Idealized Design: How Bell Labs Imagined -- and Created -- the Telephone System of the Future

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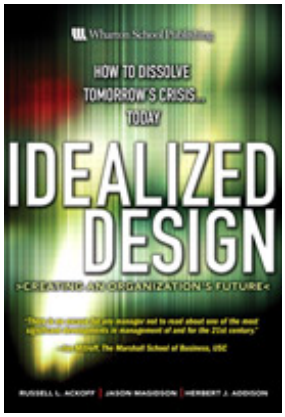

In their book, Idealized Design: How to Solve Tomorrow's Crisis...Today *(Wharton School Publishing), authors Russell L. Ackoff, Jason Magidson and Herbert J. Addison build upon a simple notion. They argue that, "the way to get to the best outcome is to imagine what the ideal solution would be and then work backward to where you are today." This excerpt, based on Ackoff's experience, shows how the process worked at Bell Labs in the 1950s.*

Idealized design is a way of thinking about change that is deceptively simple to state: In solving problems of virtually any kind, the way to get the best outcome is to imagine what the ideal solution would be and then work backward to where you are today. This ensures that you do not erect imaginary obstacles before you even know what the ideal is.

Nothing better illustrates the power of this idea in action than the experience that one of the authors, Russell L. Ackoff, had many years ago. The experience both enlightened him and proved to him that the idea could facilitate profound change in a major corporation. To relate the experience, this author "steps forward":

In every life, there are seminal experiences that exert their influence on a great deal of experience that follows. The one that is responsible for this book took place in 1951. I was then a member of the faculty of Case Institute of Technology in Cleveland, Ohio. (It had not yet merged with Western Reserve University.) On a consulting trip to New York, I drove down to Bell Labs in Murray Hill, New Jersey, to see Peter Meyers, a manager whom I'd met when he had come to Case to recruit promising graduate students for the labs.

It so happened that on the day of my visit he and other managers had been summoned to an important -- but last-minute -- conference by the vice president of Bell Labs. After some hesitation, Peter Meyers said, "Why don't you come with me?" I pointed out it was a meeting for section heads and I was not even an employee of the labs. He said that no one would know the difference.

We arrived at a typical classroom that held about forty people and was almost full. The vice president was not there yet. Nor did he appear on time. This was very unusual. He was a big man, extroverted, and voluble. He could not get near someone without punching, pinching, pushing, hugging, or pounding them on the back.

About ten minutes after the hour, the door to the room squeaked open. All eyes turned to it, and there he was. He was obviously very upset. He was a pasty gray and bent over as he slowly shuffled down the aisle without a word to anyone. He mounted the platform, stood behind the podium, put his elbows on it, and held his head in his two hands, looking down.

The room was dead silent. Finally, he looked up and in an uncharacteristically meek voice said, "Gentlemen, the telephone system of the United States was destroyed last night." Then he looked down again.

The room broke out in a hubbub of whispered conversations saying that his statement was not true. Many in the room had used a phone that morning. The vice president looked up and said, "You don't believe the system was destroyed last night, do you? Some of you probably used the phone this morning, didn't you?" Most of the heads in the room shook with assent. The vice president began to tremble with rage. He shouted, "The telephone system was destroyed last night and you had better believe it. If you don't by noon, you'll be fired."

He then looked down again. "What was wrong with the VP?" everyone was asking each other. But because discretion is the better part of valor where one's boss is involved, the whispers stopped as all waited for further word from him and an explanation of his erratic behavior.

The vice president looked up and glowered at the group. Then he suddenly straightened up, his normal color seemed to return, and he broke out in a great big belly laugh. All those in the room also began to laugh. They did not know why they were laughing, but it released the tension that his unusual behavior had created. It began to dawn on all of us that his behavior had been a trick.

After the laughter died down, he said in his normal voice with his normal demeanor, "What was that all about? Well, in the last issue of the *Scientific American*," he said, "there was an article that said that these laboratories are the best industrially based R&D laboratories in the world. I agreed, but it got me thinking."

He reached into the inside pocket of his jacket and withdrew a piece of paper and said, "I've made a list of those contributions to the development of telephonic communications that I believe have earned us this reputation. Before I share my list with you, I'd like your opinions. What do you think are the most important contributions we have ever made to this development?"

Almost every hand in the room went up. He called on one of those with a raised hand. He said, "*The dial*." "Right," said the vice president. "This is certainly one of the most important. Do any of you know when we introduced the dial?" One in the room volunteered a date in the 1930s. The vice president agreed. He then asked, "When was it developed?" No one knew.

He said he had not known either but had looked it up before he came to the meeting. He said, "It was before 1900." We were surprised to say the least. He pressed on, asking for another candidate. The next one offered was *multiplexing*, a way of transmitting multiple conversations simultaneously over one wire. This yielded an enormous increase in the capacity of AT&T's network. "Right," the vice president repeated. He once again asked when it has been introduced. Someone knew it had been between the two world wars. The vice president confirmed this and asked, "When was it invented?" No one knew. Again he revealed that it was before 1900.

He asked for one more suggestion. The person he called on said, "The *coaxial cable* that connected the United States and Great Britain." The vice president agreed and asked when it had been built. Someone knew: 1882.

"Doesn't it strike you as odd," he said, "that the three most important contributions this laboratory has ever made to telephonic communications were made beofre any of you were born? What have you been doing?" he asked. "I'll tell you," he said. "You have been improving the parts of the system taken separately, but you have not significantly improved the system as a whole. The deficiency," he said, "is not your's but mine. We've had the wrong research-and-development strategy. We've been focusing on improving parts of the system rather than focusing on the system as a whole. As a result, we have been improving the parts, but not the whole. We have got to restart by focusing on desiging the whole and then designing parts that fit it rather than vice versa. Therefore, gentlemen, we are going to begin by designing the system with which we would replace the existing system right now if we were free to replace it with

whatever system we wanted, subject to only two not-very-restrictive constraints.

"First," he continued, "let me explain why we will focus on what we want right now, not out five or ten years. Why? Because we know that where we say today we would like to be five years from now is not where we will want to be when we get there. Things will happen between now and then that will affect our goals and objectives. By focusing on what we want right now, we can eliminate that potential source of error."

"Second, why remove practically all constraints? Because if we don't know what we would do now if we could do whatever we wanted, how can we know what to do when we can't do everything we want? If we knew what we would do with virtually no constraints, we could modify it, if necessary, to become feasible and adapt it to changing internal and external conditions as time goes on."

"Now, here are the two constraints. First, *technological feasibility*. This means we cannot use any but currently available knowledge. No science fiction. We can't replace the phone with mental telepathy. The second constraint," he said, was that "the system we design must be *operationally viable*. What does that mean? Because we are not changing the environment, it means that the system must be able to function and survive in the current environment. For example, it will have to obey current laws and regulations."

The vice president then said, "This group is too large to operate as a single group. Therefore, I am going to divide you into six subgroups of about six each, each with responsibility for a subsystem. Each group will select a representative to meet with other representatives at least once a week to discuss interactions. Let me explain.

"Each group will be able to design whatever it wants as long as it does not affect any other group's design. If what a group wants to do does affect one or more other groups' designs, it must get their agreement before it can be included in their design. I can tell you in advance," he said, "that the groups will do little that does not affect other groups. At the end of the year," he said, "I want to see one completely integrated system design, not six subsystem designs. I don't even want to know what the individual teams came up with. Is that clear?" he asked.

He created a "long lines" (inter-city communication) team, a "short lines" (within city communication) team, a switching stations team, two other teams, and finally the telephone set team, on which I found myself with my friend Peter Meyers.

When the meeting was adjourned, the teams immediately gathered so that their members got to know each other. When Peter introduced me to the other members of our team, they thought it very funny that an "outsider" had successfully invaded their meeting. But, they said, the vice president had not precluded their use of "outsiders." Therefore, they invited me to participate in the effort. As a result, I spent a great deal of time in the next year with that team. What a learning experience it was!

The first meeting took place after lunch that day. The seven of us, six from the labs and I, met in a small breakout room. After the amenities, we discussed where we should begin. We decided to list the properties we wanted a telephone to have. We noted suggestions on a pad mounted on an easel. The first few were as follows:

Every call I receive is intended for me -- no wrong numbers.

- I want to know who is calling before I answer the phone so I need not answer it if I don't want to speak to the caller.
- A phone I can use with no hands.

- A phone that comes with me wherever I am, not one I have to go to in a fixed location.

We continued to add to this list for several weeks, ending with just more than ninety properties we wanted a phone to have. These properties became very complicated near the end. For example, we wanted to be able to talk simultaneously to groups in multiple locations, see all of them, and be able to transmit documents or charts instantaneously.

But we ran dry. We noted, however, that we had designed nothing yet, so decided to try our hands at it. We decided to select the first property on our list -- no wrong numbers -- and see if we could design a phone that met this requirement.

At this point, I almost destroyed my credibility in the group by pointing out that there were two kinds of wrong numbers. One consisted of having the right number in one's head but dialing it incorrectly. The other consisted of having the wrong number in one's head and dialing it correctly. One member of the group immediately pointed out that if one had the wrong number in one's head and dialed it incorrectly, one might get the right number. Fortunately, the group decided this was too rare to be of concern but that the percentage of wrong numbers of each type was of concern.

Here I was able to save credibility a bit because I knew the head of the psychology department at the labs. I called him using the phone in the room. After the amendities, I asked him if he had ever done any work on wrong numbers. He exploded at the end of the line. It was minutes before I could understand him. It turned out that he had been doing work on wrong numbers for a number of years, and I was the first one to ask him about it. He wanted to unload all of his results on me. I had to convince him otherwise. After he calmed down, I learned that four out of five wrong numbers were the result of incorrectly dialing the right number in one's head. We decided to go to work on this.

An amazing thing happened; in less than an hour, we found a way, conceptually, to reduce, if not eliminate, such errors. We replaced the dial by -- what did not exist at that time -- a small handheld calculator. There were ten keys, one for each digit, a register, and a red key in the lower-right corner. The phone was to be used as follows. Leaving the phone "on the hook," one would put into the phone the number one wanted to call by pressing the appropriate buttons. These numbers would appear on the register. If these numbers, on examination, appear to be correct, one would lift the receiver and the whole number would go through at once. If the number on the register was wrong, one would press the red button in the corner. This would clear the phone, and one would start over.

We were very pleased with ourselves, but nevertheless we recognized that we did not know whether such a phone was technologically feasible. (The handheld calculator was not yet available.) Therefore, we called a department of the lab that worked on miniaturization and asked for technical help. They sent two young men down to our meeting. They appeared to be fresh out of school, still wearing their intellectual diapers.

As we described what we were trying to do, they began to whisper to each other and were soon more absorbed in their private conversation than in what we were saying. This bothered us, but such behavior was not entirely unexpected in an R&D laboratory. However, they suddenly got up and hurried out of the room with no explanation. We were furious but decided to let it pass for the time being. We went on to another property.

Several weeks later, the young men appeared at one of our sessions looking sheepish and apologetic. They said, "You probably wondered why we ran out on you when we were here last." We told them this was an understatement. They explained, "We were very excited by what you were doing but not for the reasons you were. We did not want to take the time to explain. That wrong-number stuff was not as

interesting as the buttons."

They went on, "We went back and built a push-button telephone and tested it on a very large number of people. It turns out to take about twelve seconds less to put in seven digits by pushing buttons than turning a dial, and additional time is saved by not occupying a line until after the number is put in and the receiver is picked up. The combined saving in time is worth millions to AT&T," they said, "so we have started a project to develop that telephone. We have given it a code name that is being kept secret for now." They looked around the room to be sure no one was listening and then told us, "Touch tone."

Before the year was over, the groups had established the technological feasibility of each of our many design features. The group of design teams continued to work after I was no longer a participant, and they anticipated every change in the telephone system, except two, that has appeared since then. Among these are touch-tone phones, consumer ownership of phones, call waiting, call forwarding, voice mail, caller ID, conference calls, speaker phones, speed dialing of numbers in memory, and mobile phones. They did not anticipate photography by the phone or an Internet connection.

The impact of the design we produced was greater than the impact of any other effort to change a system that I had ever seen. As a result, I began to adapt and modify the procedure to fit such other applications that we describe in this book. As you will see, its use has been extensive and is still growing.

This experience is a convincing example of how *idealized design* can literally move mountains of change. However, applying the process involves not only discarding old mindsets that inhibit creative thinking but knowing the steps that we have learned work best in applying it. The book is intended to take you through the process with many examples of different organizations in different industries.

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