Managing R&D in Knowledge Economy--Dynamic and Portfolio incentive[*]

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Abstract: To improve the performance of R&D, the important issue of managing R&D is how to motivate the staff of R&D department. Based on dynamic and portfolio incentive, the paper builds the incentive model of system dynamics, and simulate through the different portfolio incentives and different stages of companies evolution. Authors suggest some new portfolio methods according to different period of career development and companies evolution. The paper also provides some suggestions about how to balance the portfolio incentive to improve the value of intellectual capital.

Keywords: monetary incentive, nonmonetary incentive, portfolio incentive

1. Model construction

In the science of economics and management: performance=F (competenc y, incentive), that is, an enterprise's performance is a function with competency and incentive. Supposing the competency is constant, if effective incentive mechanism is adopted, an enterprise's performance can be improved. Under this circumstance, the incentive mechanism is primarily to satisfy employees' needs and increase their utilities. Therefore, their working enthusiasms can be stirred up and the degree of their engagement in work can be increased. In the end, an organization's performance is improved. The incentive mechanism based on skill can improve employees' skill, that is to say, the incentive mechanism based on skill is according to the amount of skill employees have and the promotion of their skill to motivate employees. So it can motivate employees to be trained and strengthen their learning enthusiasm. Finally, employees' faculties are promoted greatly, which improve the organization's performance.

Figure 1 shows that the reasonable portfolio incentive of monetary incentive and nonmonetary incentive can satisfy employees' incentive utility, stir up their working enthusiasm and exploit their latent thoroughly. Therefore, an enterprise's performance can be improved; at the same time, with the improvement of an enterprise's

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performance, more monetary incentive and nonmonetary incentive will be adopted. On the other hand, the incentive system based on skill can encourage employees to learn and train themselves, which can improve their competency and then promote the enterprise's performance. The improvement of the enterprise's performance enables it to invest more money in the training programs in turn.
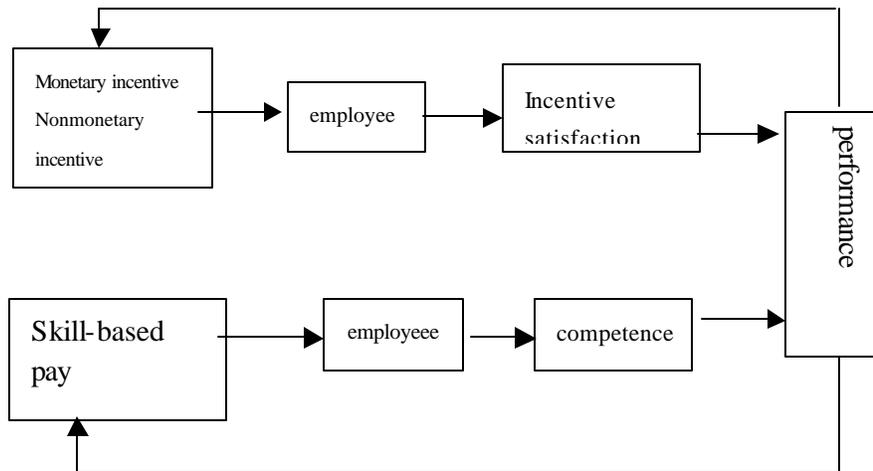

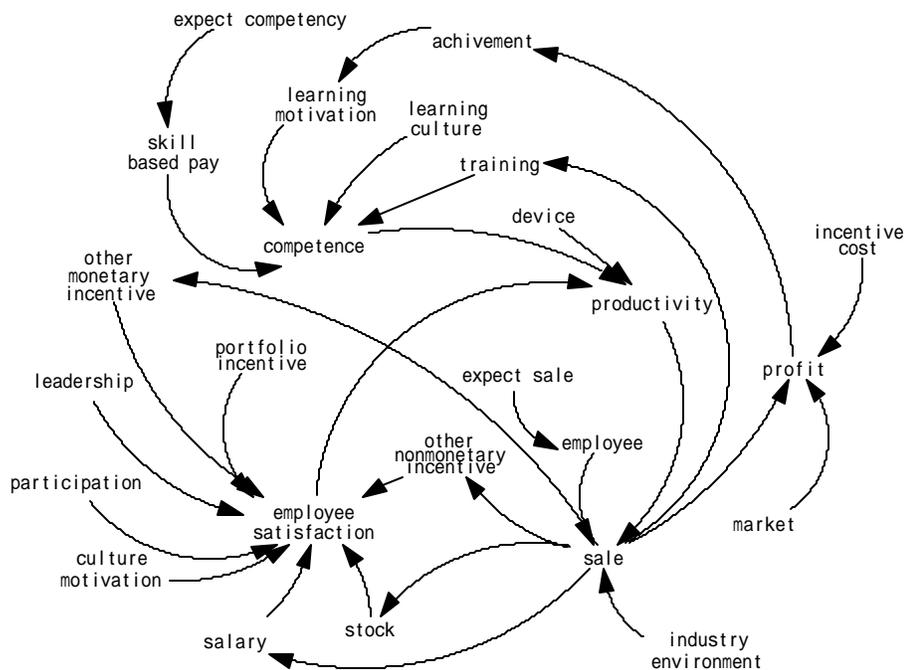Figure 1   the basic logical structure of model

Figure 2: cause-effect basic structure of portfolio incentive

2. Examination of the model's effectiveness

To simulate and analyze effectively, it is necessary to test the model's effectiveness and rationality, which is the necessary guarantee to keep the accordance between the model and the true action in the real system. The model's rationality is that the model's structure can embody perfectly the characters of the real system; the effectiveness is that the fitness between the model's action and the true action in the real system. The model's effectiveness determines its rationality, and a good model's structure is the premise to imitate action effectively. As to the model's rationality, the model's structure and its internal relations have been considered thoroughly during the construction of model. So, we will identify primarily the model's effectiveness in this section.

We use the data of a high-tech company (call it A company in the followings) in 1994 as the initial value for this imitation and four factors (sales profit productivity and the number of employees) as the parameters for this imitation. We compare the fitness between the simulation value and the true value, and then test the model's effectiveness.

According to the four indexes of A company (the sales profit productivity and the amount of employees) from 1994 to 2001, showed in the Table 1, and the comparison between the fitted value and the true value, we can see that the results of imitation are relative satisfactory, and the error of fitting is within 5% which can indicate that the simulation is good. Therefore, the model in this article is reliable and effective.

Table1　compare simulation value and true value　1994　2001

		1994	1995	1996	1997	1998	1999	2000	2001
Sale 0.1billion	true	15.5	28	43.2	49.5	59.4	74	77.14	83.99
	simulation	13.3	27.5	42.3	48.1	58.4	72.4	78.5	85.5
	Error( )	1.6	1.5	1.4	3.8	1.8	2.2	1.1	1.8
profit 0.1billion	true	0.61	3	3.1	4.5	3.3	3.99	3.78	2.07
	simulation	0.62	3.1	3	4.6	3.4	4.1	3.9	2.01
	Error( )	1.8	3.3	3.3	2.2	3.1	2.5	3	3
productivity million/p	true	82.4	115	143	178	203	228	255	288
	simulation	81.4	110	140	175	201	224	250	292
	Error( )	1.3	4.6	1.8	1.7	1.1	1.3	2	1.4
Number of employees	true	2373	2576	3020	2768	2926	3248	3024	2911
	simulation	2373	2555	2912	2725	2897	3200	3060	3005
	Error( )	0	1	3.6	1.6	2.4	1.5	1.3	3.2

3.Policy analysis of the model

3　1 The influence on an enterprise's performance resulted from the portfolio incentive mechanism of the monetary and nonmonetary incentive

When designing the incentive system, it is important for an enterprise to combine effectively the monetary and nonmonetary incentive. An enterprise should not emphasize too much on either of them, but should pay attention to the coordination between them. Only by this way, the good incentive effectiveness can be expected. Both monetary and nonmonetary incentives obey the law of diminishing marginal incentive utility, that is to say, when one incentive method is increased, its utility will diminish marginally. At this time, in order to reduce the incentive costs and increase the incentive utility, another incentive method should be adopted.

In addition, in the different stage of an enterprise's evolution, the manner of the portfolio incentive is also different, and there are dynamic games between the enterprise and its employees. Incentive certainly can stir up employees' enthusiasm and their engagement in working, which bring out the enterprise's good performance, but the incentive strength depends on the enterprise's performance. If the incentive intensity is too strong, it will affect an enterprise's further development. So an enterprise should combine effectively the monetary and nonmonetary incentive and then reach a bi-win situation between the enterprise and its employees.

This model scores based on estimating the importance and intensity of the concrete incentive means including monetary and nonmonetary incentive. We score 10 to the total intensity of the monetary and nonmonetary incentive, however, in the true results, the proportions between the monetary and nonmonetary incentive usually fall into between 3:7 and 7:3. Therefore, this model adopts primarily some proportions for our imitation such as 3:7 4:6 4.5:5.5 5:5 5.5:4.5 6:4 7:3. The results of imitation are as follows:

From the above analog output figure concerning the annual sales and annual profits, and table 2, we can see that the portfolio incentive of the monetary and nonmonetary incentive has different influence during the different stage of an enterprise's evolution, the concrete analysis are as follows:

At the stage of expansion

At the stage of 2001-2005, A company has accumulated certain amount of capital and technological capacity. Due to the fierce competition of market and china's entry into WTO, the process of economic globalization has speeded up, which force A company to expand its scale greatly. By analyzing the feasibility of the table 2, we can conclude that as for the portfolio incentive of the monetary and nonmonetary incentive in this stage, the proportions falling into 4-4.5:5.5-6 are relative good. That is, in this stage, enterprises should emphasize nonmonetary incentive more and the effectiveness of nonmonetary incentive is better than the simple promotion of monetary incentive. Because enterprises need to expand themselves in this stage, they should pay more attention to build its internal culture , present a good vision for their employees, offer employees more chances to communicate   learn and get be trained, provide employees more opportunities to develop their careers   attain and improve their technological ability, encourage employees to be involved in corporate management and increase their host-sprits, improve their leading styles, build the

outstanding corporate culture.

**At the stage of quick development**

In the stage of 2006-2010, A company has developed quickly and has possessed certain scale and relatively good performance. According to the above results of imitation and table 2, as for the portfolio incentive in this stage, the proportion is relative good when falling into 5-5.5:4.5-5. For example, at the proportion of 5.5:4.5, A company's sales reach 54.1 billion and its profits reach nearly 0.7 billion in 2010. In this stage, enterprises should pay more attention to the monetary incentive because enterprises' success is related closely to its employees' hard work. Through strengthening the intensity of monetary incentive properly, employees' human capitals can be embodied. So they can share the success of their companies and at the same time meet their feeling of achievement.

At the stage of mature

After the stages of the expansion and quick development, A company has accumulated strong financial capacity, its popularity has been enlarged, the quality of its products and service has been accepted in the market and its employees have got generous monetary returns. Therefore, since employees' monetary satisfactions have been met, they will ask new requirement to the nonmonetary incentive. Knowledge-workers consider their jobs not just as means for making a living, so they want to get more nonmonetary satisfactions from their jobs. The nonmonetary incentive is of high-level in this stage, because they emphasize the feeling of individual achievement, the contribution to their team or organization, and the repay for society.

The analog output figure above and table 2 show that the reasonable proportion should fall into 4.5-5:5-5.5 in this stage. For example, at the proportion of 4.5:5.5, A company's sales reach 70.6 billion and its profits reach nearly 0.8 billion.
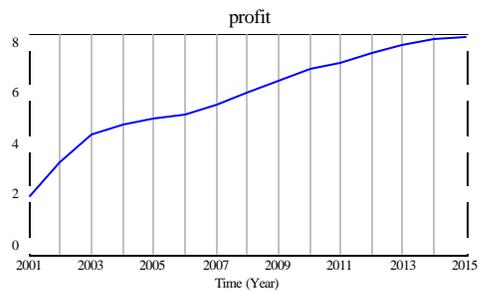
Monetary: nonmonetary 3 7
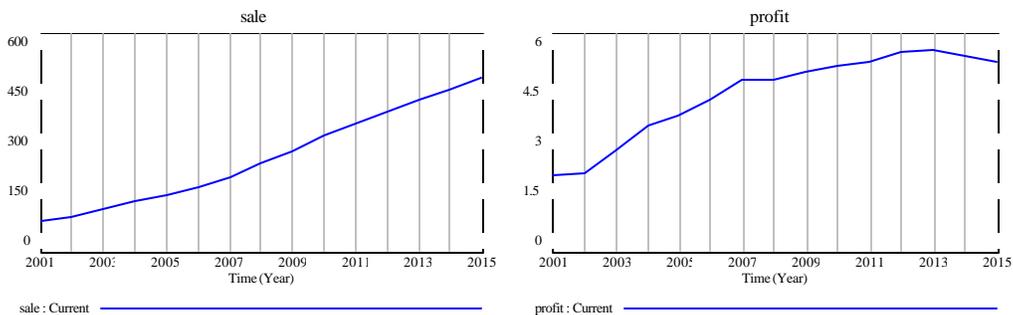
Monetary: nonmonetary   4   6
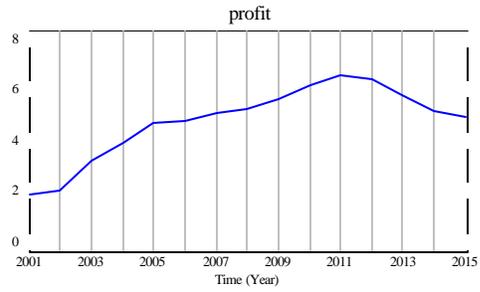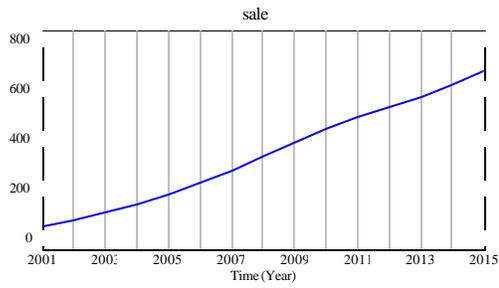
sale

sale : Current

profit

profit : Current

Monetary: nonmonetary   4.5   5.5
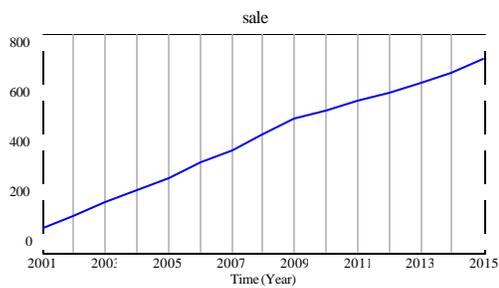
sale

sale : Current

profit

profit : Current

Monetary: nonmonetary   5   5
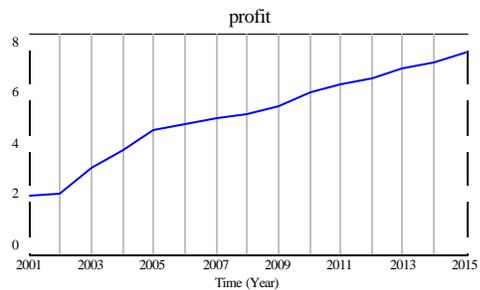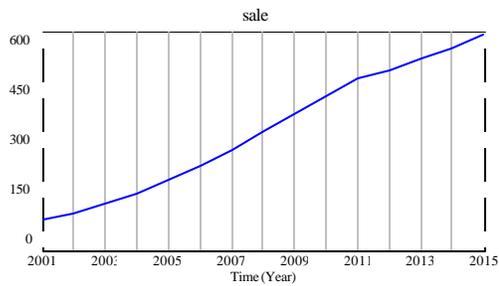
sale

sale : Current

profit

profit : Current

Monetary: nonmonetary   5.5   4.5

sale

sale : Current

profit

profit : Current

Monetary: nonmonetary   6   4

sale	profit
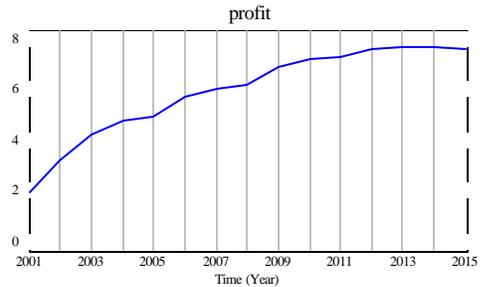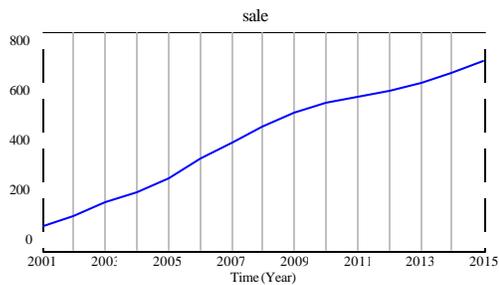
sale : Current   profit : Current

Monetary: nonmonetary   7   3

sale	profit

sale : Current   profit : Current
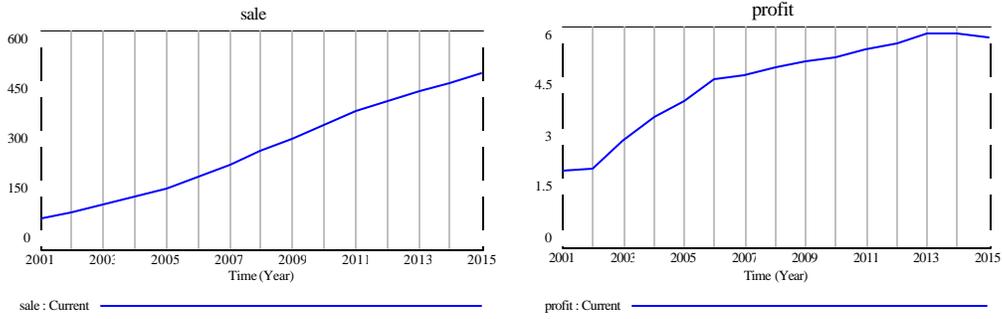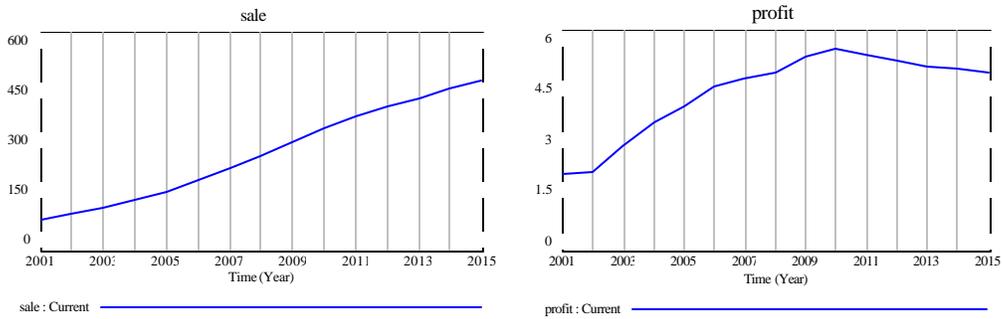
table 2   analysis about monetary and nonmonetary portfolio incentive

year / portfolio ratio		2001	2005	Feasibil-ity	2006	2010	Feasi-bi lity	2011	2015	Feasi-bi lity
3:7	sale	84	150.4	_	172.3	314.5	_	348	477	_
	profit	2.07	3.72		4.13	5.06		5.22	5.21	
4:6	sale	84	199	+	239	441	_	482	649	_
	profit	207	4.62		4.74	6.01		6.40	4.90	
4.5:5.5	sale	84	273	+++	324	490	_	552	706	+++
	profit	2.07	4.94		4.98	5.72		6.98	7.91	
5:5	sale	84	190	_	260	524	+	547	650	+
	profit	2.07	4.48		4.92	5.94		6.13	7.33	
5.5:4.5	sale	84	242	_	337	541	++	558	692	_
	profit	2.07	4.52		5.54	6.99		7.03	7.32	
6:4	sale	84	164	_	193	341	_	378	482	_
	profit	2.07	3.98		4.55	5.16		5.37	5.69	
7:3	sale	84	160	_	188	331	_	366	464	_
	profit	2.07	3.89		4.44	5.5		5.33	4.85	

3.2 The different portfolio incentive mechanism during the different period of employee's career development

In the front chapters, we have analyzed the dynamics of the incentive combination. Knowledge-workers' requirements for monetary and nonmonetary incentives are variable with the different period of career development. In order to analyze the effective incentive means for the knowledge-workers in the different period of career development, we select three types of representative employees: fresh employees(who has worked for less than two years) general growth-employees and key employees. Fresh employees who graduated from school shortly are in the period of socialization; general growth-employees, who have gone through the stage of socialization, are at the stage of learning and being trained continuously, so they are in the growth-period of their careers; key employees, who have gone through the growth-stage and have become the key employees in their organizations, are in the mature period of their career. The model analyze primarily how to adopt effectively the portfolio incentive to these three types of employees who are at the different stage of career development, and then reach the aim of the incentive mechanism. It is the key employee's analog output figure of the portfolio incentive below:

Key employees are at the mature stage of their careers. From the analog output figure and table 2, we can see that the reasonable proportion of portfolio incentive for key employee fall into 4.5:5.5, followed by 4:6. As far as these employees concerned, after having gotten certain monetary incentive, they pay more attention to individual achievement, corporate culture and their involvements in corporate management; they hope they can do more contribution for their companies and can be accepted by their companies and colleagues. Considering the key employees of knowledge-workers, enterprises should give them more trust and working freedom; only by this way, their working enthusiasm can be motivated and their enterprises' performance can be improved.

As to the fresh employees who are in the period of their socialization, so they wish to be accepted by their seniors and their colleagues, and try to adjust themselves to the new circumstance. It is the beginning of their career. In this period, considering the feasibility of the analog results of the portfolio incentive, the proportions are relative good when falling into 4.5-5:5-5.5. As to the fresh employees' preference between the monetary and nonmonetary incentive, they incline slightly more to the nonmonetary incentive, but their needs for the monetary incentive are still very strong.

As for the general growth-employee, they have gone through the period of socialization. According to the analog output table 5, the reasonable proportions of the portfolio incentive should fall into 5-6:4-5. We also conclude that the general growth-employees pay more attention to the monetary incentive. So enterprises should stress monetary incentive for them and provide them stable working and living environment, which can make them work comfortably.

Table 3　analysis about monetary and non monetary portfolio incentive for key employee

portfolio ratio year		2001	2010	2015	
3:7	sale	83.99	365.5	519	_
	profit	2.07	5.34	4.8	
4:6	sale	83.99	483	629	+ +
	profit	2.07	5.8	6.54	
4.5:5.5	sale	83.99	560	729	+ + +
	profit	2.07	5.90	7.45	
5:5	sale	83.99	460	620	+
	profit	2.07	5.5	6.0	
5.5:4.5	sale	83.99	420	580	_
	profit	2.07	5.2	4.8	
6:4	sale	83.99	378	538	_
	profit	2.07	5.27	4.72	
7:3	sale	83.99	277	386	_
	profit	2.07	4.97	4.3	

Table 4:analysis about monetary and nonmonetary portfolio incentive for new employee

portfolio ratio year		2001	2010	2015	
3:7	sale	83.99	334	459	_
	profit	2.07	5.10	4.6	
4:6	sale	83.99	424	529	_
	profit	2.07	4.9	5.64	
4.5:5.5	sale	83.99	522	687	+ +
	profit	2.07	5.5	6.65	
5:5	sale	83.99	445	582	+
	profit	2.07	5.1	5.8	
5.5:4.5	sale	83.99	380	530	_
	profit	2.07	5.1	4.7	
6:4	sale	83.99	378	513	_
	profit	2.07	5.07	4.62	
7:3	sale	83.99	270	384	_
	profit	2.07	4.87	4.1	

Table 5: analysis about monetary and non monetary portfolio incentive for genaral employee

portfolio ratio year		2001	2010	2015	
3:7	sale	83.99	343	468	_
	profit	2.07	5.20	4.7	
4:6	sale	83.99	453	545	_
	profit	2.07	4.98	5.74	
4.5:5.5	sale	83.99	477	579	_
	profit	2.07	5.2	6.15	
5:5	sale	83.99	545	642	+
	profit	2.07	5.5	6.51	
5.5:4.5	sale	83.99	580	702	+ +
	profit	2.07	5.87	7.17	
6:4	sale	83.99	578	667	+
	profit	2.07	5.47	6.62	
7:3	sale	83.99	370	584	_
	profit	2.07	4.87	4.5	

4 Conclusion

According to the analog results, during the different stage of

knowledge -workers' career development, their demands are variable. So enterprises should adopt the portfolio incentive mechanism which can meet the demands of knowledge -workers. In the period of socialization, employees are sensitive to both the monetary and nonmonetary incentive, but incline slightly more to the nonmonetary incentive; in the period of growth, employees prefer the monetary incentive; however, as to the employees in the mature period, after having gotten certain monetary incentive, they begin to pursue the new nonmonetary incentive which usually is of higher level, so they pursue the feeling of individual achievement; take part in the corporate management and pursue individual contribution. Therefore, when designing an incentive system, enterprises should pay attention to dynamics of incentive system and consider the different stage of employees' career development, and then adopt different portfolio incentive means. Only by this way, perfect incentive effectiveness and the aim to improve the enterprise's performance can be reached.

An enterprise's incentive system is a dynamic complicated and nonlinear system . This article uses the method of system dynamic to build a portfolio incentive model of system dynamic. According to the different stage of employees' career development and companies' evolution, we carry out system simulation based on the dynamic of the portfolio incentive of monetary and nonmonetary incentive.

Enterprises should adopt different methods of portfolio incentive in the different stage of their evolution. At the stage of expansion, the better proportions between the monetary and nonmonetary incentive should fall into 45:5-6; at the stage of quick development, it should fall into 5-5.5:4.5-5; and then at the stage of mature, it should fall into 4.5-5:5-5.5. At the different stage of employees' career development, the portfolio incentive of monetary and nonmonetary incentive is also dynamical In the beginning of career (the period of socialization), the suitable proportion between the monetary and nonmonetary incentive should fall into 4.5:5.5; 5-6:4-5; in the period of growth, it should fall into 5-6:4-5; and the proportions falling into 4.5-5:5-5.5 are relative good in the period of mature.

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