System Dynamics Modeling of Manpower Forecasts and Programming

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Abstract: With Delphi Expert Prediction and mathematical model, forecasting has been made in the paper for the professional technician demand and its reasonable composition of certain sizeable state enterprise in the future fifteen years. On base of forecas ting, the dynamic model of the professional technician planning was constructed with method of System Dynamics. The model has been applied to analyze the enterprise's manpower policies and simulation result has been given for the reasonable policy to manpower exploitation.

Keywords: manpower forecast & programming, system Dynamics, model -analyze, simulation

1 Introduction

Manpower forecasting is one kind of applied science. It can be used to study the quantity, quality, structure and law of future society in some certain developing period. Based on manpower forecasting and economic & scientific developing demand, manpower planning is applied to confirm developing manpower target, scientifically select and make the policies, approaches and methods to ensure the manpower supplying, optimizing and employing, then satisfy the future demand through ensuring the quantity and quality of manpower.

The principle of manpower forecast & programming can be expressed by the manpower balance equation. Denote t_0 as the current year, t the forecasting year, Y(t) the manpower number, $\bar{Y}(t)$ the manpower number of forecasting year, $Y_s(t_0 \to t)$ the transferring manpower number from t_0 year to t year, $\Delta Y(t_0 \to t)$ the supplying number that keep the manpower balanced from the t_0 year to t year. Based above, we can construct the manpower balance equation:

$$\bar{Y}(t) = Y(t) \qquad 1$$

owe to $Y(t) = \Delta Y(t_0 \to t) + Y_s(t_0 \to t)$,

then $\Delta Y(t_0 \to t) = \bar{Y}(t) - Y_s(t_0 \to t)$ 2

We also denote $X(t)$ as the variable factor which affect the manpower demand & supply. Then we can give the equation (3)

$$\bar{Y}(t) = F[X(t), t] \qquad 3$$

Equation 1 is the manpower balance equation, 2 the manpower programming equation, 3 the manpower forecasting equation. The essential of manpower forecasting is the answer of equation 3 , the essential of manpower programming the answer of equation 2 and the

decomposing & arranging of $\Delta Y(t_0 \to t)$. The aim of manpower forecast & programming can be get through equation 1, and the aim is to balance the manpower demand & supply.

2 Analysis of manpower demand forecasting

2 1 Analysis of the total manpower demand

Based on the theoretic analysis and practical investigation, we use the mathematical model to forecast the impact factors of the enterprise manpower demand. We get the main factors: technical level of the enterprise, the output ratio of labor-capital, size of the enterprise, the work force and the capital input, etc..

(1) The effect of enterprise technical level

According to the economic definition, the production level of an enterprise is the ratio of output to input. Denote A_t as the technical level of t year in a enterprise, Y_t the production of t year, K_t the capital input of t year, L_t the labor input of t year, we could get the technical level equation A_t: $A_t = Y_t / f(K_t, L_t)$. In the equation, f means a kind of function relationship.

We can analyze the relationship of technical level and the manpower number: At the beginning of advancement of production technology, because of the new emerging technology and facilities, the worker should be provided with higher laboring technology. When the automatization becomes more advancer, more and more kinds of work will be simple and will not need complicated laboring technology.

(2) The effect of output ratio of labor-capital

The output ratio of labor-capital of an enterprise equals the product of the production output ratio and the capital output ratio. It can be shown as:

$$G_t = (Y_t / L_t) \times (Y_t / K_t)$$

In the equation, G_t is the output ratio of labor-capital of t year, Y_t the production of t year, K_t the capital input of t year, L_t the labor input of t year. The index, output ratio of labor-capital, can reflect the technical level of an enterprise and it will show the same law of the effect of manpower demand as the effect of technical level.

(3) The effect of enterprise size

According to the economic viewpoint, in the circumstance of changeless technical level, an enterprise could broaden its size mainly depending on adding the production facilities. Then the enterprise must enlist more technicians. At last, along with the broadening size, the enterprise will need more and more manpower.

(4) The effect of the work force

In the circumstance of changeless technical level, there is a certain percent of the number of professional technician in the work force. So when the work force is increasing, the number of the

technician will also increase.

(5) The effect of the capital input

An enterprise input can be divided into labor input and capital input. The capital input must be suited with the labor input. The capital input is divided into fixed and flowing capital. The increase of fixed capital input can improve the configuring or the facilities number of an enterprise, so it also makes the enterprise enlist more manpower.

Based on the above analysis, we can select the indexes, technical level A_t, the output ratio of labor–capital G_t, the enterprise size Y_t, the work force L_t and the capital input K_t, as the independent variables which are used to found the mathematical model of forecasting the total technician demand. The total professional technician E_t is the forecasting variable. In the variables, the technical level A_t can be obtained through the following method:

We suppose that the technical level of an enterprise will increase along with t and the changing trend is exponential. So $A_t = A_0 e^{lt}$.

In the equation, A_0 is the technical level of the first year, l is the coefficient of the technical progress. We put the above equation into the increasing type of production function, then:

$$Y_t = A_t f(K_t, L_t) = A_0 e^{lt} f(K_t, L_t) = A_0 e^{lt} K_t^a L_t^b$$

And change it into logarithmic form: $\ln Y_t = \ln A_0 + lt + a \ln K_t + b \ln L_t$

We can use linear regression to get A_0 and l , then we will get the technical level of the enterprise.

When we select appropriate variables and get the corresponding data, we can construct two linear regression models and a model of productive function.

The linear model which variables are technical level A_t and the enterprise size Y_t is:

$E_t = 0.081 + 0.003 Y_t + 0.038 A_t$ model 1

Model 1 can pass F test (the level of significance: 0.01), the multiple correlation coefficient is 0.94. The data indicate that E_t and Y_t A_t are significantly linearly correlated. The remainder standard error of the model is 0.16

The linear model which variables are output ratio of labor–capital G_t and the enterprise size Y_t is:

$E_t = 0.794 - 0.123 G_t + 0.0157 Y_t$ model 2

Model 2 could pass F test (the level of significance: 0.01), the multiple correlation coefficient is 0.98. That indicate E_t and G_t A_t are significantly linearly correlated. The remainder standard error of the model is 0.09.

The form of the productive function is: $Y_t = c\, K_t^a L_t^b E_t^g$; we can change it into logarithmic form: $\ln Y_t = \ln c + \ln a \ln K_t + b \ln L_t + g \ln E_t$

After dealing with the two equations through linear regression, we can get the model of the productive function: $\ln Y_t = 1.90 + 0.506 \ln K_t - 0.260 \ln L_t + 0.295 \ln E_t$

Model 3 passes the F test (the level of significance: 0.01), the multiple correlation coefficient is 0.97. The remainder standard error of the model is 0.19.

2.2 The reasonable composition forecasting of manpower demand

Because of the diversity and complexity of the impact factors that affect reasonable composition forecasting of manpower demand, especially there is much influence of the non-quantitative factors, it is difficult to use the Delphi Expert Prediction to forecast the composition through constructing effective mathematical model. The principles of the method are put the inside of the enterprise first and put the outside of the enterprise secondly, let the minority first and the numerous secondly. After commending each other and the agreement of the person himself, we select 29 prediction experts (including the managers of manpower, technical experts and the leaders of administration). The selection of forecasting aim–method: we use the method of multi-round feedbacks, analyze the reason and give the improving steps. Table 1 is the forecasting result:

Table 1. forecasting results of reasonable composition of manpower predicated by expert

From Table 1, we can see that the forecasting result of specialty composition get by experts is: research :engineering economics teacher& physician politico assistant=1 7.5 3.1 2.3 1 0.5, now the ratio is 1 15 5.6 6.3 2.7 1. The total structure is reasonable basically. The main problem is the less percent of researcher and it will affect the capacity of technological innovation and the enterprise long-term development. The forecasting result of professional title composition of professional technician is: the senior the minor the junior=1 3.8 5.4, now the ratio is 1

The indexes of manpower composition	Forecasting result	Now
Specialty composition Research: project: research :engineering economics teacher& physician politico assistant	1 7.5 3.1 2.3 1 0.5	1 15 5.6 6.3 2.7 1
P:rofessional title compositioin the senior : the minor : the junior	1 3.8 5.4	1 4.2 7.2
Educational level composition master : bachelor :junior college under technical secondary school	1 20 15 5	1 45 45 50
Age structure agedness : middle age : youth	1 2 3	1 1 2.3

4.2 7.2. It means that the enterprise needs to improve the percent of the minor and the senior. The forecasting result of educational level composition get by experts is: master : bachelor : : under technical secondary school=1 20 15 5, now the ratio is 1 45 45 50.

The methods of optimizing the technician composition given by experts are: (1) Strengthen the manpower cultivating, especially the cultivating of the professional and multidiscipline manpower. (2) Adjust the manpower composition, lessen the overmuch professional, encourage the reasonable fluxion of manpower. (3) Make the program of manpower-indraught, incept the master rationally, especially the manpower with higher educational level or higher level. (4) Strengthen the management of assessment & engagement of the technician, enhance the degree of rewards & punishment; let everyone do the work that fit his ability. (5) Reform the promoting policy of professional title assess and engage manpower scientifically and strengthen the diaphaneity, develop the method of assessment & engagement. (6) Strengthen the cultivating of middle age & youth manpower, encourage the employees to heighten their education level through sparetime study.

3 The SD model of manpower forecast & programming

How to dynamically and rationally detail the certain, static and indirect total target into the program of every year based on the enterprise development? The System Dynamics is used to research the feedback of multi-information in the social and economic field and it is a theory and method of non-linear complicated system simulated by computer-simulation. Because of it fitting the manpower system and satisfying well the need of manpower programming, we choose the SD model to construct programming model of the enterprise. The total structure of the model is divided into five associated subsystems: the total number subsystem, the subsystem of professional title composition, the subsystem of educational composition, the subsystem of age structure and the subsystem of specialty composition.

3.1 The subsystem of total number

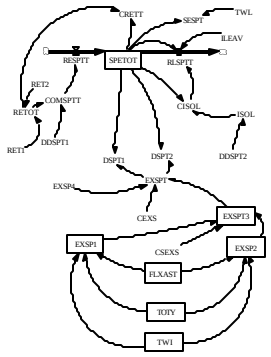


Figure 1. the flow chart of total number subsystem

The main equations on programming of the total manpower number are as follows:

L SPETOT.K= SPETOT.J+ DT RESPTT.JK-RLSPTT.JK

R RESPTT.KL=COMSPT.K

A COMSPT.K=MAX DDSPT1.K RETOT.K

R RLSPTT.KL= RETOT.K+ILEAV* SPETOT.K+ISOL.K

A ISOL.K= DDSPT2.K* 1-STEP 1 5

The total professional technician (SPETOT) depends on the ratio of total entrance number of the professional technician (RESPTT) and the ratio of total leaving number of the professional technician (RLSPTT). The RESPTT is equal to the complement ratio of the professional technician (COMSPT) and it depends on the expectative value of total professional technician, viz. the forecasting difference between total demand and total retirement ratio (RETOT). RLSPTT depends on three variables: the total retirement ratio, abnormal leaving ratio and the diffluent number of professional technician. Meanwhile, the diffluent number of professional technician depends on the superfluous number of them.

3.1.1 Analysis of complementary policy of the total manpower

The main control equations on variable of complementary policy of total manpower (RESPTT) are:

R RESPTT.KL= COMSPT.K

A COMSPT.K= MAX DDSPT1.K RETOT.K

A DDSPT1.K=SMOOTH DSPT1.K TDSPT1

A DSPT1.K= MAX EXSPT.K SPETOT.K

The control mechanism of the function is: complement for total manpower means filling the gap between expectative total manpower (EXSPT) and existed total manpower in system (SPETOT). When the gap is small, the policy is executed according to the number of retirement.

3.1.2 Diffluent policy of the total manpower

The main control equations on policy variable of the total manpower are:

A ISOL.K= DDSPT2.K* 1-STEP 1 5

A DDSPT2.K= SMOOTH DSPT2.K TDSPT2

A DSPT2.K= MAX SPETOT.K- EXSPT.K 0

The control mechanism of the function is: the diffluent number is controlled by the positive feedback of the superfluous number of professional technician. The superfluous number equals the difference between SPETOT and EXSPT. The come off sentry duty control will be finished in 5 years (realized by STEP function).

3.1.3 Transferring policy analysis of manpower

Adaptation and optimization of the model on specialty composition are realized by three policy parameters: first, supplement professional manpower in need according to supplementary policy; second, attain come off sentry duty of superfluous professional manpower through executing diffluent policy; third, adapt specialty composition according to reciprocal manpower transfer within system, i.e. manpower transferring policy. Diffluent policy and complementary policy are adapted by exchange with outer environment, but transferring policy is self-adapted within system.

Transferring policy is divided into two parts as transferring-in one and transferring-out one. The main control equations on transferring-in policy (TRTOEN) are:

A TRTOEN.K=TRREEN.K+TREDEN.K+TRECEN.K
+TRPOEN.K+TRSUEN.K

A TRREEN.K=SWTRAN*CTREEN.K*TRREOP.K

A CTREEN.K=SWREEN*DDENT1.K/CCC3.K

A CCC3.K=SEREEN* DDENT1.K+SWREED*DDEDU1.K
+SWREEC*DDECO1.K+SWREPO*DDPOL1.K
+SWRESV*DDSUB1.K

(Control equations on transferring-in policy of TREDEN TRECEN TRPOEN TRSUEN are the same with that of TRTOEN 's.)

DDENT1 DDEDU1 DDECO1 is the absent professional number after it being smoothed. SWREEN SWREED SWREEC SWREPO SWRESV is the switch of manpower transferring. When transfer can be attained, the value is "1", or is "0". The control mechanism is: TRTOEN is positively feedback to the product between transferring coefficient of the specialty and the total transferring-out number of the specialty, and the transferring coefficient is the proportion of professional number in need in total number of transferable professionals

The main control equations on TRENOP are:

TRENOP.K=SWTRAN*DDENT2.K

A TRENRE.K= SWTRAN*CTENRE.K*TRENOP.K

A CTENRE.K= SWENRE*DDRES1 /CCC2.K

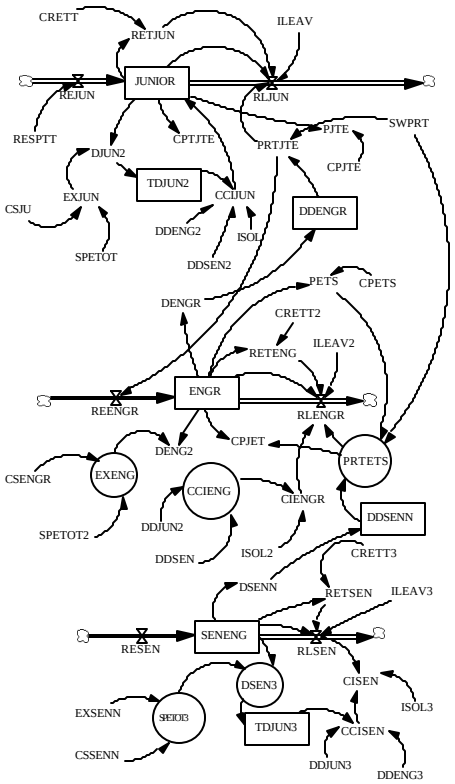
A CCC2.K= SWENRE* DDRES1.K+SWENED*DDEDU1.K
+SWENEC*DDECO1.K+SWENPO*DDPOL1.K
+SWENSV*DDSUB1.K

(The transferring-out control equations of TREDEN TRECEN TRPOEN TRSUEN are the same with that of TRTOEN 's.)

As we can see, the control mechanism is: TRENOP is positively feedback to DDENT2, and the transferring manpower number depends on transferring coefficient. The coefficient is the proportion of professional number in need in total transferable professionals .

3.2 The subsystem of professional title composition

The subsystem of professional title can be divided into three lower subsystems: the junior, the minor and the senior. The flow chart of its structure is as follows:



(Figure 2: the subsystem of professional title composition)

The main control equations on the junior subsystem are:

L JIUNIOR.K=JUNIOR.J+ DT * REJUN.JK-RLJUN.JK

R REJUN.KL=RESPPTT.KL

R RLJUN.KL=PRTJTE.K+RETJUN.K+CIJUN.K

The total professional technician of junior professional title (JIUNIOR) depends on the entrance ratio of the professional technician of junior professional title (REJUN) and the leaving ratio of the professional technician of junior professional title (RLJUN). The entrance ratio of the professional technician of the junior professional title equals the entrance ratio of total manpower). The leaving ratio depends on three variables: the promoting number from the junior to the minor (PRTJTE), the retirement ratio of the junior manpower (RETJUN) and the diffluent number of the professional technician of junior professional title (CIJUN).

The main control equations on the minor subsystem are:

L ENGR.K=ENGR.J+ DT * REENGR.JK-RLENGR.JK

R REENGR.KL=PRTTJTE.K

R RLENGR.KL=PRTETS.K+RETENG..K+CIENGR.K

The total professional technician of minor professional title (ENGR) depends on the entrance ratio of the professional technician of minor professional title (REENGR) and the leaving ratio of the professional technician of junior professional title (RLENGR). The entrance number of the professional technician of minor professional title equals the promoting number from the junior to the minor (PRTTJTE). The leaving ratio also depends on three variables: the promoting number from the minor to the senior (PRTETS), the retirement number of the minor manpower (RETENG)

and the diffluent number of the professional technician of minor professional title.

The main control equations on the senior subsystem are:

L SENENG.K=SENENG.J+ DT * RESEN.JK-RLSEN.JK

R RESEN.KL=PRTETS.K

R RLSEN.KL=RETSEN.K+CISEN.K

The total professional technician of senior professional title (SENENG) depends on the entrance ratio of the professional technician of senior professional title (RESEN) and the leaving ratio of the professional technician of senior professional title (RLSEN). The entrance number of the professional technician of senior professional title equals the promoting number from the minor to the senior (PRTETS). The leaving ratio depends on two variables: the retirement number of the senior manpower (RETSEN) and the diffluent number of the professional technician of the senior professional title.

3.3 The subsystem of the educational level composition

The subsystem of the educational level composition can be divided into four lower subsystems::under technical secondary school :junior college, the bachelor subsystem and the master subsystem. Their compositions are similar. Then we only explain one of them as an example: the bachelor subsystem.

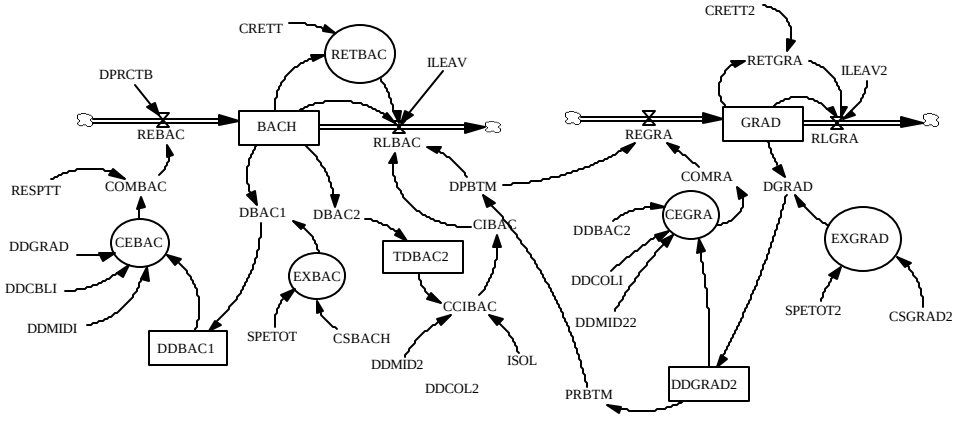
The main control equations on the bachelor subsystem are:

L BACH.K=BACH.J+ DT * REBAC.JK-RLBAC.JK

R REBAC.KL=COMBAC.K+DPRCTB.K

R RLBAC.KL=DPRBTM.K+RETBAC.K+CIBACH.K

Total bachelor number in technician depends on the entrance ratio of the bachelor manpower and the leaving ratio of the undergraduate number. The entrance number of the undergraduate manpower equals the complementary number of the undergraduate (COMBAC) and the promoting number from the to the bachelor (DPRCTB). The leaving ratio depends on three variables: the promoting number from bachelor to master (DPRBTM), the retirement number of bachelor (RETBAC) and the diffluent number of the undergraduate (CIBACH).



(Figure 3. the flow chart of the subsystem of educational level composition)

3.4 The subsystem of age structure

The subsystem of age structure can be divided into 7 lower subsystems: under 30, 31-35, 36-40, 41-45, 46-50, 51-55, 56 and above. Their structures are same to each other. We give an example, 31-35 subsystem, to explain them.

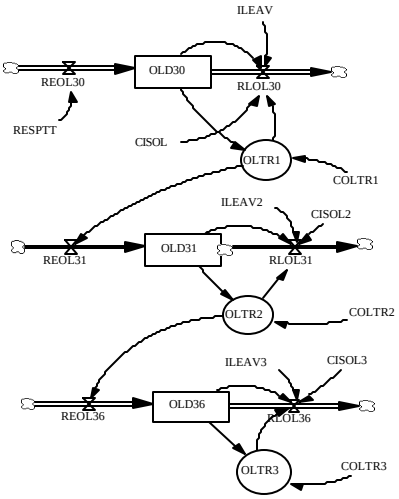
The main control equations on 31-35 subsystem are:

L OLD31.K=OLD31.J+ DT * REOL31.JK-RLOL31.JK

R REOL31.KL=OLTR1.K

R RLOL31.KL=OLTR2.K+CIOL31.K

The number of professional technician in 31-35 subsystem (OLD31) depends on the entrance and leaving ratio of this age period (i.e. REOL31 and RLOL31). Meanwhile, the entrance ratio of this age period equals the transferring-in number (OLTR1), and the leaving ratio equals the transferring-out number from this age period (OLTR2) and the diffluent number of this age period in every year (CIOL31).



(Figure 4. the flow chart of the age structure subsystem)

3.5 The subsystem of specialty composition

The subsystem of specialty composition is consisted of engineering, researcher, research :engineering economics teacher& physician politico assistant subsystems. Their structures are same as each other's. We choose the most representative subsystem, engineering subsystem, to give reader an explanation:

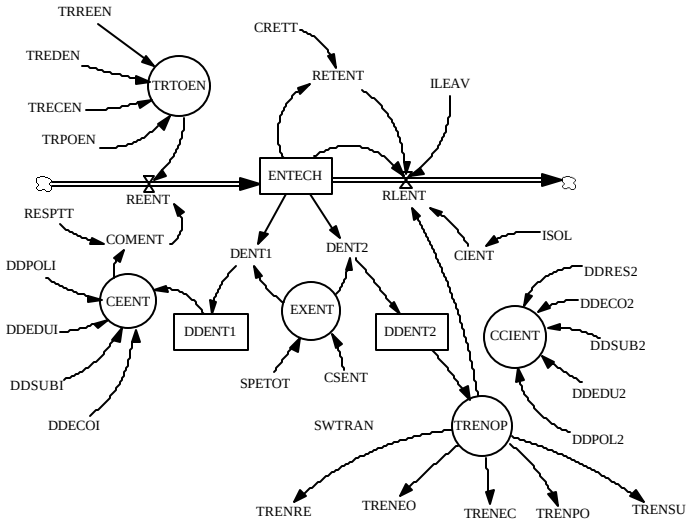
The main control equations on the engineering subsystem are:

L ENTECH.K=ENTCH.J+ DT * REENT.JK-RLENT.JK

R REENT.KL=COMENT.K+TRTOEN.K

R RLENT.KL=TRENOP.K+RETENT.K+CIENT.K

The total engineering technician (ENTECH) depends on the entrance ratio of the engineering technician and the leaving ratio. The entrance number of the engineering technician equals the total complementary number of engineering and the transferring-in number from other specialty (TRTOEN). The leaving ratio depends on three variables: the leaving number from this specialty every year (TRENOP), the retirement number of bachelor (RETENT) and the diffluent number of technician in this specialty.



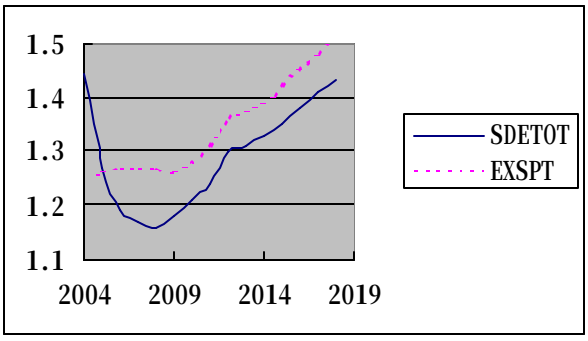
(Figure 5. The flow chart of the specialty composition subsystem)

4 Simulation result and analysis

When we choose the certain manpower policy, we can obtain the simulation result of every state variable (i.e. the horizontal variables and the structural coefficients as the programming target) through using simulating system to adjust actions.

(Table 2. The simulation result of the model of total manpower number)

year the number of person variable	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SDETOT per ten thousand person	1.44	1.27	1.19	1.17	1.16	1.18	1.21	1.24	1.30	1.31	1.33	1.35	1.38	1.41	1.43
EXSPT per ten thousand person	1.25	1.26	1.27	1.27	1.27	1.26	1.28	1.31	1.36	1.37	1.39	1.42	1.45	1.48	1.51



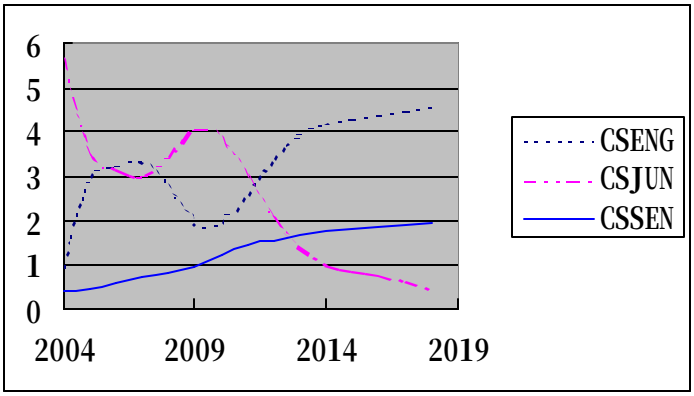
(Figure 6. Simulation graph of the model of total manpower number)

From Table 2, we can see that the difference between the manpower possession and the

demand is 0.07 ten thousand persons in the enterprise. The results might be caused by the policy delay of the model. The trend of the curves seems that the SDETOT and the EXSPT are parallel curves with little interval and both of them ascend steadily after the primary adjustment of program. That means the enterprise is not saturated appreciably in the programming period. But the non-saturation could be eliminated through a little adjustment when the enterprise executes the policies.

year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
percent variable															
CSENG	32.97	35.01	35.23	35.32	34.75	33.95	33.92	35.08	35.36	35.92	36.20	36.31	36.38	36.46	36.36
CSJUN	58.60	56.46	56.17	55.98	56.44	57.06	56.86	56.00	55.01	54.39	54.03	53.86	54.74	53.62	53.69
CSSEN	8.43	8.46	8.60	8.70	8.81	8.99	9.22	9.42	9.57	9.69	9.77	9.83	9.88	9.92	9.95

(Table 3. Simulation result of the model of professional title composition)

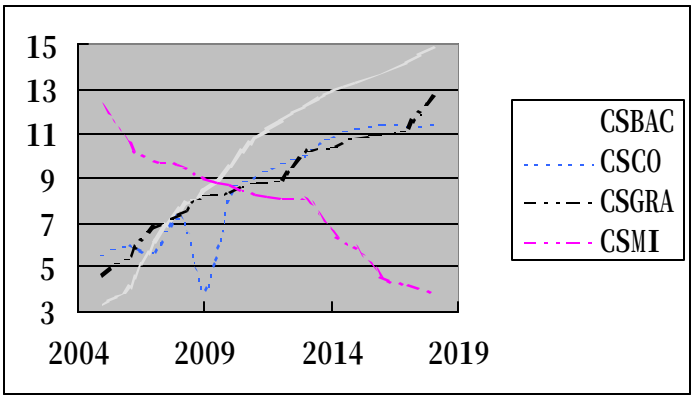


(Figure 7. Simulation graph of the model of professional title composition)

The simulation result in Table 3 shows that the ratio of specialty composition at the end of programming period of the enterprise is: the senior : the minor : the junior=9.95 36.36 53.69. The result is similar with the forecasting reasonable result (the programming aim), 1 3.8 5.4. The simulation curves show that after the adjustment of the primary program period, the ratio of the senior and the minor ascends steadily and it approaches the reasonable ratio gradually, but the junior ratio is descending to the reasonable ratio. That trend is accordant with the aim of the adjustment.

(Table 4. Simulation result of the model of educational level composition)

year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
percent variable															
CSBAC	34.31	36.34	38.12	40.10	41.55	42.41	43.54	44.77	45.60	46.23	46.98	47.29	47.70	48.20	48.82
CSCO	31.21	33.61	34.03	33.60	33.86	34.63	35.01	35.12	35.48	35.85	35.95	36.44	36.75	36.82	36.76
CSGRA	0.96	1.16	1.39	1.62	1.75	1.83	1.94	2.05	2.11	2.16	2.23	2.26	2.28	2.39	2.47
CSMI	33.52	28.90	26.46	24.69	22.83	21.13	19.51	18.06	16.82	15.77	14.87	14.01	13.27	12.58	11.95

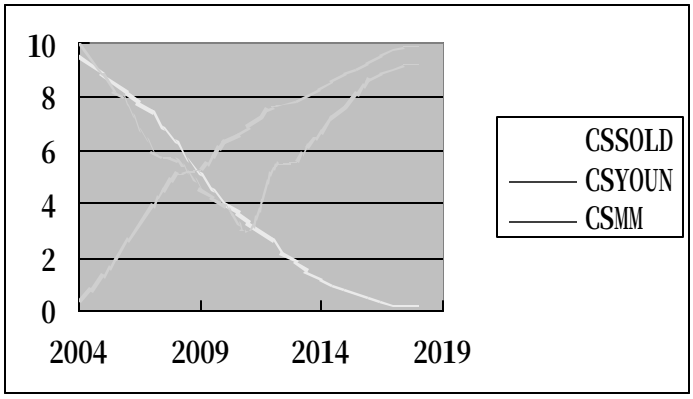


(Figure 8. Simulation graph of the model of educational level composition)

From the simulation result of Table 4, we can know that at the end of the programming period, the ratio of educational level composition of the professional technician in the enterprise is: the master : the bachelor : the undergraduate : under technical secondary school =2.47 48.82 36.76 11.95. The reasonable ratio of the program is 1 20 15 5. The two ratios are similar too. From the simulation curves, we also can see that all the structure coefficients are smoothly approaching the reasonable composition except the primary shake of the undergraduate curve. The ratios of the master, the bachelor and the undergraduate are ascending gradually, while the ratio of technical is descending by year. The trend is according with the adjusting aim of educational level composition.

(Table 5. Simulation result of the model of age structure)

year percent variable	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CSSOLD	27.60	26.80	26.19	25.41	24.28	23.08	22.02	21.30	20.61	19.83	19.21	18.83	18.46	18.20	18.20
CSYOUN	49.13	48.66	48.32	47.67	47.93	48.51	49.04	49.36	49.60	49.83	49.93	49.90	49.86	49.79	49.57
CSMM	23.27	24.51	25.85	27.02	27.79	29.39	28.96	29.35	29.80	30.34	30.86	31.27	31.67	32.01	32.23



(Table 5. Simulation result of the model of age structure)

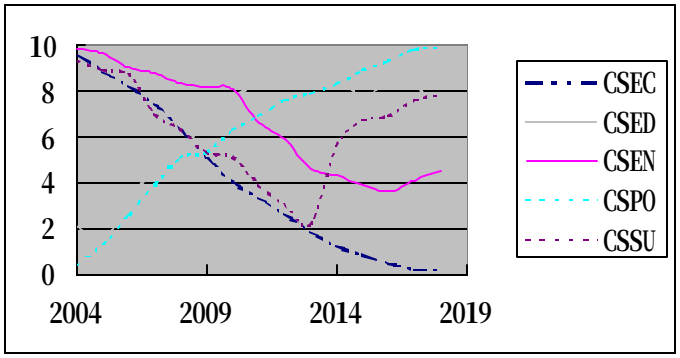
The simulation result of Table 5 shows that the ratio of age structure of the professional technician in the enterprise at the end of programming period is: the aged : the middle age : the youth=18.20 32.23 49.57, it is similar with the reasonable composition: 1 2 3. The simulation

curves show that the percent of youth manpower is 47%~50% and it fluctuates with lesser swing. We think that the main reason is the impact of the manpower complementary policy. The percent

year / percent variable	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CSEC	21.92	21.85	20.22	19.44	19.33	19.25	19.50	19.98	20.04	19.85	19.88	20.00	19.92	19.98	19.92
CSED	9.72	7.87	8.88	10.25	11.86	14.79	16.02	15.75	15.02	14.71	15.05	15.08	14.89	15.03	14.95
CSEN	53.69	52.39	51.63	51.95	51.33	48.86	48.12	49.08	48.71	49.08	48.71	48.82	49.02	48.70	49.07
CSPO	4.05	3.59	4.34	4.98	5.54	6.37	6.69	6.60	6.37	6.43	6.40	6.36	6.42	6.41	6.36
CSRE	7.45	10.98	11.66	10.13	8.68	7.53	6.45	6.11	6.49	6.79	6.69	9.66	6.51	6.63	6.51
CSSU	3.38	3.24	3.09	3.03	3.03	3.00	3.02	3.08	3.10	3.09	3.09	3.09	3.10	3.09	3.09

of the aged people decreases steadily and it approaches the reasonable ratio, the percent of the middle age people increases and it also approaches the reasonable ratio. The situation is according with the adjusting aim of manpower age structure.

(Table 6. Simulation result of the model of specialty composition)



(Figure 10. Simulation graph of the model of specialty composition)

The simulation result of Table 6 indicates that, at the end of the programming period, the ratio of specialty composition of the enterprise's professional technician is: researcher, research :engineering economics teacher& physician politico assistant =6.51 49.07 19.92 14.95 6.36 3.09. The result is according to the reasonable ratio: 1 7.5 3.1 2.3 1 0.5 and it has achieved the programming aim. From the simulation curves, we find that after the shake of the primary programming period, all the specialty ratios achieved reasonable ratio.

5 Conclusion

Manpower forecast & programming is a field that need to be researched deeply. Because of complicated factors inside and outside the manpower system, the sole mathematical method or sole qualitative analysis is not enough to give reasonable forecasting of manpower demand accurately. We must combine them with each other in order to form an organic method. In this paper, we combine the Delphi Expert Prediction with the mathematical model to design a kind of manpower demand forecasting method. The analysis and the results can offer the great-enterprises manpower forecasting some suggestion.

Based on the detailed investigation and analysis of the enterprise professional manpower, along with the development strategy of the enterprise production & management, we use the combining method of quantitative and qualitative analysis to forecast the manpower demand of the enterprise in the future 15 years. We give a total manpower demand and the reasonable

composition of professional technician, viz. reasonable professional title ratio, educational level composition, age ratio and specialty composition. In order to achieve the programming target based on the manpower forecasting results, we also construct the imitating model of System Dynamics for the enterprise manpower forecasting. Then we use the model to give the policy analysis and simulation execution. We can say it is a bigger innovation. The simulation results indicate that the constructed model can simulate the actions of real system well, reasonably control the manpower policy to realize of programming target. After some suitable modification, the model can be used for the manpower system of different enterprise. So it is good for popularize and applying and it is a kind of ideal assistant decision-making tool for manpower programming.

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