PhD research at Oxford was on innovation, strategy, and entrepreneurship.**
- **My background from Pakistan as developing country motivated me to focus on leveraging innovation in healthcare sector.**

Figure 6.1 in Bhatti et al (2018)

# Articles on Emerging Trends in Innovation



In light of growing discourse on 'frugal innovation', this book offers novel approaches to innovation based on extensive empirical research. The study complements a decade of scholarly attention on frugal innovation by taking a research-based approach to innovation in resource-scarce and complex institutional contexts. The findings suggest that concepts such as frugal, reverse, jugaad, social, grassroots and inclusive innovation in fact represent heterogeneous assemblies of innovation for social, environmental and economic value. The conceptual framework invites attention to more plural sources and elements in the study of models of innovation to inspire further research in the fields of strategy, innovation, entrepreneurship, economic sociology and development studies. The design framework offers models, metrics and competencies for practitioners and policymakers to identify, evaluate and design frugal innovations. The comprehensive view of frugal innovation demonstrates how firms can implement globally competitive strategies by pursuing innovation for humanity to improve lives for everyone, everywhere.

"Policymakers around the world and especially in emerging markets can leverage frugal innovations to better promote human welfare. The models and tools in this book should support leaders in their efforts to foster equitable growth and sustainable development."

*Shaukat Aziz, Chairman of the Oxford Emerging Markets Symposium Steering Committee and former Prime Minister of Pakistan*

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Bhatti, Basu,  
Barron and Ventresca

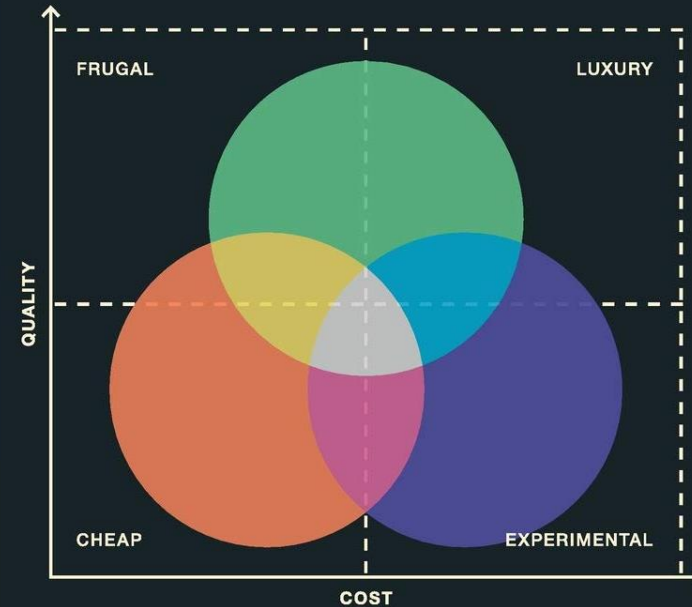
Frugal Innovation

CAMBRIDGE

# Frugal Innovation

## Models, Means, Methods

Yasser Bhatti, Radha Ramaswami Basu,  
David Barron and Marc J. Ventresca



## 2 Rooms-1 Cooler



# Plastic bottles as inhaler spacers: improving the effectiveness of healthcare using clinical skills

Posted 25th November 2018 by [Dr Adam Sandell](#) & filed under [Uncategorised](#).

Spacers can be hard to find in low- and middle-income countries. But you can make a perfectly good one for free from something that otherwise litters the environment everywhere: a small, empty, plastic drinking-water bottle.



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## Examples

- **GE**

- <https://www.youtube.com/watch?v=yB47wx-b6sY>
- <https://www.youtube.com/watch?v=TBjvCU9tdfQ>

- **Narayana**

- <https://www.youtube.com/watch?v=xmHXOcgvCdo>
- <https://www.youtube.com/watch?v=L15fD477Pio&t=138s>

- **Aravind**

- <https://www.youtube.com/watch?v=3cjinPua7Ag>

- **Arbutus**

- <https://vimeo.com/116393761>

- **Hernia Mesh**

- <http://www.bbc.co.uk/news/av/health-24397202/mosquito-nets-used-in-hernia-repair>



\$10K vs \$1000



**GE**  
healthcare

# Electrocardiograph MAC400

The GE MAC 400 in use in a remote village in Karnataka, India

A photograph showing a doctor and a nurse using the GE MAC400 ECG machine on a patient lying on the floor in a remote village. The doctor is wearing a white lab coat and a stethoscope, and the nurse is wearing a white uniform. The patient is lying on their back with several ECG leads attached to their chest. A woman is standing in the background holding a child.

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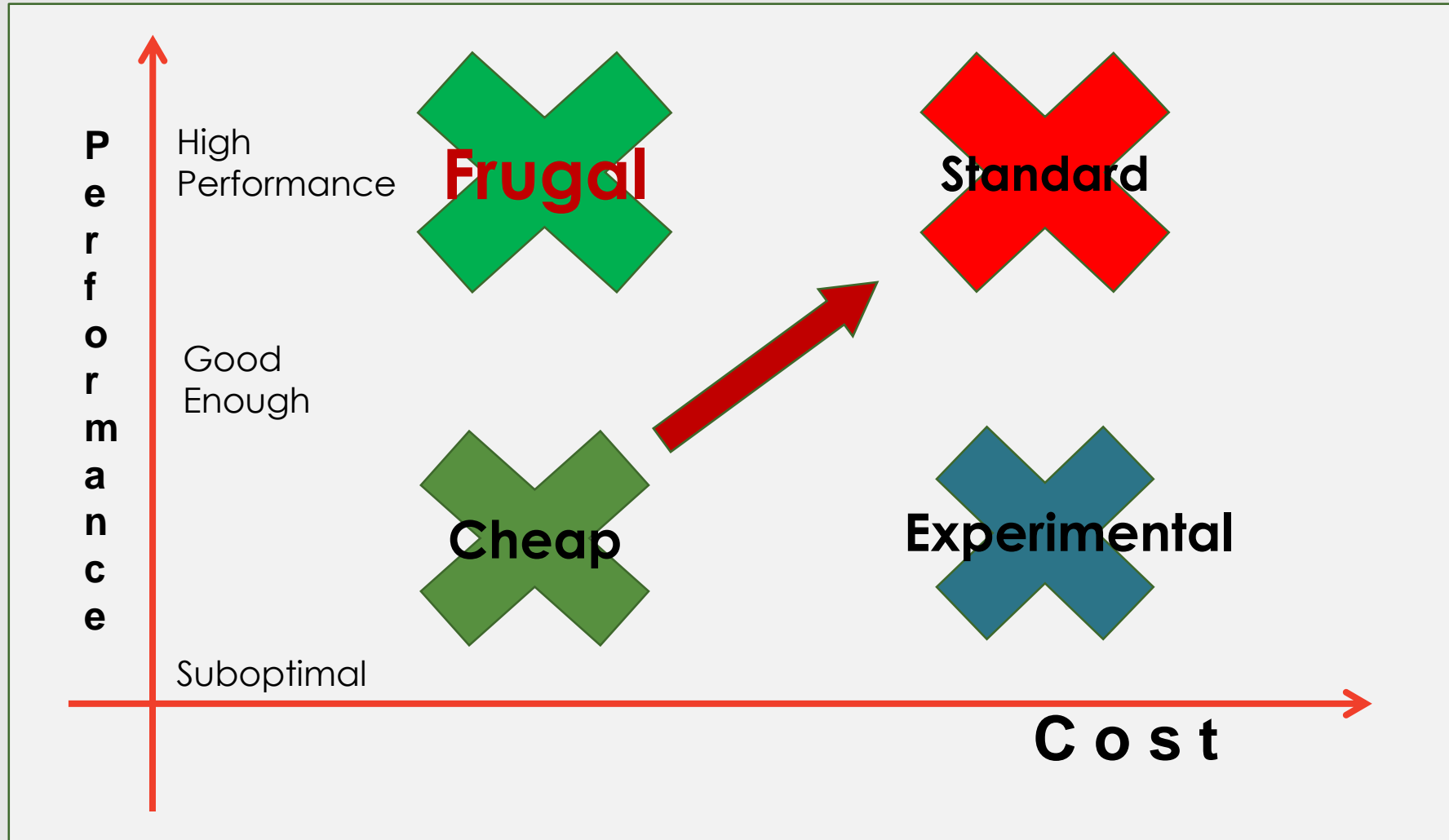


# Development and Diffusion

- Needs and ideation locally identified in developing countries
- But draw from best practices in other sectors, innovations, and from developed countries
- Scale up in mostly developing countries

Figure 4.3c in Bhatti et al (2018)

# Frugal is not Cheap



PREV



# The **50** Best Inventions Of the Year



## 18 The \$20 Knee

Thousands of amputees in the developing world wear an inexpensive prosthetic called the Jaipur Foot. But poor patients who lose a knee joint have few options: a Western replacement can cost \$70,000, and crude models don't work very well. Now a team of Stanford engineering students has designed a knee that's not only dirt cheap—just \$20—but also mimics the natural joint's movements. Developed with the Jaipur Foot group, the Jaipur Knee is made of self-lubricating, self-heal nylon and is both flexible and stable, even on irregular terrain. The device is being tested in India; more than 300 people have been fitted so far.

The Jalpurknee comprises few pieces of plastic and four nuts and bolts. It requires no special tools, and takes just a few hours to manufacture.

## 19 A Watchdog for Financial Products

The Consumer Financial Protection Agency is still just a bill, but it's already up getting passed and created, so the Obama Administration has been pushing for Americans to have a bold new step every time they sign up for a credit card, make a check or taken out a home loan. The goal is to make sure that financial products aren't rigged in favor of the firms selling them and that ordinary people have a shot at working through complicated contracts and the structures to really understand what they're getting themselves into.



## 20 The Electric Microbe

Bacteria have always gotten a bad rap. But we should be thankful for one especially talented microbe, Geobacter, which has tiny hairlike extensions called pili that it uses to generate electricity from mud and wastewater. Professor Derek Lovley and his team of researchers at the University of Massachusetts at Amherst have engineered a strain of Geobacter that's eight times as efficient as other strains at producing power. The next step: creating Geobacter-based fuel cells that can generate cheap, clean electricity.



[http://www.jaipurfoot.org/what\\_we\\_do/prosthesis/stanford\\_jaipur\\_knee.html#.UihcStKPPHQ](http://www.jaipurfoot.org/what_we_do/prosthesis/stanford_jaipur_knee.html#.UihcStKPPHQ)  
<https://www.youtube.com/watch?v=GTyw-EsB3tg>

Figure 4.3b: Price-performance space for frugal innovation ©Remotion  
(Adapted from and used with permission)

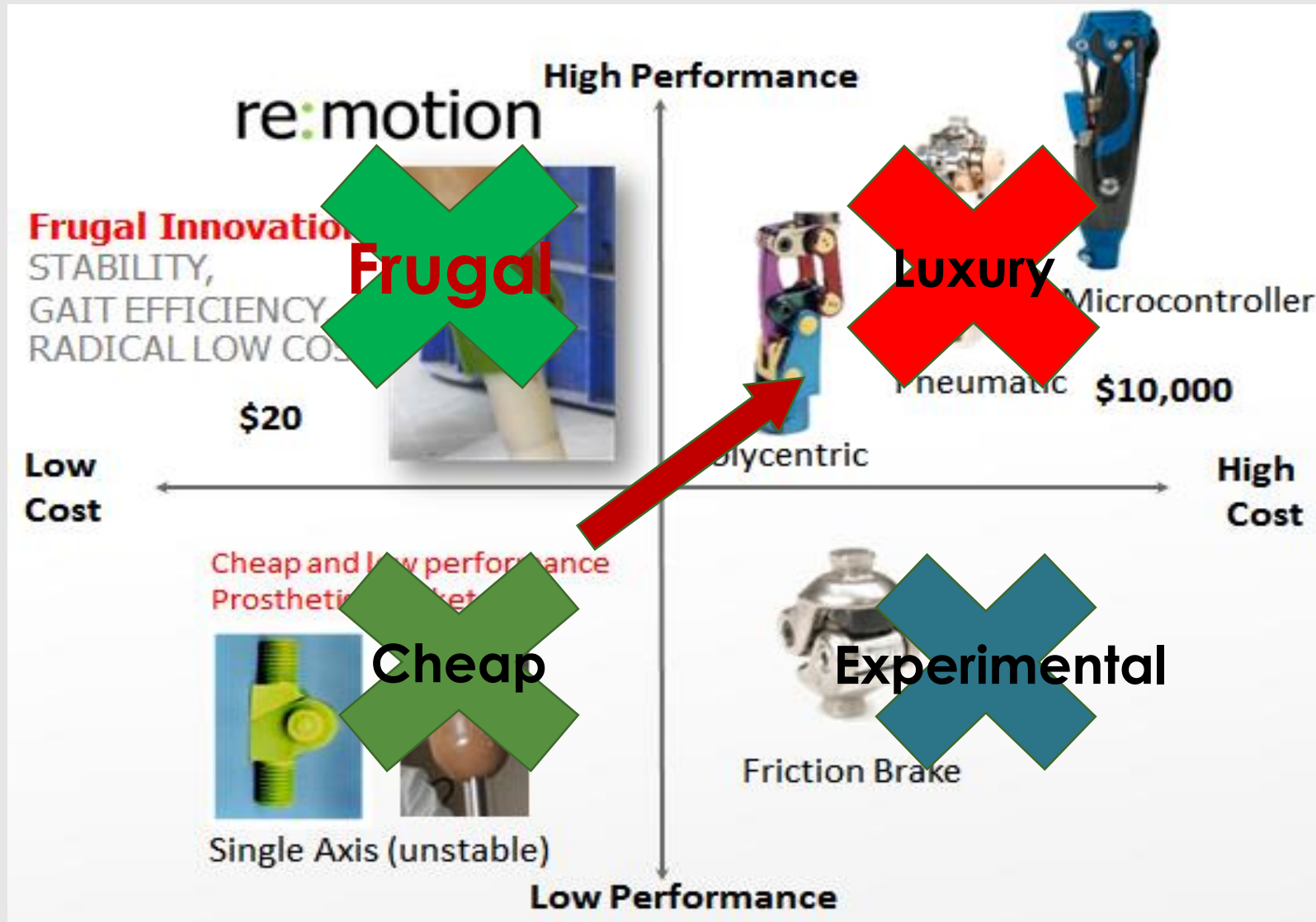


Image source: Bhatti et al, 2018. Frugal Innovation – Models, Means, Methods. Cambridge University Press.



## Figure 4.3a: Development from Jaipur Knee to ©ReMotion Knee (used with permission)

### History of the ReMotion Knee



**JaipurKnee (v1)**

Students at Stanford University developed the v1 ReMotion JaipurKnee for production and fitting by the JaipurFoot Organization, the largest provider of prosthetics in India and the world.



**ReMotion Knee (v2)**

The v2 ReMotion Knee was manufactured in Menlo Park and distributed through Fundación Protesis Para la Vida in Ibarra, Ecuador.



**ReMotion Knee (v3)**

The v3 ReMotion Knee is our first version that is designed to be mass produced for world-wide scale.

# Definitions of Frugal Innovation from varying perspectives

**Conceptual definition**

**Institutional perspective:** Frugal innovation is viewed as a purposeful systematic change on how development can be best achieved within specific social contexts. This contributes to it developing as a new field (field formation).

**Theoretical definition**

**Process-related perspective:** Frugal innovation is viewed as a set of tasks or actions to redesign products and services and reconfigure value chains to improve efficiency and create value for inclusive markets.

**Operational definitions**

**Functional perspective:** Frugal innovation focuses on how the outcomes are used and for what purpose. For instance it may mean to satisfy unmet needs (user driven), become more efficient (efficiency driven), solve social problems (social driven), or solve wicked problems for underserved markets (challenge driven).

**Operational perspective:** Frugal innovation involves means and ends to do more with less for many.

# Definitions of Frugal Innovation from varying perspectives

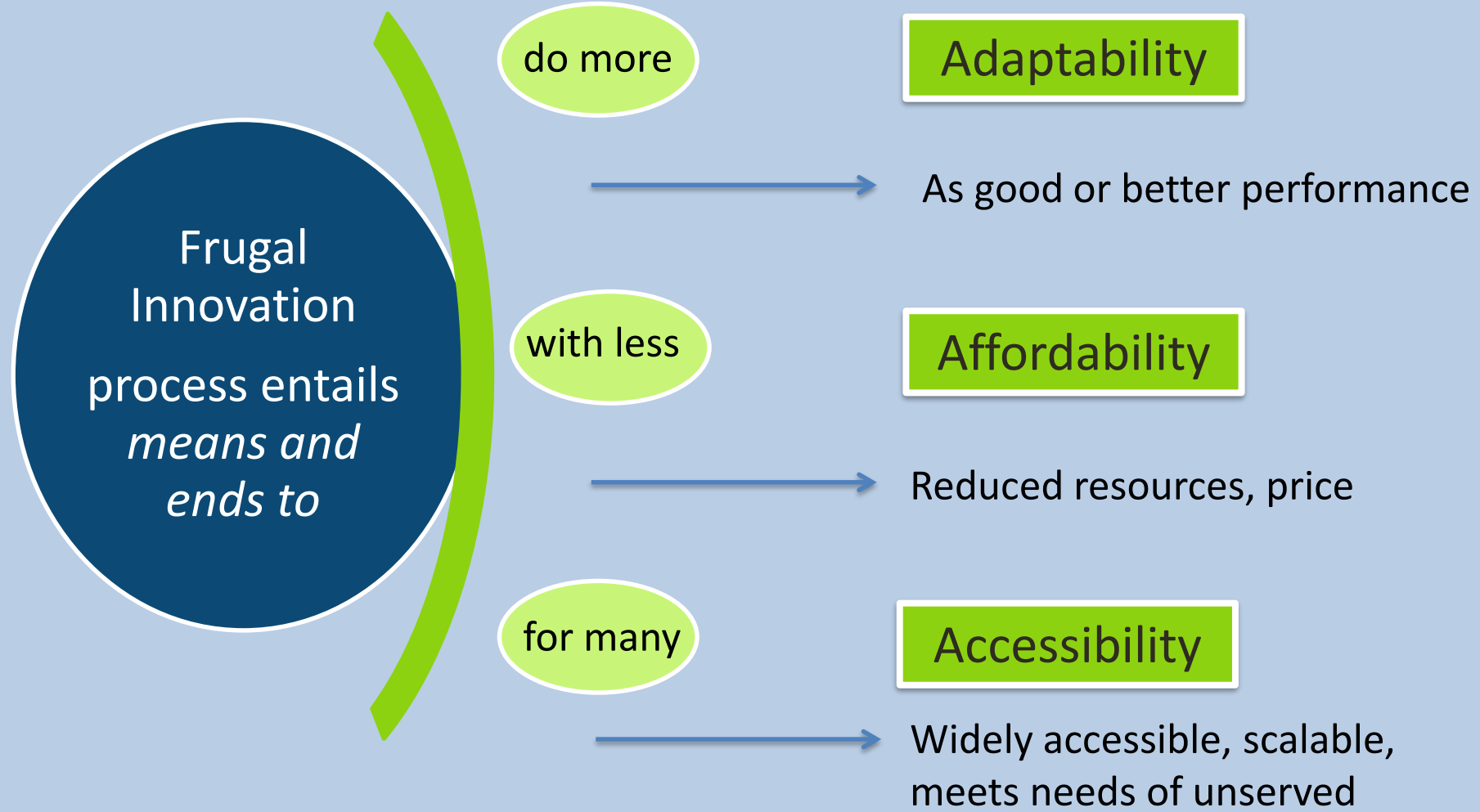
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*“Means and ends  
to do more with less  
for many.”*

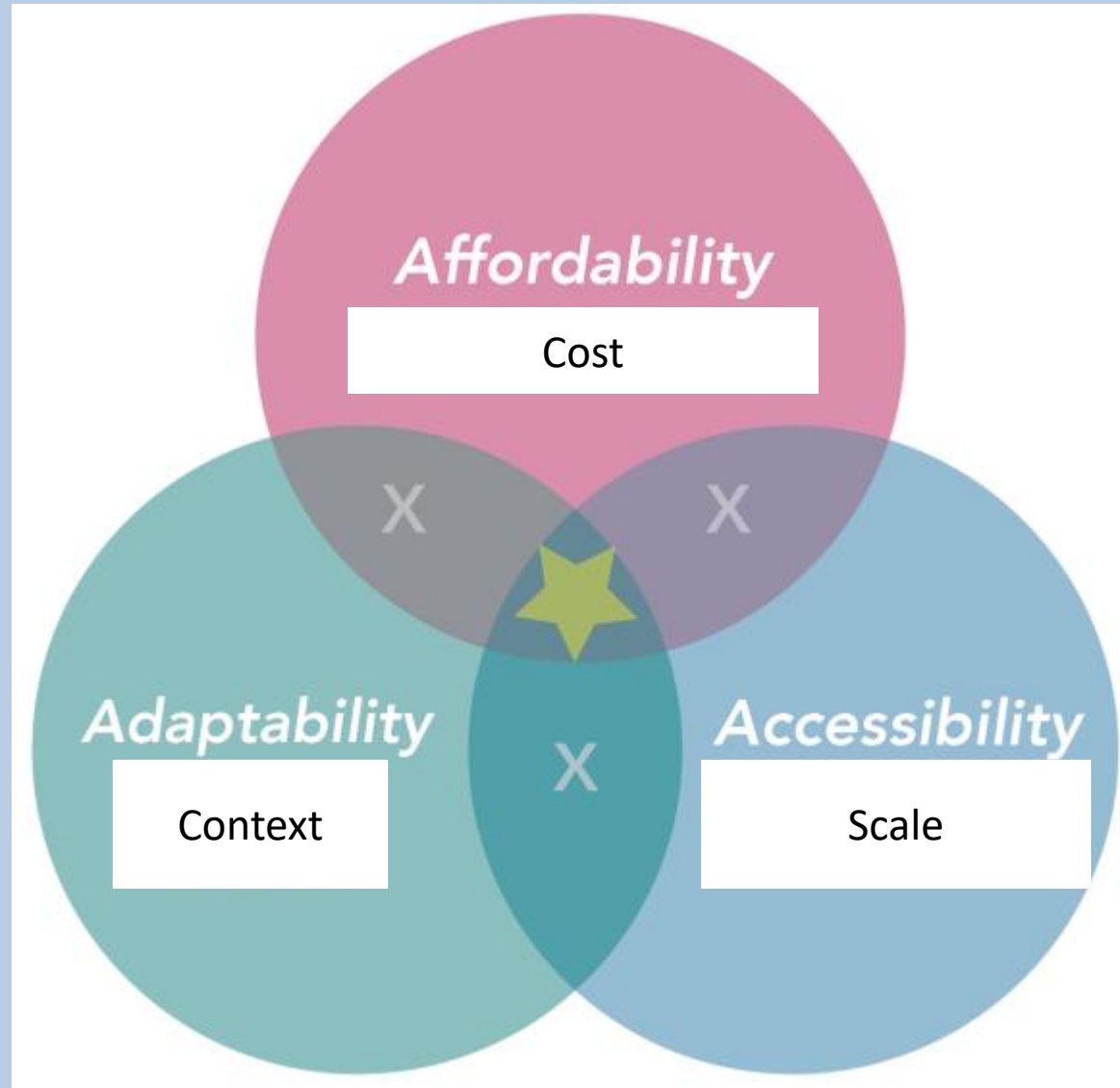
(Bhatti and Ventresca 2013)



# Definition of Frugal Innovation



# Frugal Innovation Dimensions





# Surgical and Household Drill



<https://youtu.be/YbWD6u5O45g>





Figure 1 Arbutus Medical Drill Cover fully sealed with DeWalt drill beside.

#### METHODS

Over a 2-year period the Institute of Global Health Innovation (IGHI) has conducted an international search for frugal innovations with potential application by healthcare providers in high-income countries (HICs; ie, potential for reverse innovation).<sup>8,9</sup> In 2015 we conducted a global search of hundreds of cost-saving innovations including products, processes and policies that addressed all types and domains of healthcare.<sup>10,11</sup> Key criteria used to evaluate frugality included affordability, adaptability and accessibility. In 2016 we narrowed down this search to shortlist those related specifically to surgery with potential for piloting in the UK's NHS. One of the most promising offerings we found in surgery is the Arbutus Drill Cover System. An unrefined version of this method

#### ORIGINAL ARTICLE

## From Malawi to Middlesex: the case of the Arbutus Drill Cover System as an example of the cost-saving potential of frugal innovations for the UK NHS

Matthew Prime,<sup>1</sup> Ibtihal Attaelmanan,<sup>1</sup> Arjuna Imbuldeniya,<sup>2</sup> Matthew Harris,<sup>3</sup> Ara Darzi,<sup>1</sup> Yasser Bhatti<sup>1</sup>



Figure 2 Arbutus Medical Drill Cover System disconnected to show chuck mechanism and liner, with DeWalt drill beside.

#### RESULTS

##### How was the innovation conceived?

In 2013, as part of the University of British Columbia's Engineers in Scrubs programme, a team of biomedical engineering researchers, orthopaedic surgeons, registered nurses, reprocessing staff and health administrators from Canada and Uganda looked at pressing clinical needs at Mulago Hospital in Kampala, Uganda. They identified the problems arising from inadequate availability of expensive surgical drills and embarked on developing a solution. The project ideation and lead target market in East Africa is facilitated by urgency of need and lax regulatory enforcement. However, design, engineering, manufacturing, quality management system, as well as strategic and operational control are based in Canada.



Figure 3 Drill Cover System being assembled.

##### What are the key features?

The Arbutus Drill Cover System is a sterilisable and reusable cover that fully encloses a hardware drill, transforming it into a surgical grade drill. The Drill Cover System consists of a robust, double-layered surgical-grade textile which attaches to a drill's mechanics via a waterproof chuck adapter interface (figures 1–6). This creates a completely sealed barrier between the non-sterile drill on the inside and the sterile surgical field outside. The chuck has a lifetime of at least 600 use cycles when reprocessed appropriately. It can be autoclaved up to 75 times and will be sterile after 30 min exposure of steam autoclave at 121°C, or after 15 min at 131°C, either by using gravity displacement or preevacuum autoclaves.<sup>10</sup>

Arbutus Medical Inc. provides two versions; the 5, which is used with a surgical drill to increase uptime throughout the day and extend its lifetime by eliminating the harsh sterilisation cycles that drills must



Figure 4 Close-up of the Drill Cover System, specifically highlighting fully sealed waterproof chuck interface.



Figure 5 Oscillating saw launching towards the end of 2017. Product will feature a quick-change cam mechanism for easily switching blades (not shown here).

otherwise undergo, and the Hex, which is used with a standard hardware drill. (For product suite, please see online supplementary video 1). It has been designed for easy assembly following sterile technique, and the cover material is soft enough for the surgeon to control the drill through the fabric without hindrance. The textile and manufacturing techniques follow an AAMI/ANSI PB70 standard for Level 4 medical barriers. The Drill Cover is CE marked as a Class I medical device, registered with the US Food and Drug Administration and approved with Health Canada. Further tests are being conducted to reclassify the whole package of cover plus drill as a CE Class IIa device.



Figure 6 Cannulated drill and reamer launching early 2018. This features a universal quick-change interface for easy exchange of AO, Jacobs, Hudson and K-wire collet during practice.

# Affordability

Incumbent	Innovation
<p>At the national level, if the NHS were to replace all incumbent drills with similar offerings this could cost £115 million.</p> <p>(approximately 5000 at estimated cost of £23K per drill)</p>	<p>However, if all of NHS providers were to move to the Arbutus Drill Cover System it could cost as little as £7.5 m.</p> <p>(estimated cost per drill £1500)</p>
<p>At the hospital level, the total cost to equip and maintain surgical drill equipment for two theatres over 5 years would be £324 500.</p> <p>(11 drills at £23K per drill with annual battery replacement for years 2–5)</p>	<p>While Arbutus Drill Cover System would be £47 993.</p> <p>(2 drills+2 saws; 22 initial linens; 14 p.a. replacement linens and 4 replacement batteries per drill for years 2–5).</p>

94%  
saving

85%  
saving

# Adaptability

- Off the shelf components
- Modular design for attachments
- Reusable, washable option for LMICs
- Disposable covers for HICs

# Accessibility

## NEED

- **5 billion** people around the world don't have access to safe surgery
- **2 billion** of whom don't have access to surgery at all
- **25 million** people are injured every year due to road accidents.
- **5.8 million** die annually as a result of their injuries
- **10%** of the world's deaths are due to accident related injuries

## PROGRESS

In 5+ years

- 53,000+ human patients
- 38,000+ animal patients
- 36+ Countries



# Frugal innovations and COVID-19

## Fast and frugal innovations in response to the COVID-19 pandemic

Necessity has been the mother of invention in the response to the COVID-19 pandemic, triggering many an innovation, often without the luxury of time to test these makeshift solutions to pressing problems. But there is much to be learned from times of crisis for times of plenty.

Matthew Harris, Yasser Bhatti, Jim Buckley and Dhananjaya Sharma

COVID-19 has required unprecedented responses from all countries. Such has been the speed and severity of the pandemic that few countries have been afforded the luxury of following traditional processes of testing and trialing new technologies, processes and medicines. Countries that have delayed their response to COVID-19 seem to be faring worse. The lack of time and resources available to respond to the crisis, as well as the need for rapid scaling in every context, has led to an explosion of innovative responses.

There have been some extraordinary moves. India and Pakistan are refitting their rolling stock of trains to become hospital wards for patients with COVID-19. China constructed a 1,000-bed hospital in 10 days (ref. 7). Distilleries have pivoted to produce millions of bottles of hand sanitizer<sup>8</sup>. Nations that uphold free choice, movement and competition have suddenly foregone many fundamental values and privileges. For example, in addition to enacting widespread social-distancing measures, the UK, in a landmark deal, has commissioned all of its private-sector hospitals for use by the National Health Service, at cost, expanding capacity by 8,000 beds<sup>9</sup>.

These responses bear the hallmarks of so-called frugal innovation—that is, doing more, with less, for the many, and being creative, innovative and resourceful in the face of institutional voids and resource constraints<sup>10</sup>. This has been the reality of the experience of many low- and middle-income countries, even before the COVID-19 pandemic, which is why so many frugal innovations emerge from these contexts<sup>11</sup>. Frugal innovation has been touted for its merits in serving the needs of the poor or the bottom of the pyramid, formulating business internationally competitive<sup>12</sup> and for achieving sustainable development<sup>13</sup>. Frugal innovation in healthcare does not mean low quality but instead means the ability to provide safe healthcare in the best way possible under given circumstances

and constraints. Challenging as the current public health crisis is, frugal innovation provides opportunities to expand access to care and to ensure that the care, although perhaps not perfect (yet), is good enough under the current circumstances. While there is a predominant emphasis on affordability and low cost in frugal innovation, there are many other associated drivers, competencies and dimensions as well<sup>14</sup>. Of these, we believe three approaches help us to relate the examples we have encountered thus far in responding to the COVID-19 threat: repurposing, reuse and rapid deployment. Although it is not an exhaustive list, Table 1 describes several such frugal innovations in some detail.

The accelerated pace of clinical-trial approval around the world, including in the USA and Europe, has shown how traditionally conservative institutions can act rapidly in times of urgency. And given the imperative to scale up protective equipment, ventilators, medicines and potential vaccines to the whole world, underpinning all of these approaches is the need to contain costs toward affordability. Although many may be willing to pay anything for containment or cure of COVID-19, governments worldwide can ensure fairness and equity only if the solutions are affordable to individuals and to society as a whole.

These innovations are not without their challenges. Some have not been field tested, let alone evaluated, in randomized, controlled trials. There are other risks, too, with one person reported to have died from the improper repurposing of a form of chloroquine phosphate for prophylaxis following US President Trump's advocacy of the drug<sup>15</sup>. However, in the context of this rapidly evolving pandemic, during which even national lockdowns threatening the economic, social and cultural fabric of society have also not been first evaluated and tested, there is merit in using these frugal solutions, improving on them and sharing the resultant findings so that they

can bring benefit and needed care to as many victims of COVID-19 as possible.

The physical barrier to co-creation posed by social distancing has been mitigated partly through the greater use of digital tools. Indeed, where the COVID-19 pandemic has witnessed the most effective innovation has been in the sharing of new knowledge through social media, transcending the traditional boundaries of knowledge production, dissemination and consumption. Such has been the speed with which local, regional and national experiences have been shared, nimbly, rapidly and without borders, that it may have left many wondering whether this will disrupt traditional academic publishing altogether.

There are many underlying lessons. Necessity is the mother of invention, and human beings can be resourceful, particularly in crisis, in coming up with frugal solutions that get the job done. It is sometimes necessary to forego high regulatory standards in order to rapidly address new demands at low cost, and although the imperative for frugal approaches to healthcare provision has been witnessed in developing countries for many years, the value of humble approaches to innovation is now being seen even in the most technologically advanced countries. It remains to be seen whether this global crisis will permanently disrupt how innovation occurs in healthcare. Furthermore, the unconscious biases faced by researchers from low-income countries<sup>16–18</sup> may be mitigated by this improved global knowledge flow, and this may result in improved uptake of innovations from these contexts, so-called 'reverse innovation'<sup>19,20</sup>.

After the world finishes dealing with the COVID-19 pandemic, the important lesson for humanity here might be to learn from everyone and for everyone. The pandemic may serve as the greatest leveler of our time and teach us to recognize the fragility in all our healthcare systems. There may be, at least, this one positive outcome. □

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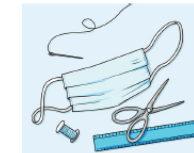
Stanford SOCIAL INNOVATION Review  
Informing and inspiring leaders of social change

Health

## Frugal Innovation for Today's and Tomorrow's Crises

Organizations that reuse, repurpose, recombine, and rapidly innovate under resource and time pressures can help build a more inclusive and sustainable future.

By Yasser Bhatti, Jaideep Prabhu & Matthew Harris | Jun. 23, 2020



(Illustration by iStock/WestermannCreative)

Faced with the COVID-19 pandemic, civil society organizations and governments around the world have been caught off guard. As they continue to struggle to respond, a concept known as frugal innovation may help them develop better and cheaper solutions at the rapid pace that is essential to controlling the spread of the disease.

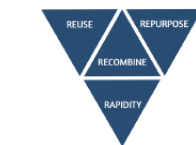
Over the past decade, we have researched and written about frugal innovation—sometimes referred to as *figeas*—in various sectors around the world, including health care. As the COVID-19 crisis continues to unfold, the co-creation of such innovations among health care practitioners and ordinary people is at an all-time high. For instance, Germany's government hosted an open innovation hackathon involving more than 26,000 people to identify responses to the pandemic. The solutions typically fall into three broad areas: prevention (such as protective gear, hygiene, and social distancing), services and technology (such as devices, new procedures, and pop-up hospitals), and potential cures (vaccines and drug development).

Our analysis of many of these responses suggests that they apply four underlying principles of frugal innovation: reuse, repurpose, recombine, and, informing all of the others, rapidity. Organizations can use these principles to help address challenges arising during and after the pandemic.

### 1. Reuse

This entails finding available but outdated resources and using them in new ways without requiring much alteration.

Hydroxychloroquine and chloroquine—drugs from the 1950s that have grown largely ineffective in treating malaria—provide one example. Though the US Food and Drug Administration (FDA) recently revoked its COVID-19-driven authorization of emergency uses of the drugs, the government stockpiled millions of the pills to potentially use them to help combat the disease. Though there is no evidence that these drugs work against COVID-19, the initial decision, flawed though it may be, reflects the reuse principle—something outdated being considered again. More recently, *desamebasone*, another globally available and affordable drug in use since the 1960s, has been clinically found to be effective in treating COVID-19.



Worldwide, governments are asking local residents and businesses to improvise and produce masks, gloves, gowns, and other personal protective equipment (PPE). In part, this reflects the weaknesses of a monolithic supply chain: China provided about half of all PPE equipment before the pandemic, and when the nation restricted exports, everyone else had to find other sources. Creative solutions include using a hole puncher and overhead transparencies, resources designed for a pre-digital era, to make protective shields. As a short-term measure, Vice President Mike Pence of the United States asked the construction industry to donate their



### Rethinking Social Change in the Face of Coronavirus

In this series, SSIR will present insight from social change leaders around the globe to help organizations face the systemic, operational, and strategic challenges related to COVID-19 that will test the limits of their capabilities.

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**REUSE**

**REPURPOSE**

**RECOMBINE**

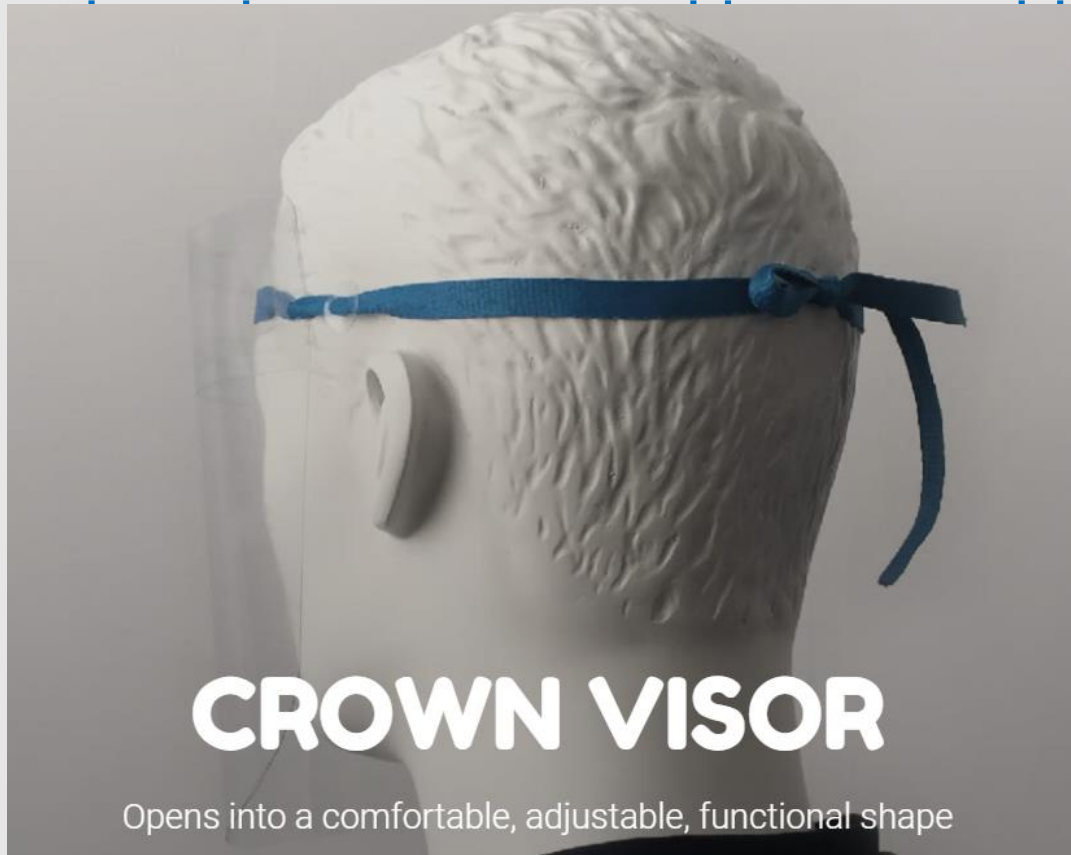
**RAPIDITY**

# Reuse

- This entails finding available but outdated resources and using them in new ways without requiring much alteration.
1. Hydroxychloroquine and chloroquine—drugs from the 1950s that have grown largely ineffective in treating malaria—provide one example.
  2. [Dexamethasone](#), another globally available and affordable drug in use since the 1960s, was the first to be found clinically effective in treating COVID-19.
  3. Creative solutions include using [a hole puncher and overhead transparencies](#), resources designed for a pre-digital era, to make protective shields.

# Reuse

- This entails finding available but outdated resources and using them with much alteration.



protective shields.

# Repurpose

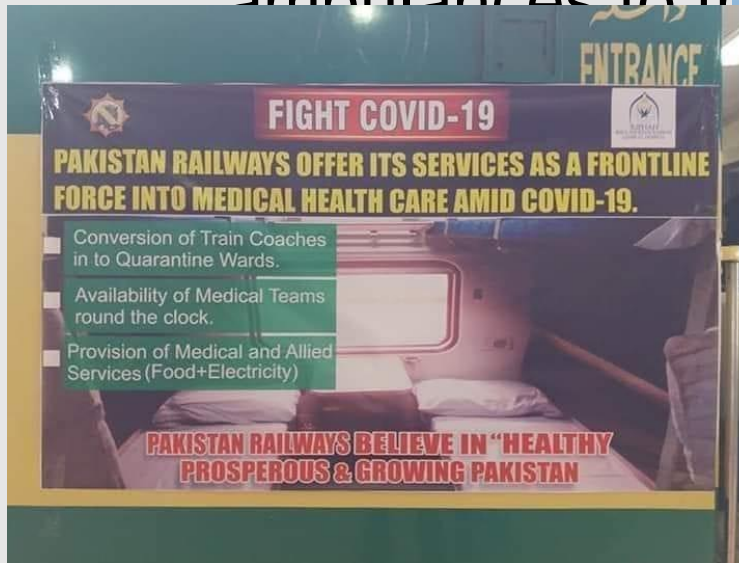
- This involves altering a currently valuable resource to serve an originally unintended purpose.
1. [France's high-speed trains have been repurposed](#) into ambulances to transport COVID-19 patients to less busy hospitals.
  2. [Indian](#) and [Pakistan](#) railways have turned their trains into intensive care wards, which can move to keep up with the spread of the virus.
  3. In Senegal, researchers [repurposed a Dengue fever test kit](#) to develop a \$1 coronavirus version that gets results in just 10



# Repurpose

- This involves altering a currently valuable resource to serve an originally unintended purpose.

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# Recombine

- This describes the mixing of resources, processes and practices.
  1. In Britain, the [OxVent initiative](#) by Oxford University and King's College developed a ventilator by recombining off-the-shelf components already in the NHS's supply chain.
  2. In New York, the capacity of individual ventilators has been [multiplied several times](#) with 3D-printed connectors that split the oxygen from a ventilator into several streams that can simultaneously treat multiple patients.
  3. In another example, more than a million volunteers recombined their [personal computer processing power](#) into a network—which was [notably more powerful than the fastest traditional supercomputer](#)—to sequence coronavirus protein structures.

# Recombine

◦ This describes the mix of

1. In Britain, the [OxVent](#) is developed a ventilator from the NHS's supply chain
2. In New York, the capacity is [several times](#) with 3D-printed ventilator into several

processes and practices.

University and King's College London shelf components already in



[ing power](#) into the fastest transition structures.



# Rapidity

- In the face of a fast-moving virus that becomes exponentially deadlier the longer it goes unchecked, interventions that move more quickly will be more useful.
1. For instance, the British government [provided a list of specifications](#) for the manufacture of a ventilator system – the Rapidly Manufactured Ventilator System (RMVS).
  2. The government fast-tracked regulatory approval of a design from [the VentilatorChallengeUK](#), a consortium of more than 20 organizations from around the world, and placed orders for [15,000 devices](#).
  3. The consortium's approach to *reuse* existing production capacity, *repurpose* one of its member's [existing anesthesia products](#), and *recombine* members' individual sector-specific strengths led to *rapid* regulatory approval and the capability to scale up production for faster delivery.



# Rapidity

- In the  
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VENTILATOR  
CHALLENGE | UK

## GALLERY

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# Frugal is here to stay

- COVID-19 has affected the whole world. In fact, as official numbers stand, wealthier countries seem to have the largest number of cases.
- Everyone, everywhere have turned to solutions that reflect frugal innovation principles.
- Frugal innovation—with its highly collaborative nature and its ability to make the most of limited resources—can help to build a more inclusive, secure, and sustainable future.



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# Mentimeter questions

1. Have you come across COVID-19 frugal innovations?
2. Where have you seen these?
3. Describe some of the innovations
4. Which 4Rs relate to your innovations?



# APPENDIX