

The Development of New Engineering Talents with the Support of Information Technology and Financial Scheme

— From the perspective of talent industrial life chain and based on the experience of the
Peking University College of Engineering

Li Yongmei ¹

Deputy research fellow, assistant dean
College of Engineering, Peking University
Beijing, China
yml@pku.edu.cn

Dou Erxiang ²

Professor of finance
School of Software & Microelectronics, Peking University
Beijing, China
douex@ss.pku.edu.cn

Abstract—This thesis studies the TEF model for the development of new engineering talents, on the basis of actual practice of the College of Engineering of Peking University. The TEF model has the following three features: Firstly, the development of new engineering talents must coordinate with downstream industries so that students can become competent professionals who meet the market demands. Secondly, through the use of information technology, new engineering talents are developed on an engineering-based procedure involving such education links of assessment, decision-making, allocation, implementation and bringing to the market. Thirdly, the engineering personnel development platform must make enough capital available for their purpose. This TEF model has been fairly successful in the College of Engineering of Peking University. It is believed that their experience can serve as a reference for other schools and the country as a whole as it seeks to find effective models for the development of new engineering talents.

Keywords—New Engineering; Education Chain, TEF, Informationization, person finance

I. INTRODUCTION

How shall we develop new engineering talents forms an important part of the global exploratory efforts to find a good model that nurtures new engineering talents in the world. It is a pressing issue in China's transformation of its human resources development models. If China can seize the opportunity and eventually find an effective way for the growth and development of its more than one billion people, it will make an enormous contribution to human civilization.

As an industrial gene technology, information technology is making rapid and all-round infiltration into traditional industries. The “hybrid gene advantage” will create transdisciplinary new products which are smart and tailor made for each individual so that they can better satisfy people's needs in production and daily life. Human resources development through innovative, transdisciplinary integration and engineering is in the offing.

After the country reinstated the system of *Gaokao*, education in China developed rapidly and stakeholders in this field began to realize that under the old model grades were the sole criterion for judging the performance of students and the importance of academic diplomas were overemphasized. Drawbacks of the old model: Students display no individuality, some talented people were not selected, low efficiency in study and lack of innovation. It is imperative that China establish a new education model under which students enjoy their study, their innovative potential is tapped and everyone can display his/her talents.

The need for new engineering talents has set new requirements for the development of personnel by engineering programs. They are: new concepts in engineering education, new structures of the programs, new models for developing talented people, higher quality in teaching and new systems of categorized development. Of these, new concepts in engineering education and new models for developing talented people are the two most important. The new concepts refer to the following four features: use of information technology, quantification, procedure-based and feasibility in developing

engineering talents.

As regards new models for developing new engineering talents, models that can be duplicated and adopted in wider areas shall be established, with the following four features: First, new engineering talents must be involved in the creation of the value chain to ensure their values are realized with high efficiency. Second, make sure that all potential traders, on condition that they have full access to all available information, find their resources accurately matched. Third, all traders can make their deals in line with their preferences, potential and social demand and realize a high level of satisfaction. Fourth, justice. Education qualifications are decoupled from a family's financial conditions but are closely related to a person's potential capabilities.

The development of new engineering talents is a ministerial-level topic approved by China's Ministry of Education. Our research group succeeded in the tender mainly for two reasons. First, I am currently in charge of innovation in Peking University in general and in the College of Engineering in particular and throughout the years I have had experiences and lessons associated with innovation by university students. Second, over the years our research group has conducted many studies on education and development of talented personnel. Our study results are reflected in the following three aspects: First, in natural persons' equity investment mechanism we find the resources allocation mechanism conducive to the development of talented personnel. Second, we have adopted the means of information technology in our education-finance system, forming the TEF model that integrates information technology, industry and finance. Third, both models have the support of actual cases, showing initial proof that the student-based share financing system and the personnel-based TEF model is effective.

The share financing system is a system under which the scholarships provided to students are not government financial transfer payments or grants, but is educational-financial capital with the nature of equity investment. [1]

TEF model is a new model for developing talented personnel when education industry is supported by the information technology and financial system technology, resolving the two tough problems of information asymmetry and resource scarcity. [2]

This thesis, with its theoretical basis in the two books—*Innovation of Financial System in Education* and *Education Innovation: the Model of Deep Growth*—discusses the TEF-based model on the development of new engineering talents all the time giving full consideration to the special characteristics of such personnel, involving some case studies of new engineering talents from the College of Engineering.

II. CHAIN RULES INCREASE THE EFFICIENCY OF THE DEVELOPMENT OF NEW ENGINEERING TALENTS

The following are likened to a chain: the entire growing process of a student, value-based industrial life and the six phases in a person's life cycle. The three chains are integrated in a perfect manner.

A. *Growth chain is the manifestation of the engineering procedure in the development of talents*

The growth of a talented individual is closely related to the six chain-like relationships, among which are potential assessment, decision making on aptitude, resources allocation, bringing talented personnel on the market and reset of career. When the marginal efficiency brought in by investor's every unit cost on each chain is equal, the total efficiency of the investor is maximized.

An individual and his/her parents are the first investors on his/her own growth. This relationship is a bond of blood. Through "becoming sworn brothers" or "establishing a nominally adoptive kinship" in China, such as the example of the Three Sworn Brothers in Taoyuan in ancient China, an investment relationship based on kinship bond can be established. When two people, by helping each other, form a relationship of benefactor-beneficiary, this is referred to as a bond based on virtue. Still another more formal investment relationship can be defined as a bond based on law, such as the relationship between a movie star and his/her agent.

Currently, the six links of an individual's growth are incomplete or weakened, and education still lags behind in the time of the small craftsmen's workshops. Shuji Nakamura, winner of the Nobel Prize in Physics 2014, wrote an article in which he criticized the education system of East Asia, saying that many lives are wasted under the system and pointing out that the system's biggest drawbacks are the selection of personnel by grades and the model of rote learning. This education system can be likened to the Taylor System in the time of industrialization. But modern society has moved onto the era of information technology, and the themes of the new education are transdisciplinarity, integration, exploration and innovation. Education must be carried out in accordance with the principle of love, potential and need.

B. *Life chain of value industries can promote the integration of industry and education*

Education, a type of indirect production, is an activity involving input of resources for the purpose of economizing on resource consumption. Education is not about writing poems in your leisure time, but is an investment in human capital in which an individual's potential is tapped to meet the needs of

society. Education activities should correspond to industries in order to realize the value of human capital and prevent the occurrence of the phenomenon that university graduates find no opportunities on the job market.

The value chain formed after industry is integrated with education consists of two parts. The first part is enterprise incubate chain, which consists of education, innovation and starting business. Education creates three types of people: innovators, business start-ups and implementers. Next is innovation, followed by business start-up based on innovation. The second part refers to the supply chain of mature enterprises, consisting of upstream, mid-stream and downstream. Putting them all together, we have education-research-industry-upstream-midstream-downstream, an industrial life chain characterized by the transformation of values. The value guarantee logic on this chain can be expressed in the right order or reverse order.

By reverse order we mean education is centered on consumers' needs. In recent years, institutions of higher learning have established subsidiary schools or have turned many of the colleges into specialized technical schools. When technical innovation is relatively stable and when domestic and overseas demands remain relatively stable we understand the reason for the market-centered setup of colleges. However, when demands are changing constantly or when demands do not reflect national strategy, market-centered educational programs show many drawbacks.

By the right order we mean consumption is decided by education. This is in line with the theory that supply creates demand. It is the people who decide the type of enterprises, the products that are supplied and the final consumption. Jack Ma, who served as an interpreter for foreign tourists in West Lake and taught in a software school when young, established the company Alibaba.

C. Six phases of a life cycle—raising the total value of new engineering talents

An individual's life cycle can be roughly divided into six phases: the marriage of one's parents, the pregnancy of one's mother, the pre-school period, the school period, the work period and finally retirement. Every phase has its specific contents, characteristics, goals and scarcity of resources.

People grow and improve in every of the six phases. An individual's growth at the next point is the function of the growth of the previous point. Of the six phases, we should pay particular attention to the period from birth to six years of age and the retirement phase. There is a popular saying that "from a three-year-old baby you will know what kind of adult he will turn into and from a seven-year-old child you can tell what he

will be in old age." This is a rough generalization of the psychological development of a young child. In terms of intelligence, 80 percent of the abilities are achieved from the baby's birth to seven years old. What is more important, parents' expectations, behaviors, and some norms in life will be internalized by the baby as his/her own expectations and system of rules.

There are many misconceptions about the phase of retirement, and pensioners are regarded as a burden to society and retirees have nothing to contribute but to move toward the end of life. As a matter of fact, people in this phase have the wisdom from learning and experience all their life. What we must do is to link them closely with the relevant industrial chain, match them appropriately with those in their early period of the six-phase life cycle in order to take advantage of their wisdom that has been accumulated throughout their life.

As more and more wealth is amassed, people's needs are moving closer to the top level of Maslow's hierarchy of needs. As people's understanding of happiness deepens, their needs are more and more reflected in the processes of work. As one approaches retirement, one values the satisfaction of the mind more than of the body and ultimately peaking at the satisfaction of the soul.

III. MORAL REALM IS THE PREREQUISITE FOR ALLOCATION OF RESOURCES FOR THE GROWTH OF NEW ENGINEERING TALENTS

The growth process involves various kinds of trading and cooperation, in which people in a world of information asymmetry will be inevitably troubled by the fact that their trading partners go back on their words. The way to address such a problem is to extract, explore and objectively record these pieces of information, and give corresponding reward or punishment according to them.

A. Authorization and management of the trading qualification of the stakeholders involved in the growth of new engineering talents

A society is never composed of a single person. The essence of a society lies in division of labor and cooperation. We can only presume that, under the condition of information asymmetry, people keep their promise in the sense of value in use or value in exchange when they conduct cooperation. As a matter of fact, however, humans experienced untold sufferings caused by the loss of honesty or credibility in a fairly long period of time when information technology developed at a quite low level. The loss of honesty or credibility greatly increases the risks of trading, as well as the costs of trading between people in their efforts to dispel such risks.

The prisoner's dilemma indicates the irrational choice made by people in cooperation when they lack information. Suppose that two people both commit a crime. In case neither of them pleads guilty, each of them will be sentenced to five years of imprisonment. In case both of them plead guilty, each of them will be sentenced to 10 years of imprisonment. In case only one of them pleads guilty, then this person will be sentenced to 20 years of imprisonment while the other person not pleading guilty will be released without charge. The result of contention: both people plead guilty, and are sentenced to 10 years of imprisonment. Obviously this is not the result of the most rational cooperation. Suppose a market is composed of two kinds of people – those who are honest and those who are not. As dishonest people infect honest people, the market degenerates into a “market for lemons.” The market cannot be maintained unless trading is conducted between honest people.

We call these laws of trading “social gene theory”, whose policy implication is that we must put traders under categorized management, and we should at least guarantee to protect honest traders by separating them from dishonest traders and the traders whose honesty has not been acknowledged. Such a separation amounts to taking one step further in exercising qualification management over the members. Only those members whose honesty and credibility have reached a passable level are entitled to enter a certain ring to get involved in trading. We call such a ring “realm.”

It can be seen from the definition that new engineering talents are people who “will respond to the changing world to shape our future. Outstanding engineering personnel with composite and innovative capabilities will be developed through the means of inheritance and innovation, transdisciplinarity and integration, coordination and sharing.” This requires us to reveal the “moral” aspect of both educational services and fund-raising to all potential traders, with the emphasis put on new engineering talents who are also part of the potential traders, in a bid to guarantee that trading is of low risk, high efficiency and sustained prosperity.

B. Information about the moral aspect of the value in use for the stakeholders involved in the growth of new engineering talents

The main traders involved in the trading themed with the growth of new engineering talents include, first and foremost, students, next, teachers, followed by schools including all kinds of teaching aids and experimental instrument, even the providers of the resources required by all new engineering talents in their growth stage. All these actors provide value in use to the new engineering talents in their growth stage. The trading is not rational unless the actors are subjectively willing to get involved in the trading and the pairing of trading is

objectively maximized.

In reality irrational pairings are fairly common, resulting in high costs and grave risks. For example, a certain student may commit suicide when he or she is paired with a certain teacher, or specializes in a certain field of learning, or is admitted into a certain school. Things may take a much better turn, however, when the student is paired with somebody else. Such a phenomenon is sometimes called “Fengshui (geomancy)” in China. The law governing the appropriate pairing can be disclosed through data.

The data fall into two categories: objective trading data and subjective trading data. The former refers to abilities which are expressed as a person's skills, capabilities and characteristics, and the latter refers to virtuous conducts which are expressed as a person's morality, integrity, preference, characteristics, and others. Any trader is not entitled to enter the “realm” under any of the following three circumstances: the trader has neither sufficient personal skills nor sufficient integrity; the trader has sufficient personal skills but insufficient integrity; the trader has sufficient integrity but insufficient personal skills. For any trader entitled to enter the “realm”, his or her trading facts are recorded in relatively detailed ways, can be explored through cloud computing, and their objective existence can be guaranteed with the support of block chain. These measures enable traders to make the best pairs in the days to come, just as an old saying goes that “Each has his own favorite, be it radish or eggplant.”

C. Information about the moral aspect of the value in exchange for the stakeholders involved in the growth of new engineering talents

The financial nature is the most distinct characteristic in the growth of new engineering talents. A really good new engineering talent has good international vision, whose growth process is complex and who needs more high-level resources. The formulation of a precise, engineering-oriented and complicated fostering plan also calls for the involvement of growth partner, as well as the function of sharing financial risks. Thus a company based on “realm platform” is required to use the angel investments made by natural persons to attract and integrate more capitals for cultivating new engineering talents, and the company is also required to indirectly provide sufficient financial services to other stakeholders.

Take students as an example. Seen vertically, the capitals for cultivating students need to be raised at three levels: from growth to making innovation then to starting one's own business. It is a challenging task to become an innovative person, and it involves more risks to engage in the research that has innovative characteristics, because a person may not necessarily attain success despite life-long research. Making

innovation requires a risk-sharing mechanism in addition to specialized investment. Starting one's own business is more operational than making innovation, because it requires the start-up to predict market demands, understand how to work out a budget for making profits, purchase innovative proprietary rights according to the budget, and more important, be able to persuade project investors for securing their support.

There are not sufficient financial services for new engineering talents. Implementers, innovators and business start-ups all lack precise financial support. As a result, there appears the structural insufficiency in the education of new engineering talents. While the innovative practices of new engineering talents are regarded as innovative activities of innovative talents, insufficient provision of innovative financing means gives rise to the innovative activities whose frequency remains to be increased. Likewise, owing to the limited financing means for starting one's own business, start-ups are operated in their primary stage. As a result, the costs and risks involved in starting one's own business stay high.

The so-called value in exchange is reflected in the capital trading activities which are held with cash flow as both the objective of capability and the objective of willingness. Such a kind of capital trading activities can be divided into capital trading contracts with the characteristics of debt and capital trading contracts with the characteristics of stock. The so-called skills or abilities concerning capital flow of a trader refers to the capital-raiser's capabilities of repaying capital with interest or distributing dividends for investors in the future. The so-called skills or abilities concerning capital flow of a trader refers to ... under the condition that the moral strength is sufficient. For example, "immoral conduct" refers to that the trader has the orientation of going against the real intention of the contract. Based on the principle of financial security and efficiency, any trading activity whose value in exchange involves insufficient moral conduct cannot enter the realm of finance.

IV. FINANCIAL MODEL OF TEF REALM ADDRESSES THE SHORTAGE OF RESOURCES IN THE GROWTH OF TALENTS

The lack of three types of industrial financial instruments can be attributed to insufficient low-capacity credit resource. In China, low-capacity credit resources are collectively manifested by non-systematic credit resources such as mortgage (pledge), guarantee, and supply-chain finance for small and medium enterprises and individuals; and there is a severe shortage of a state credit guarantee mechanism characterized by the compulsory nature. This section describes how to create a small systematic credit resource based on

shadow mortgage technology for traders on the realm platform for the growth of new energy talents.

A. The benefits derived from the realm platform have the function of creating credit limit

In terms of China's rural finance, the bad debt rate, even that of usurious loan, is quite low. This can be attributed to the almost exorbitant costs that may be incurred by breaking contracts, since great viscosity is formed by farmers who live together and those who return to their rural hometowns to spend the rest of their lives after residing elsewhere. We call such a phenomenon shadow mortgage, as it follows the logic of mortgage although there seems to be no mortgage. Such a mechanism of rural finance is borrowed in the establishment of realm platform of new engineering talents. Efforts are made to increase the viscosity of the realm platform towards stakeholders to produce shadow mortgage effect, and turn such a kind of viscosity into the "credit limit" of capital raisers.

The viscosity is dependent upon four kinds of realm benefits: first, the Internet-based club benefits, or the above-mentioned trading qualification management system based on the moral level; second, the reputation benefits based on information technology, or in other words, the trading opportunities with sound moral basis are naturally disclosed on the platform, and are revealed in a safe way to potential traders to save their costs of seeking trading opportunities and eliminate their risks involved in trading; third, the cost benefits derived from economies of scale, economies of scope, and Internet-based economy; fourth, the above-mentioned benefits will generate viscosity of traders, and, along with the pure credit limit derived from viscosity of traders, these benefits will be turned into financial benefits.

B. The function of sharing investment opportunities between investors inside and outside the realm

The main functions of a realm platform company are to serve as an intermediary for developing new engineering talents. The core function of the company is not to provide stakeholders on the platform with financial services, however; otherwise the platform is likely to be turned into a financial intermediary organization since it undertakes the task beyond its capability. Undertaking the task beyond its capability will not only cause the problem of non-specialization, but may also incur the risk of capital chain rupture. Proceeding from the principle of "professionals do professional work", a realm platform might as well give the investment opportunity to capital providers outside the realm.

In case the principal-agent mechanism exists in the investigation of investment opportunities, the agent may run the moral risk. To prevent the occurrence of such a kind of principal-agent problem, it is appropriate for the agent to

provide capital providers outside the realm with an inferior or a guarantee mechanism. The agent may reward his own sharing behavior with risk premium. However, the risk premium of the agent may be kept within a relatively reasonable scope as the realm platform can exert sufficient countervailing power against stakeholders.

C. *Dual roles of realm finance create and change the functions of credit-rating organizations*

At the TEF-realm platform for new engineering talents, the platform company plays at least two roles: one is information discloser, disclosing the dual-layered information based on the value in use and the value in exchange. The information disclosed includes absolute indicators about selves, relative indicators about selves, and relative indicators about others. Of these indicators, absolute indicators about selves are similar to those used in the present-day credit-rating organizations. As the agents serve both investors and fund-raisers, the present-day international credit-rating organizations are highly liable to run moral risk.

Backed by the inferior or guarantee arrangement, a realm platform can integrate the risk-bearing responsibility and risk-control capability of the realm finance into one main body, a design that almost prevents a realm platform company from running the moral risk in credit evaluation. Such a design is arguably a beneficial innovation and attempt to address the moral risk that may be posed by a modern financial credit rating organization. What needs to be stressed is that traditional credit-rating system is incomplete. The evaluation of the characteristic of debt and the characteristic of stock of a contract cannot be included into credit-rating unless the traditional credit-rating system is elevated to a system integrating credit disclosure and inferior arrangement.

V. CONCLUSIONS

The development of information technology characterized by connectivity, big data, block chain, artificial intelligence and human-computer interaction makes it possible for the humans' economic activities to have "a head for intelligent decision-making" in addition to "visible hands" and "invisible hands." A new economic model characterized by "company-based platform + platform-based company" takes

shape. In this thesis we have discussed the most ideal model of "realm platform" following the appearance of dot-shaped platform, line-shaped platform, angle-shaped platform and plane-shaped platform.

The adoption of the "TEF realm model" for developing new engineering talents can achieve the following three effects. First, new engineering talents are put in the life chain of value industries; the application of information technology, the project-based approach and the observance of procedures are characteristic of the growth of talents. Second, the full-fledged information technology is used to address difficulties such as imprecision and high costs and risks which are resulted from information asymmetry in the trading activities of stakeholders. Third, in the growth of new engineering talents, the shadow mortgage technology and the inferior technology provided by realm finance are used to fully address the shortage of funds, a problem faced by all parties involved in the trading.

Based on the construction of an isolated moral base market, the "TEF realm model" for developing new engineering talents provides positive incentives for expanding the realm platform for the growth of new engineering talents. The characteristic of the low liquidity cost of digital assets on the cloud platform makes it possible to allocate the resources in an integrated way for the growth of international talents. Such a model is under trial implementation in the College of Engineering, Peking University. As part of the extraordinary achievements scored under such a model, more than 10 talents excelling in making innovations and/or starting their own businesses have come to the fore. The achievements not only provide experience for the growth of new engineering talents in China, but also provide an experiment for the integrated growth of new engineering talents worldwide. Here we appeal to people from all walks of life worldwide to support the implementation of such a model.

- [1] Dou Erxiang, Li Yongmei et al, *Innovation of Financial System in Education*, Tsinghua University Press, 1ed, February 2012.
- [2] Dou Erxiang, Li Yongmei, Li Chang, *Education Innovation: the Model of Deep Growth*, Intellectual Property Publishing House, October 2018.