Simplest Innovations Are, Empirically, the Most Promising: An Explanation

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Abstract

Many examples show that the simplest innovation are the most promising. In this paper, we provide a theoretical explanation for this empirical observation.

1 Formulation of the Problem

Simplest innovations are, empirically, the most promising. At a recent (2015) Annual Conference of the American Society of Mechanical Engineers, one of the plenary talks was given by Dr. William E. Cohn from Baylor College of Medicine [1]. Dr. Cohn is Director of the Center for Technology and Innovation, Associate Director of Laboratory Surgery Research in the Center for Cardiac Support, and Director of the Cullen Cardiovascular Research Laboratory at the Texas Heart Institute. He has many patents on new technologies for cardiac and vascular surgery. He was one of the pioneers in developing the fully implantable artificial heart.

In his talk, Dr. Cohn gave advise to engineers and scientists designing innovative devices. One of the main points of his advise was that the simplest ideas are, in general, the most promising ones. He illustrated this recommendation on several examples from his own experience and from the experience of others.

But why? Dr. Cohn's talk provided many convincing examples that the simplest innovations are indeed the most promising. But why? What is the reason behind this empirical observation?

In this paper, we provide a possible theoretical explanation for this observed phenomenon.

2 Our Explanation

How to formalize the usual trial-and-error approach to innovations. In his presentation, Dr. Cohn considered the usual trial-and-error approach to innovations, similar to the one used by Thomas Edison when we discovered the best material for an electric bulb: trying different alternatives until we succeed. This is how the material for artificial arteries was first discovered: by trying different materials one by one, until an appropriate one was found. This is how many other important innovations were made.

How to describe simple vs. complex innovations in precise terms. An innovation consists of several components. A simple innovation has few components, more complex innovations contain many components.

Thus, the number of components can be viewed as a reasonable measure of the design's complexity.

Analysis of the problem. Let c be the number of components in an innovation. Let a be the number of different alternative ways to select each component. So, we have a total of $D = a^c$ possible designs.

Let us assume that d of these designs solve the original problem. Usually, this amount is small, e.g., $d = 1$: indeed, if this number was large, we would have found a solution to the original problem.

Let us denote by N the number of different alternative designs that we can analyze. The probability that the first of tried designs solves the original problem is equal to $\frac{d}{D}$. Correspondingly, the probability that the first design does not solve the problem is equal to $1 - \frac{d}{D}$.

If the problem is not solved by the first tried design, then we try another design out of remaining $D-1$ designs. The probability that this second attempt will also be unsuccessful is equal to $1 - \frac{d}{D-1}$. Thus, the probability that we did not succeed after two attempts is equal to the product

$$\left(1 - \frac{d}{D}\right) \cdot \left(1 - \frac{d}{D-1}\right).$$

Similarly, the probability that we did not succeed after three tries is equal to

$$\left(1 - \frac{d}{D}\right) \cdot \left(1 - \frac{d}{D-1}\right) \cdot \left(1 - \frac{d}{D-2}\right),$$

and the probability that we did not succeed after all N tries is equal to

$$\left(1 - \frac{d}{D}\right) \cdot \left(1 - \frac{d}{D-1}\right) \cdot \ldots \cdot \left(1 - \frac{d}{D-k}\right) \cdot \ldots \cdot \left(1 - \frac{d}{D-(N-1)}\right).$$

One can see that the larger D, the larger each factor in this product and thus, the larger the probability of not succeeding.

Thus, to increase our chance of success, we should try the designs with the smallest possible value D. Since $D = a^c$, this means that we should try the designs with the smallest possible number of components c – i.e., designs with the smallest complexity c.

Conclusion. So, our analysis have indeed explained the observation that the simplest innovations are the most promising.

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References

[1] W. E. Cohn, "Engineering in Healthcare", *Proceedings of the ASME 2015 International Mechanical Engineering Congress & Exposition IMECE'2015*, Houston, Texas, November 13–19, 2015.