

Preface

Two Decades of Research on Innovation

In 1995, with the publication of a simple article by the author in *Theories and Practice of Systems Engineering*, the author thought about performing institution design using the engineering design method. We all know that in architecture, there are drawings; in electrical works, circuit diagrams; and in mechanical design, mechanical drawings. With the aid of these drawings, project designers may go about their work in both an intuitive and an objective/scientific manner with high operability, with each improvement made to the design in question grounded and practical. In contrast, in the fields of economics and management studies, despite the popularity of institution research, the study results obtained are often recommendations that are deemed to present “inadequate supervision,” “insufficient impact,” or which are “excessive intervention.” Hence, despite the popularity of institution research over the years, the practical applications of such research remain far and few in between.

The key reason for this situation is the lack of common institution design tools and techniques, with the vast majority of studies relying on personal experience and thinking. This means that the resulting studies lack depth and are flawed. Without the use of an overall institution diagram annotated with clear symbols, an over-reliance on intuition and experience can make it difficult to observe the multivariate factors in, and complex structure of, an institution. Without the use of a mathematical model, a precise comparison and consideration of effects and costs of various institutions cannot be performed. A variety of solutions have been proposed for similar problems plaguing the institution, and this is precisely because these solutions have been forged in individual, personal experiences.

Years have come and gone (the article published in *Theories and Practice of Systems Engineering* in 1995 was written in 1993), and in these 20 years, the author has gone through successive attempts and failures in his efforts to develop a viable set of rules and a symbol system for institution design drawings. Finally, in July 2013, he achieved a key breakthrough, successfully developing a set of symbols

and rules for institution design. As the original name was too long and unwieldy, and in order to commemorate the two decades the author had spent on the subject (he started at the age of 40, and is now aged...), the author decided to term this diagram the “Sun Diagram.”

Standing in contrast to the “Sun Diagram” is the “Behavior Reward Function,” a simple function that conforms to the law of diminishing marginal rewards and which was discovered at the same time. The use of the function in conjunction with the Sun Diagram makes for a simple and incisive analysis of various institutions. When reading this volume, the reader will soon discover that the author seeks to keep mathematical model used clear and simple without redundancies.

Through analysis with the “Sun Diagram” and the “Behavior Reward Function,” the author has discovered that there are five fundamental institution structures across all of human society from which derivatives and adaptations arise.

This volume provides practical methods of institution design and analysis, including the “Sun Diagram” that reflects institution structures and institution components’ configuration. These methods all have tremendous practical applications.

This volume also includes a number of significant findings made by the author which come with practical applications.

When there is production by an organization, if production behavior does not produce any externalities, independent operation and management should be prioritized ahead of other models as enterprise production will reach spontaneous equilibrium of optimal scale of production under such model, without needing any management costs.

Where there are positive externalities from production behavior, the spontaneous equilibrium of the enterprise’s production scale will decrease and fail to reach optimal scale. One key finding of this volume is that the subsidy mechanism can lead to the spontaneous growth of production scale where production scale has positive externalities. Therefore, if we want the enterprise to spontaneously grow its production scale, we would need to adopt a cost subsidy policy for the enterprise. Production with positive externalities includes production activities like the construction of basic infrastructure such as reservoirs, roads, and bridges.

Where there are negative externalities from production behavior, the spontaneous equilibrium of the enterprise’s production scale will increase and cause the drying up of resources. With regard to this issue, the analysis result in this volume shows that tax mechanisms can be used to shrink production scale for production with negative externalities, so that resources may be better conserved. Hence, a high-tax mechanism needs to be put in place to shrink enterprise production scale in order to better protect the environment and to conserve resources. Such production activities come with negative externalities such as the consumption of vast amounts of water, mineral resources, fishery and forestry resources, or atmospheric, water, and soil pollution. One discovery made here is that the importance of tax collection lies not in the redistribution of citizens’ income but in reducing the overconsumption of various resources. This explains the puzzle of why countries with high tax rates tend to have better-protected natural resources and environments.

Therefore, from the perspective of management by the state, when production behavior presents either positive or negative externalities, either the free-market mechanism of independent operation by each enterprise be abandoned in favor of a centralized management mechanism or the free-market mechanism be retained with supplementation by policies.

The significance of this conclusion is that it has proved, in theory, the key approach to improving the supply of public goods and protecting our earth effectively lies in the institution.

Around the world, in some countries, production behavior that presents externalities is governed by centralized management, while in others, the free market is allowed to operate with regulatory policies in place. However, with the growing scale and increasing complexity of social institutions, centralized management is becoming a less attractive option by the day, for reasons of the need to communicate across multiple levels, significant distortion, and loss of fidelity. In a management institution where the free market is supplemented with regulatory policies, the information chain of an autonomously run enterprise is much shorter, which means that the enterprise is more responsive. If the state implements its regulatory policies effectively, the production scale of the enterprise will grow swiftly with self-regulation and reach an equilibrium point with optimal social benefits. Relatively speaking, this would mean a more successful outcome.

For some enterprises, different externalities associated with production emerge under various circumstances. For instance, for enterprises in the cultural industry, such as those in publishing and journalism, if their product aids the development of society—such as when they publish motivational books or volumes with scientific content—their production comes with positive externalities. If their products bring harm to society, such as when such products promote superstition or contain pornographic content, then their production presents negative externalities. Based on the analyses in this volume, if these enterprises are allowed to run their operations with complete freedom as in the free-market model, then production behavior with positive externalities will have a smaller production scale due to lack of effort, while on the other hand production with negative externalities will tend to become greater as a higher level of effort is applied. Therefore, for enterprises of this type, either centralized management should be applied or governmental subsidies should be applied to production with positive externalities to promote the scale of such production, while high taxes be levied on production that presents negative externalities to reduce profits of such production.

For research and development (“R&D”) behavior that inherently presents positive externalities, as R&D outcomes can easily be copied (with an externality produced, i.e., benefits for the copier), the equilibrium point of self-motivated effort is comparatively lower. Hence, currently in various countries, there are measures that protect innovators, i.e., patent rights measures. This type of institution can lead to a lack of visible externalities from R&D behavior within a certain period (with the copying of R&D results in this period being illegal), thereby optimizing the effort equilibrium for R&D behavior. The problem is, if patent rights institutions are

not run effectively and copying behavior cannot be hence curbed effectively, individuals would then lose their enthusiasm for R&D and innovation.

As for the competitive behavior often seen in the society, the finding of this volume is as opposed to the common assumption that the more crowded the field, the fiercer the competition, and the competition is fiercest when there are only two units competing with each other. This means that in order to tackle vicious competition such as the malicious suppression of competitors, the right approach would be to allow more enterprises into the market rather than to reduce the number of players in the market. This conclusion explains why two persons pitted against each other in a competition would engage in rivalry greater than they would in a multiplayer competition. In international relations, this explanation also provides the theoretical ground for why a multipolar world would be more peaceful and stable than a bipolar world. Indeed, we can all remember how two world superpowers had nearly brought mankind to the brink of nuclear war during the Cold War period.

These findings may be harnessed in institution design to tackle key challenges that humankind faces today, such as environmental pollution, overconsumption of natural resources, carbon emissions, peace and stability issues, and stagnating productivity levels.

Further, the engineering method for institution design proposed in this volume allows the process of institution design to become more like the process of engineering design, with a choice of graphics and institution components for the designer as well as the ability to calculate and compare institution effects for the optimization of design plans. This makes for institution designs that offer greater operability and which are more practical, making significant impact from the scientific method on management practice.

Finally, in the area of fundamental theory, this volume proposes the three conditions necessary for any sort of behavior: behavioral utility (positive utility), behavioral resources, and behavioral opportunity. All the three conditions must be present at the same time. Clearly, this is significantly different from traditional theories of economics where only behavioral utility is considered. In addition, the proposal of the concept of exchange utility has also provided an effective method for considering the scale of benefits of different types.

For over 20 years, I have been indebted to the generosity of a number of R&D funders (the contents in this volume include the outcomes of what have been funded, but not in their entirety), who are the National Natural Science Foundation of China (71171134, 70871080, 70471066, 70271005); the Shanghai Key Basic Research Project (03JC14054); the Shanghai Social Science Planning Project (2011BGL006); the Innovation Project of Shanghai Municipal Education Commission (01F06, 11ZS138); the Shanghai Top-Tier Disciplines Project (S1201YLXK, A14006); the Doctoral Fund of Ministry of Education of China (20070252002); and the Management Science and Engineering of Shanghai Municipal Plateau Discipline.

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