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The Basic Concept of NUANCE

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1. Introduction

In our university, we replaced the computer system equipments for fundamental-level education in this (1994) fiscal year. Most constructive work of this replacement was held in the summer vacation of this year, and we have begun the scheduled class with this new system since the second half of this year. (1) This peper will try to explain it in its "conceptual" aspect.

I have concerned to this replacement work from its preparatory stage, as a member of the Computer System Committee in 1992 and 93 fiscal year. And as the most leading member, beginning by the submission of the report on our distress of the former equipments, I directly concerned to write the original requirement specification for selecting the company in-charge (called "requirement" below,) and also concerned the research work on technical trends in advance of it. This report mainly concerns about this work. In a word, I made the fundamental design (or conceptual design) of the system. This work should be, from circumstances, considered one of college's routine works. I also had no idea to take it as a subject of my own study, but I only took up it for resolving out current problems in any way. However, by and by, this work became a difficult (or interesting, in a sense) one, which was to construct a system under many restricsions. And as a result, I, a little expert person of information systems, had to dedicate my time for research work and technical knowledges for a period. From my own viewpoint, this activity had very strong color of research work, that includes investigations and considerations of information systems or educational systems along the way.

Anyway, as its result, I wrote a draft of the specification referred above by the end of last year (1994). (2) It was relatively large one, that tends to 60KB of text file. If possible, it was better to begin with writing some other documents such as research reports, commentary of major points of the specification (that means this paper should have been written a year before) and proceed with debating widely based on it. (3) However, because there was a strong restriction in time and human aspects, and because it was the time the new committee succeeded the former one, after relatively informal process such as verbal explanation, the specification was adopted as the sub-document for requesting for companies to write an estimation, and then it comes now. Although it might be late, now I write this paper as a supplement to the lack of information arose there, and for confirming the understanding

(1) This construction work (mainly remaining work for improving the software environment) is still being done when I am writing this paper (January 1995.)

of our college members' and of other peoples' to this new system, and for discussing how information systems should be, in the era of post down-sizing, and about the difficultes of them. In addition, I will be happy if this paper will produce some information for the people who are concerned to construct information systems of educational and other organizations.

In this year (the year the company in charge has been already fixed,) for the stage of implementation, the company is mainly on duty of the concrete process of design, provision and installation based on the specification; I have been successively a committee member because of the continuing previous circumstances, and taken the charge of technical affairs by contacting with the company (that is, have been almost the person on duty.) I have to report on each individual element technology and know-how, and about the complete system and its evaluation, after the work has been comleted in this year. But now I will write mainly in the level of conceptual design.

I have given the name NUANCE (Nagano University Advanced Network Computing Environment) to the new system as its developing code. Although it is currently an inofficial name, I use this name (and its logo) in this paper, for the sake of convenience.

2. Background in that Era

2.1. The Changing Speed

The speed the information technology changes is said "Nisshin-Geppo (an advance a day, a step month,) although it is somewhat trite one. (4) Especially sometimes, as development of a new elemental technology matches exactly to the requirement of the era, it arises large change that will affect the entire world. Once, the computer itself was the case, and so-called "personal-computer (I call it PC below as a name of this equipment,) that appeared ten-odd years before, have changed the shape of computer systems drastically. Recently, the computer systems have been changing more, by taking the network technology and such in it, which have not been in the field of computer technology (or, it can be also considered that the communication systems are taking computer technogies in it.) Therefore, it can be said a new transitional time in that aspect.

Of course, these kind of changes affect constructional works in colleges and other educational institutes. And it is always observed that some persons concerned are not following well with the changes, so that there frequently arise restrictions and difficulties due to the

(2) Here I apologize to related persons that there were much delay mainly due to my poor capabiliy and much inconvenience due to the shortage of communications.

(3) But democratic process does not always incur good results, because the process of information-system design has the aspect of "art," as same as other fields.

(4) Someone says instead "Byoshin-Funpo" (an advance a second, a step a minute.) On the other hand, it might be in doubt that it advances really; however, anyway it can be said it "changes" very fast.

gap. Concerning some of these problems, I will discuss my opinion on the conceptual design of NUANCE in the chapter 3 and following chapters, and prior to it, I summerize my recognition about the current circumstauces in this chapter.

2.2. Past Technological Trends

As I told above, due to the development of PCs (5), the shape of information systems have changed drastically. The change can be summerized in the following two keywords:

2.2.1. Downsizing

According to the advance of IC and some other technolgies, now there is such equipment that has all mandatory elements of indepndent computer, that is, CPU, memory, and OS, inside it, which are small enough to put at users hand, that is, top of the desk etc. And it has become cheap at the same time. In addition, the position in producing or distributing them have changed, from professional use or industrial equipments, to consumer use, and then got predominant in price, performance, and reliability. As they are connected together with networks, the fundamental shape of information systems has changed from Fig. 1 (a) to (b). Computing has been released from a few expert persons who have their accounts on "computer room", to general users, and now they can construct and maintain their own systems autonomously, as a single person or as a small organization (division, section, or laboratory.)

2.2.2. Open-systems

It has been already fixed as an industrial custom that manufacturers will open the information to the public (or that they write it in documents as a standard) which is mandatory for combining the elements of computers together and making it operational (that

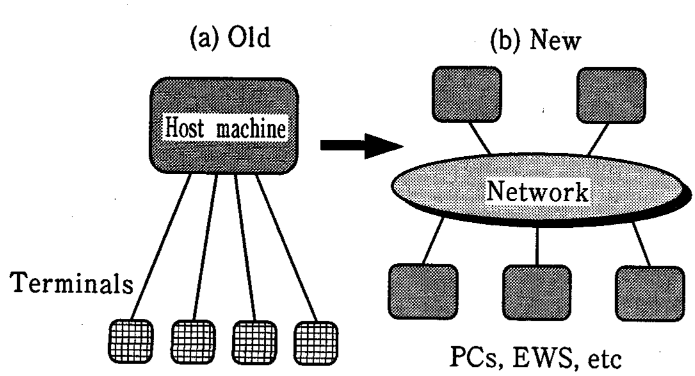

Fig 1. Change of the shape

(5) In fact, UNIX workstations (almost for engineers; I call EWS below) have appeared at the same period, and it can be said that both of EWSs and PCs have drawn and made this trend; however I will not look at the history in detail.

is, interface specification.) According to it, now users can construct a system by combining equipments of different manufacturers together. In case of non-open systems, once a user has fixed a product X of a manufacturer A as the main unit (CPU), he/she can use only the products for X, all of which are produced by the company A. That is, the user's option is very few, which will be disadvantageous in most cases in price, performance, and capability. In open-systems, users can choose the elements for construction relatively freely from the market.

3. Lifespan of Systems.

3.1. obsoletion

However, the change discussed above has been made at manufacturer side's pace. On the other hand, users need not necessarily follow the pace rigorously. It can be said that any user may construct its own system appropriate to his/her own needs, with any available technology and products at that moment.

However, it is not necessarily true. Computers, which has been created as "incomplete machine" that cannot be useless without programs, have been trailing its own history along, and therefore, have always grown with some kind of incompleteness in it which have been allowed by the market; and they come to now. That is, computer systems are always incomplete ones in any moment of time (6), and always it must be repaired and improved (both on site and in the manufacturers,) aiming to comming up to the perfect one. Moreover, the criterion what should be regared as "complete" changes according to the change of technology and the market. Especially in colleges, because it has the role to provide opportunity of studying information technology that meets social demand, the criterion for colleges (that may be called "desirable image of information systems") tends to shift itself according to the relative position to the social demand.

The gap between the ideal image of information systems and the real system in use becomes larger and larger as time goes by. Once it extends to a certain degree, the system is called "obsolete" at that time. "Obsoletion" is different to its stain, damage, or physical aging. It is not physical lifespan, but can be said logical lifespan. In severe obsolete situation, following problems arise:

*The system becomes useless.
*It becomes that users feel painful in using it.
*Users cannot be delighted by using it. (It is an innegligible item in educational systems, different to productive systems.)
*Repair and improvement of problems above become exceedingly expensive.

(6) Someone says that recent computer technology and other electronic technology have been developed using its users as "beta-testers."

Obsolete systems can be said, comparing to biology (7), that its growth and metabolization have ceased.

Obsoletion of systems occur almost with following steps:

(1) Obsoletion in mental aspect: according to the generational alternation of products of that vendor, the model which was the newest one at the moment of introduction becomes older and older model, so that users feel "inferior" comparing to the model sold at that time.

(2) Obsoletion in performance: the speed and memory capacity become short comparing to the new model, so that users become conscious of the time to wait and the inconvenience.

(3) Obsoletion in cost: assuming that we update the system so that it can provide users with the features which are available in the newest model, it will be very costly. (Frequently it is rather cheaper to discard it and buy a new one.)

(4) Obsoletion in function: the vendor terminates supporting the model or producing softwares or peripheral equipments corresponding to it, so that the user loses the way for repairing or improving the system. (Things come to dead-end.)

Once it comes to (3) or (4), replacement of equipments is necessary, prior to be aged or, in some organizations, prior to be wholly written off. In fact, our former system (8), used for more than six years since the establishment of "the division of industry and information science" of the college, has been already in such situation when the preparation of replacement began.

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(7) "Biology" and "raw foods" are written in the same Kanji in Japanese. Readers may also regard this word "biology" as "raw foods" here. In fact, I consider and treat information systems as "raw" ones.

(8) In practice there appear more advanced situations such as:
(5) The annual cost for maintaining the system solely exceeds the price to purchase a new system of almost the same performance.
(6) Comparing the performance (calculating in terms of money) and the cost to dispose it, the latter is no longer cheaper. (The system, which once was a "property,"is now "implied debt.") But it cannot be said that the purchasing plan of the former system was a large failure at that time. Rather it can be regarded as an episode that shows the difficulty to predict the future in the field of information systems.

[This paragraph is written by Ben T. WADA.]

I have an argument partially against above. Of course, it is difficult to predict the future in information systems, and it is true that I could not do it enough when I construct the former system. But much larger and more essential problem was (and is being forever) that "Nobody can purchase any product which will be developed and put on sale in future." I believe that, even if I could predict the future (that is, the present time) perfectly, I could made my plan only a little bit better than the actual one; or I could only cry "Any choice of equipments cannot help being useless in very near future. So we should buy or construct nothing now!"

[End of comment by WADA.]

3.2. Objective in the system design

Although replacement of a system is, in other words, "purchasing a new one," usually it begins by shutting down the existing system which is running for the time, and removes them, then proceeds to the construction of the new system into that space (unless it accompanies moving of the room). And it also needs the time in which users become adopted to the change of the system (in its usage etc. It is helpful in colleges' environments that there are seasons when systems are much less-crowded (spring and summer vacations,) although, of course, it cannot be said enough. However, even in such environment, it is desirable that the replacement only rarely happens, because of the confusion among students and teaching staffs, and of the ethical problem that disposal of equipments incurs loads to the natural environment. For that purpose, it is necessary to minimize the confusion of each single replacement and to attempt to extend the system lifespan, by maintaining and improving the existing system continually through the lifetime.

In addition, we must construct systems that will not become obsoleted when we construct it; however, it is easy to say and difficult to do in fact, because it implies prediction of future. Suppose that the logical lifetime of systems is 5 to 7 years, you will understand the difficulty by considering whether you could predict the current circumstances in 5 to 7 years before. (Although at that time I belonged to an organization whose duty was to think the future in 5 to 10 years span, the circumstances of nowadays are nothing but "surprise." Therefore, at most, now designers can only try to design systems that "will not likely become obsoleted." (The result of my choice will be known in 5 to 7 years after it.)

The focus at the time will be the compatibility problem. For example, suppose that there is a software with some functional lack or problem. And even though there is a new version software which has been improved on that point, the problem cannot be resolved if the software cannot run on the existing hardware. That is, it is important to choose such standards or platforms that will be strongly expected to be used for a long time in future and for which corresponding products will be kept supplied in the marketplace. However, although often this kind of choice might be the newest technology, standard, or products, one must take care of the risk to adhere to the newest choice without any particular reason. They are often costly, or often cause much trouble in their introduction. As there are some cases that "matured" technology is better to be adopted, the balance will be a troubled point for designers.

3.3. NUANCE 's case

In this section I show the design principle I settled as the designer. In the articles in university publications etc., there is a trend that the gorgeous catchphrases favored to the public are shown in a row, such as:
*Corresponding to the multimedia era
*The newest technology

which might be felt meaningless for professionals. However, especially for the delicate points such as those I describe in this section, I would like to strongly encourage to "appreciate" them (as in fine arts.)

In addition, the construction itself consumes much time in the case that the scale is as large as in the systems of universities. Moreover, if the designing or other preparation stage take a long time, there is a risk that the system might become obsolete mentally soon after (or before) it begins utilized. Therefore there might be several items the organization should concern other than described in this section, such as organizing it so that the designer can quickly collect informations or making decisions. However, as I was a designer who was in the situation to be benefited by it, I cannot discuss about it in detail.

3.3.1. Use standardized product.

I rejected the standards of any single vendor's own as far as possible, so that I adopted international standards or de facto standards supported by many vendors. Even in other cases, I adopted the phoducts in the situation of cooperative-competition, in which the internal information is open to the public or some other vendors are supplying compatible product. I did so because such standards or products have long life in general, and because there are advantages in obtaining technical information and repair parts. In the past (or unfortunately even now) I saw many cases that someone purchases the products of a vendor's own standard (which are frequently seen in office-computers or relative products,) and, caught by a trap of incompatibility, it becomes troubled in later system extension; so I am taking much precautions on that point.

The world of information systems is becoming borderless more and more, so I will give the priority to the products that are acknowledged internationally, not only in Japan. However, as we are in the circumstances where Kanji is used frequently, and as manuals or system messages are preferably written in Japanese, I cannot follow this criterion completely; in such cases it is preferable to do Japanization as a member of "internationalization," (9) not mere "Japanization."

3.3.2. Reserve in bus-like sections.

Regarding the information system as a double-layered bus-structure shown in Fig. 2, I used superior products for the bus or similar portions in these two layers, in spite of over-specification. That is, the computer bus shall be of 32-bit. But, as 16-bit ISA bus is also necessary for constructing systems now, I must use both bus simultaneously. Although EISA or VL busses practically serve also as ISA bus in their structure, VL bus is almostly a dedicated bus for video-board. So EISA and PCI might be candidates, and especially, PCI will be

(9) There might be room for argument with respect to dare to adopt this criterion even to the softwares related to natural languages such as (Japanese) word processing software; but items in the footnote of section 5.3 should also be considered.

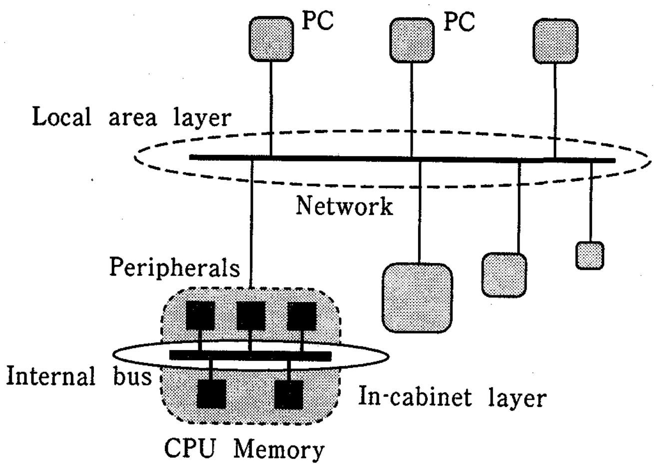

Fig 2. Double-layered bus-structure

the first candidate. (10) On the other hand, as the network device, I use such products that will be able to be adopted to the technology comming next. I use the Category-5 UTP indoors, and use optical cables with room in the number of cores among buildings.

I did so because these two bus-like sections will have large effects once they become obsoleted, and therefore they are desired to have long lifetime. To change the in-cabinet bus to another new-standard one means that all parts directly connected to it becomes useless. It incurs large effect, which means the whole central-unit of the computer must be replaced by the new one. On the other hand, in case of replacing the cables outside, it needs large-scale construction work of removing and laying them.

3.3.3. "Opportunism" on peripheral sections.

On the other hand, I am not particular about the newest one on the products I desire little at their lifetime, while I consider the items concerning the standard described in 3. 3. 1. About those products such as OS (Windows NT etc.,) networking architecture (FastEthernet or ATM etc.,) MPU (Pentium etc.,) some substituting products had already announced or released when I wrote the requirement. However I did not write about it in the requirement as mandatory items, and I left the choice to the company in charge. (The company would decide about it considering the entire condition in economics, its own accumulated technologies, and its plan for expansion after it.) Generally speaking, I would be tolerant of the following parts.

a) Something which is one of the modularized elements, and which does not occupy the bus-like position described above, and therefore which can be replaced solely so that other section will be affected little by it.

b) A server machine or network machine etc., which only a few machines are installed, so

(10) At the moment I released the specification, no vendor had announces PCI machines in the price reasonable for client-machines. So, in fact, there was a large risk when I included this term in the requirement.

that a small amount of cost is required for future replacement.

c) Such product that belongs to a "hot" area, which will unavoidably have only a short life-time, which is expected to be changed drastically in near future so that nobody can forecast the future more than 3 or 4 years. (That is, we must inevitably prepare for their obsoletion in the near future.)

3.3.4. Reserve in displays. (11)

I required that displays should be the highest-level products aimed for general-purpose (not for CAD or other special-purpose); that is, it must be 17-inch and the 1280-dots vertical resolution (non-interlaced). I did so because it comes under neither of three terms described in the previous section, because:

a) It is not modularized, so that there is no way to replace it other than replacing the whole display device.

b) The same number of displays as the number of user machines are necessary.

c) The change is expected to be slow in future because:

1. CRT technology itself is becoming matured and the performance is comming to the limit.
2. If the resolution becomes higher (assuming both the vertical and horizontal ones becomes higher,) the performance requirement on the transmitting frequecy etc. grows in proportion to the square of the growth of its resolution. Therefore there will be much technological difficulties.
3. In 17-inches screens, even if the displays will have higher resolution than now, the limitation of human eyes will not be able to make them use. And it cannot be expected that displays of larger-size screen will widely spread, because of Japanese circumstances of small offices and small homes.

Although, at present, it is out of consideration to use devices other than CRTs, developments of displaying devices in other areas are being carrieed out hot. So, if the CRTs we introduce now will be removed in future, the devices put next there instead of them will be something other than CRTs (that is, flat-type ones of Liquid-crystal etc., or 3-D pictures.)

4. Problems on the procurement of equipments.

4.1. Frequent traps.

According to the changes described in Section 2, on information systems, the degree of users' freedom has increased drastically. Now is the era that knowledgeable users can construct and operate information systems by themselves. Basically it is desirable. However there

(11) In this the part I raised the level of requirement when I changed the specification after the company in charge had been fixed. However the screen size and the resolution had been already fixed when I wrote the specification.

is a trap which "technology" is likely to fall into. Probably the technology's side should not solely blamed for it, but the immediate cause would be the pressure from the society which has taken the technology in it. However anyway, it often occurs that, once becomes "one can do XX," in short period of time it becomes "one has no choice other than XX," that is, other alternatives than XX disappear.

There are too many cases of such phenomenon in our society. For example, in our neighborhood (especially in countryside,) public transportation systems are being destroyed by the popularization of family-use cars, and other ways to move are becomming to be lost. (XX is "self-supplying of the way to move" in this case.) (12) Also in computer's case, often, not only becomming that the construction or administration become possible by ourselves, moreover there becomes that no way exists other than doing it by themselves.

4.2. Circumstances of administrators.

In the mainframe's era, computrs were expensive, so that, once purchased (or leased etc.,) one had to recover the cost, and the corresponding section for it, which was called as "center" in general, was provided. Now it is not necessarily needed. So oftern the corresponding section will not be provided. There might be a natural law that "things NEEDED no more are not done." Or, many of organization administrators consider that one can make a system only by purchasing personal computers and putting them in rows in a room. Nowadays in many organizations those who take care of computers and networks are not the staffs devoted to the work, but are a few number of voluntary individuals (in colleges, they are researchers or office workers) who have their own work. (13) Even if the work itself is done in office hours, the research work necessary to support it (which might be a kind of shadow-work) is done in their non-official hours, and often they are not paid for it. (Although in some of colleges graduate students' powers are utilized, it is still their nonregular duties which are not related to their research subject, in general.)

Of course, this kind of activity is not always unbeneficial to the individual, rather there are some benefit in the knowledg he/she will get through the activity. That is, they can study through the work. (It was also the case for me.) However it might be a problem that the "graduation," which is the smartest mechanism in the school system, is not provided there. In most cases they are not released from the duty until some successor comes. The duty to take care of computers (which are to take care of computer-users, at the same time,) will never disappear. Rather it tends to grow in most cases. Now, after a lapse of more than ten years of personal-computers' era, volunteers are getting tired in being volunteers. (14)

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(12) The information technology has much risk of this kind, so I cannot take my eyes off this kind of phenomena, and anyway I would like to research thoroughly about it later.

(13) According to an empirical law, the choice is decided by a function:
f(person) = (related-knowledge * curiosity) / (degree-of-position * a udaciousness.)

(14) As this problem should be considered by the organization manager, it is difficult to affect it for a mere sysetm designer.

4.3. Un-bundling of services.

Organizations which will not be able to hold enough voluntary administrators will expect providers' (vendors' or shops') support. In past, one could consider that the engineers who would be provided as "extras" of purchasing machines would fully take care of them, and providers also could make systems to meet this kind of wishes. That is, as the hardwares were expensive, it could absorb the costs for the support or other services into it.

It is not the case in the downsizing era. The reason is that, as hardware price is becoming lower and personnel cost is (relatively) more expensive, the relatienship among each costs has been changed (reversed) from:

hardwares > softwares > services

to:

hardwares < softwares < services.

Since about 20 years before, the un-bundling of software (in the narrow sense, that is program products) began, that is, softwares were not appendices of hardwares any more, and now it has been already a common practice. Moreover, the software in wider sense, which is not restricted to programs but includes administration, support, etc., is beginning to hold their own price systems.

However supposedly, it seems that the user's side have not yet clearly been conscious of it. In purchasing equipments, still now tangible matters (hardware or software products) are usually written on the specification, although one of the reasons is that the information supplied by the providers' side (catalogs etc.) is still not enough. Anyway, it can be said that there is much sacrificing work by the small vender who provided the system and volunteers of the users' side, which absord the cost (labor etc.) necessary to construct (see the next section) or administrate the system, and we should say that systems are now working barely by them. It is nearly comming to the limit. We must seek the alternative.

Although in this section I point out some problems arisen as the result of the motion toward downsizing+opensystem, I do not mean that it was wrong. Now we can freely get computers and their informations in hand and use them. As this is a great advance, we should never return to the past, in which informations were concentrated and hidden in a small number of large vendors. The subject of this paper is the necessity of getting over the current situation and going ahead.

4.4. Integration

"Open-system" means a system constructed by multi-vendors. As hardware-and software-vendors have become sharing out their territories and have become specialized each, (15) it is becoming impossible to construct systems only by products from a single vendor. (Also in this matter, the law described before is the case.) As it is necessary to construct systems by joining the products of several vendors together, the task that belongs "system integration" arises as described below.

*To select the optimal products among abundant ones produced into the market. (The advantage that there are many alternatives unfortunately becomes a drawback that this work is huge.)
*Confirmation that they are conformed each other.
*Arrangement of the time of delivery and the preparatory work such as purchasing cables.
*To share out the trouble factors and to call up to the corresponding vendor, in case of trouble.

They do not only produce additional works, also they need wide and deep knowledge that extends over several areas, such as computers, softwares, devices, networks, and (in case of classroom systems) image (television) engineering. And as there are something like an "affinity" for each other even if the products are under the same standard or interface, there occasionally the performance drops or some incompatibility arises; such risks have to be shouldered by someone.

Frequently someone in the user's side who has some superficial knowledges acts (imitates) a SE, writes a specification on which the names of products and parts are written in rows, and purchases them. (I myself did it often.) As a result, he/she ofen causes some incompatibility like that they cannot be connected each other or that the model number of their adapter are different each (even not under the multi-vendor circumstances.) In those cases, the user cannot hold anybody responsible for it. The user only can "implore" the dealer, or "distress" it, or "give up everything"; anyway there arises some loss or trouble in somewhere. This risk should not be shouldered by the user's side.

There is a business called System Integrator (16), which undertakes the whole work of (wide-sense) software, that is, such works and risks as described above, and also undertakes the services described in the previous section. It is most appropriate to use (and learn the way to use) the S. I. 's services, which are produced as their merchandise, so that we, people in user-side organizations, may resolve or avoid the problems described in this chapter.

Of course, SIs will not produce infinite support to each equipment or part the user has arbitrarily chosen or bought. It is not easy to arrange the business which consists of services only, (17) and each SI is strong in some areas but not for others, because of the range of technologies each SI can cover and limited connections to many vendors. Therefore it will be

(15) There are some vendors that have a wide line-up of products by OEM etc. But we might have to call them a commercial house.

(16) MITI (Ministry of International Trade and Industry of Japan) has an authorization system for SI. But here I do not mean only SIs authorized by MITI, but those companies engaged in integration or related services in generally.

(17) Practically yet many SIs only can write estimates mainly consists of hardwares. So this would be a further problem both by the customer's and provider's side.

the best strategy, for organizations with poor human resources, to order many matters as bundled as possible, including buying products or, as far as possible, selecting them (it is true at least from the viewpoint of the people at work.) This will be effective to go on with the sound constructive work by reducing unnecessary risks or troubles, and to keep the people at work from getting tired miserably. Therefore, in NUANCE I did not plan to purchase products individually, nor to buy products directly from vendors, but negotiated only with SIs and wrote the specification in the collective-purchase basis. (18)

In addition, in colleges in countryside like us, ones should also pay attention to the difference of information-related technologies among regions. Although, for the production of hardwares and the development of package softwares, there are accumulated excellent technologies also in Shinshu area for example (19), but unfortunately, there are large difference between large city areas such as Tokyo and countryside, in respect of the amount of information about system integration or in respect of the number of engineers. However it will not be beneficial to leave everything to a SI company in Tokyo area (although it might avoid risks at the moment.) There is the problem that the cost for the support in the next year and later becomes higher. (In most cases our side must bear also the travel expense and time of the engineer.) And also it is a loss for the regional economics. As people in a college, it will be necessary to have the spirit of educate companies in the area for SIs.

4.5. Purchase the function.

4.5.1. Think in a different way.

Here I would like to confirm the purpose we introduce a system. It is not true that our purpose is to put many machines in rows in a computer-studying room (although it has some significance as a signboard for the advertisement of the college.) The purpose is to have students study about computers. It is most important that the softwares for study will work well. What we want is not physical machines, but their functions. In another word, we want computing, not computers. In very extreme words, it does not matter even if there are pretty angels in the computer box, instead of CPU and disks, as long as the function is established.

Nevertheless we say "buy things" ("kaimono" in Japanese, which means "to buy things" in literal translation, is generally used for "shopping") at the contract for introducing a system. Despite what we want is not equipments but more general matters, such phraseology often avoid to change our way of thought. (20) Hereafter it might be appropriate to say, for example, "buy matters."

(18) In fact, a part of the system had to be purchased separately, because the work to find the way about technical and price aspect of the video-displaying system had delayed.

(19) In fact, many products developed or produced in Nagano Prefecture are used in NUANCE

4.5.2. Alternatives in implementation.

It is frequently said in the world of programming "There's more than one way to do it." [2](21) This means that there are many ways to realize a single purpose. (22) This can be apoted also in constructing information systems widely. Moreover, in implementing a particular function, there are different alternatives in their forms, that is, the way in hardware, the way in software, and even the way with manual human work without such mechanisms. Especilly for recent years, as emulation technolgy has been widely developed, a computer can "pretend" another kind of computer by software (that is, emulation for terminals or operating systems,) or pretend as if it contains some equipment or circuit (FPUs, disks etc.)The decision which ones have to be chosen and be combined should be decided by considering their performance, occupying spaces, costs and so on collectively. It would exceed what dilettantes can be in charge.

4.5.3. Description on the Requirement statement.

From the reasons above, on the requirement statement of NUANCE I mainly wrote the functional requirements exhaustively, and avoided to describe matters that are already broken down into the level of implementation, such as the name of individual technology or product. That is, I aimed at the requirement with no enumeration of product names. In practice, it has a feature that there is only a few words about specific vendors or products, instead there are much description about the name of specific standard and about functional conditions. (As a result, the requirement have got large.) However there are many cases in which it is easier, both for the writer and the reader, to write "a feature like XX" or "YY or equivalent product" by using the name of specific products, rather than enumerating features. So there is a few portions I wrote such. It can be said that we tend to form our image of information systems not from "needs" but from "seeds," that is, based on the products actually sold in the market. Therefore in fact, rather than omitting the work to break down the requirement terms to product names, rather I can say I did also some additional work to re-construct the term for the requirement from my own image which consists of actual products, which was a work in the direction for abstraction.

4.5.4. Performance Requirement

Although in this work we have completed to describe the functional requirement, on the other hand, concerning the preformance requirement, it was difficult to describe it in

(20) Many of libraries ("toshokan" in Japanese, which means "building of books") are facing difficulties in getting clear of ones specialized in paper-media, despite it is already the era of electronics information. Probably the reason would be probably that they are prescribed by the name of themselves.

(21) Probably this might be the true not only in this area.

(22) We often forget this fact, for example, in the field of educating students. We must admonish ourselves.

a concrete way. In a word, in the preformance aspect, we just require "available to use without problems (such as long turn-around time) in any cases." However it is a subjective term what kind of circumstances should be regarded as problematic. However we need to represent it as an objective number in order to use it as a term for business trade. And it is impossible to examine the performance in all of "any cases," either for the purchasing side or the providing side.

Once there was the era when computer performance depends almost only on CPU performance, because we used them as "computers" literally, that is, in CPU-bound usages. And another reason was, as a single company designed and developed the whole computer system, it was possible to design the system as a whole so as not to suppress the CPU performance. Therefore the benchmark had been prepared as the index for representing the CPU performance as a number, from of old, and it was enough just by writing them as the requirement term. Now CPU is not the critical factor of the system performance in many usage of computers. There may arise performance bottlenecks in various portions of a system, such as memory, busses, disks. Therefore the numerical index which will represent the total performance of computer systems including them is getting used now.

However they still aim at standalone computers. Only little consideration have been given to the case that network is the bottleneck, so that the performance index for entirely-networked systems remains undeveloped. In the case of standalone computers, (restricting those with only a single processor,) in a sense, simply its configuration can be represented as "it varys only in their bus structures"; but on the other hand there are many kinds of configuration on networks. This would be one of the causes which makes it difficult to represent the performance as a number. Furthermore, as various kinds of configuration is possible, the network configuration is critical to let the performance of individual equipments useful or useless; that is, the human skill to design the network configuration has much effect on the performance of the entire system. Therefore the decision on its network configuration would be the most difficult issue in system integration.

As I have already written in this chapter, I adopted the strategy that we do not solve this problem in user's side. I included no description of definite items such as the network architecture, nor the name nor number of servers. In short, I adopted the policy to accept anything if it satisfies the performance requirement, and to leave the way of implementation to SI. However, as I will describe in the next chapter, as the network has the most major role in NUANCE, therefore there is a large possibility that the network will determine the entire performance. But there is a difficulty that no effective index for this purpose has been got ready. And in fact, there is only a few data or documents in the past which we can use as the rough scale for estimating the realistic value we cın use in describing the performance requirement as a definite number.

By considering them, I adopted the way to describe the required maximum (acceptable) waiting-time, assuming some of such typical cases that some waiting time will be usually incurred, such as booting an user machine, or starting a software. I wrote the value which is a little bit more generous (23) than those which I experienced practically when I used PCs in standalone mode. This should be said a rather informal index. It will be a significant further problem of the information engineering in users' side to seek effective ways for it.

4.6. The Designing Process.

4.6.1. Principle to use ready-made products.

Now as a result, the requirement document written as above is a collection of the functional and performance requirements. But for a requirement document, it is not enough only to enumerate items which users consider necessary. *Realizability is important*, that is, we cannot write in the requirement that "we require this item, which does not exist in fact." In the case of information systems, almost requirements are realizable by using custom-made software/hardware in case of need, unless there is any unrealistic requirement in its speed or other performance. Absolutely unrealizable cases are rare. However, things are different once we must consider another item, the cost. "Requirement" is, in fact, a document for calling for "any company which will undertake the construction work of the system, which satisfies the items written there, in reasonable price." It is out of the question if there comes no proposal with reasonable price.

In the world of information systems, the development cost is much larger than the production costs. (Especially in the case of softwares, the latter one is almost nothing.) Therefore, comparing the cost of ready-made ones and custom-made ones, the difference is so extraordinary that will be incomparable to the case of tailoring suits. We introduced about 100 user machines in NUANCE ; although it is a large nunber for users, it is only a small lot for the developer's side. The developer's side will never bear its cost, unless they also expect other large markets. (If so, they might have already begun the development work before we request it. Therefore the cost must be borne by the user's side, together with the risk of the development. As far as one expect reasonable price, custom-made products should not be used, unless there is any considerable reason.

Furthermore, in the case of custon-made, later maintenance work needs to be supplied by the user's side. Of course it is fascinated that, as users can keep holding the source code (in the case of softwares) or other technical informations, they will be able to keep improving the software without influence of the business policy by the developer. However only few users can maintain enough money and human power, and especially in softwares, commercial softwares and free softwares being trained in the market are going to be advanced more steadly (and more rapidly.) Therefore custom-made softwares tend to be obsoleted

(23) In practice, the data transmit via network has often higher performance, and it is obvious by thinking in the theory. But it was an area I have only few experience, so I could not be aggressively in it (although SEs who concerned to the negotiations with me will not agree it.)

earlier, and there is high possibility that the software will be just a garbage as a result. The work does not pay unless the user's organization have the mind, and is prepared, to take care it by themselves continuously. (24) It can be said that the technology to construct informations systems in this era is the technology to combine and utilize the products sold on the market. (25)

But this conclusion is a very sad one for users. Always there is a gap between the user's requirement and the products provided to the market, and the conclusion above means that users are always required to yield to the gap (that is, users must withdraw their requirement.) Although recently users are getting stronger positions in the respect of price, the provider side still keep deciding what kind of product are to provided to the market. One of the reasons might be that the network among users are not developed well (26) so that "joint operation" in the sense of consumers' union is not yet carried on. It might be another problem of information engineering in future.

Even in NUANCE, there are many items we had to give up to insert in the requirement, because there are no appropriate products in the market yet. On the other hand, there are some items I dared to insert in the requirement, despite I knew that such products did not exist in the market or that there were no preceding experiences (because of something like obstinacy of me, who is a system designer.) It had a significance as a challenge toward information systems construction work lead by user. In the next section, I will report some of its major items, for some of which the SI on charge is still working in tough time, and there are still some unresolved problems among them.

4.6.2. Information sources.

According to the principle described in the above section, any design process begins with the research work for technologies and products in the market. Items shoud be researched on are: trend of technologies and products; feature and price of each elemental technology and product; their problems; instances of users for them;future direction. And the problems which possibly arise when we combine them together should be known before beginning the design. The research work will be significant in quantity if we grapple with it seriously. The ways to research on them are: to operate a real machine and verify the problems on it; to watch around exhibitions; to collect informations in magazines or on Internet; inquiry

(24) We must be careful against the SIs who offer custom-made ones unnecessarily, hiding the reason that that they hold programmers without jobs, or that they have no enough ability for researching the market.

(25) However, it can also be said that this conclusion is merely the usual way of designers (in all areas,) that is, we need to compromise between the circumstances both of the top-down (requirement) side and of the bottom-up (available resources) side.

(26) The organizations at present among users in the field of computer are mostly the societies by users of a specific vender or product, in which information exchange is mostly lead by the vender, and there will be no appeal to the market.

by phone. In practice, I used each of them together.

But they are not enough. In addition to that it consumes much time, there is a fetter for the people in users' side that they have no direct connection to vendors. In practice, information about prices rarely comes to users directly (except only a few products for which the sale-route for consumers has been established.) And the prices (especially for softwares) change widely according to the circumstances and to the concept of circulation. So it is unmanageable matters for users. Therefore the cooperation with SIs is necessary since the researching stage. Then, there arises a problem which SI one should committed to.

4.6.3. Decision process.

Here arises the loop of dependency (the problem known as "Bootstrap problem" in computer science(27), or as "hen and egg"or "deadlock of three" in our neighborhood) in double or triple as below.(Fig.3)

a) Estimation by any company is necessary for deciding about the budget.

b) Usually the company works in a fundamental pattern, that is, to make and issue their plans according to the proposed budget.

c) The selection of requirement items should be done so that it will fit to the budget.

d) For deciding the company in charge, a public process such as "write a requirement, then offer the price for it" is necessary. (Although bidding is not obligatory in private universities, any similar process would be the soundest way, which will exclude the effect of subjective metters or connections.)

e) Requirement itms being available differ according to the policies, skills, or etc. of SIs in charge.

f) Companies'service works (research etc.) also need some compensation, and the company which will be in charge of it need to be fixed in advance of the research.

g) Enough research work must be taken in advance, in order to fix the requirement.

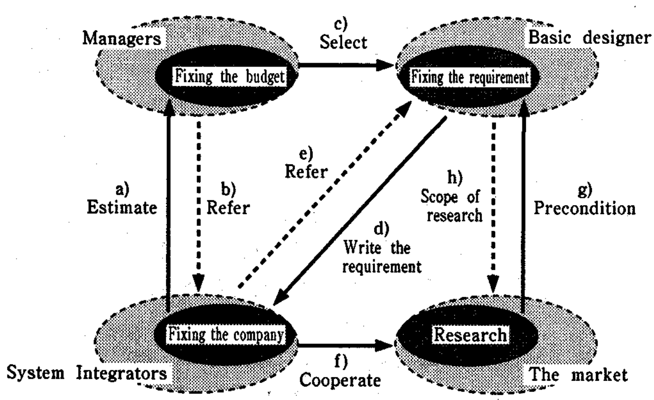

Fig 3. Loop of dependency

(27) Here "computer science" is appropriate because such problem exists since the dawn era of stored-program computers. (Refer to the section 5.3.)

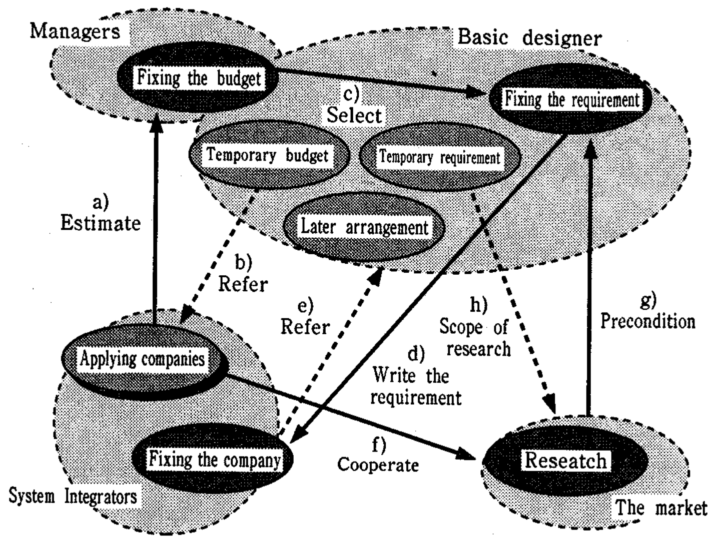

Fig 4. Loop Cancellation

h) Research works should be done not indiscriminately, but only to some small area which has been restricted depending on each requirement items; or it will be ineffective.

Among above, which should be resolved first and which second? Of course, it is a problem which will arise in any organization.

In the preparatin stage of NUANCE, I used the procedure shown in Fig. 4. At first I presented the temporary requirement items and the temporary budget. (This removed the link (a) and (h) from the loop in Fig.3.) And, at the preparation stage which was before the SI in charge had been fixed, I requested to several companies to make effort for the research and to write a temporary estimate without charge, in exchange for "the permission to participate this business" which I proposed them as a bargaining point. (Now the link (f) has also been removed.) (Although I was not authorized to issue the permission, I could do it under the pretext "I evaluate the capability of each company.") By doing them I could achieve the arrangement of the order of the procedure. It can be said that official (of semi-official) information will go two rounds among three participants (excluding the market itself.)

However, as a result, each agent of several companies often came to my office one after another in order both to cooperate to our research work and to act as salesmen, so that I would come to spend a tough time of another kind. If there were too many companies I asked (or was offered) to be cooperated, the effort would increase with no benefit; on the other hand if it was too few, I would suffer a lack of information, and it might be expected that there would be no appropriiate offer in the bidding (because each company has a free choice whether it bids or not.) Although there is an alternative to gather all companies together and announce to them collectively, but then probably useful information will not come to me. It is a troublesome matter for us, voluntary system managers, to let these miscellaneous works be compatible with our own jobs. At the same time, this kind of process which users'side suffer has not be arranged appropriatelly yet, and know-hows for them have not be accumulated. It might be another problem.

Although I wrote about the problems for user organizations in this chapter (in a somewhat lordly way,) but I do not intend to declare that I have accomplished the purpose enough in my work. In this paper I wrote the direction of my purpose (and I myself feel considerably that I have not accomplished them enough in some aspects,) and at the same time, I pointed the problems and called for users to unite together.

5. Fundamental Design of the System.

5.1. Uncertainty

In educational organizations, there is the feature that users are periodically shifted by the clever mechanism, "graduation." And it will be another feature that their members (students) "do not have their own (personal) seat" in general. As this is a topic about using computers, it is not restricted only to colleges. It will not change until the "a machine a student" era, when workstations (or "WS"; which means PC or terminals each of which an user operates directly on) will be installed in each classrooms in primary-and highschools. That is, the most significant feature of systems in educational institutes is that each WS will be shared by students (in time-divide basis.) Of course, also in many of companies or other offices, their systems are built in shared-type basis, not "a WS a person" basis. But the sharing extend only inside each division or section. On the other hand, in educational institutions one cannot know who will use any particular WS, that is, there WSs are shared in higher anonymity. Here arise a couple of uncertainty:

(1) (From WSs' side) uncertain who uses it.

(2) (From users' side) uncertain which WS he/she will use.

5.2. Bid farewell to programs.

Here I use the word "program" with two different meanings. Both is an old common sense to which we are liable to be tied, when we consider information systems of colleges. At the same time, two requirements which are (appearently) contrary each other are delivered from this discussion.

5.2.1. Programming.

Once upon a time, there was an era when that one use computers means exactly that he/she makes programs. There was an era that the only action users are permitted to do for computers is to "input" programs (and JCL) to them. And there was an era when it was said that programmers would run short by thousands or even a million, and therefore educational institutes were expected to train programmers. Also in my case, I began using computers with programming.

However, because now many kind of softwares are available, users can use computers without writing programs by him/herself (nor by their organization itself.) Terefore the technology and the knowledges to use them well (namely "software" in broader sense I described above) is becoming more and more important. This is an important issue in training talents, both in hardware or software providers' side and in users' side, and it is true also in teaching them as liberal arts. Once computer was a tool of programming and its object, but many other usages have been already developed and are being developed unrestrictedly now and in future.

However I do not deny that programming is important and necessary as an intelligent activity. But we, people who teach in classrooms, sometimes tend to make the curriculum too much biased to programming, as a result of our sense in the era we ourselves have studied, or as a result that we failed to follow the trend of computer usage varietization. (28) We must bear this risk in mind. I must notice that, among a variety of usages today, the most notable role of computers would be the role as a window on many kind of services provided through communication networks. Now computer is a kind of media (29), or we can even say that it is an element of information cnmmunication networks. If so, the most important part of NUANCE is the network. They are necessary that many kind of services can be utilizable inside it, and that services outside it are available (the accessibility to Internet is mandatory as far as it is in a college,) and the services expected to begin in the college in future (services by libraries or college offices) should be also available.

Because of the background described above, systems are required to provide many kind of services. It can be said that abundant softwares are mandatory for providing it. It is important that many kind of softwares are provided to the market and that they can be bought cheap. And moreover, as I have already described in chapter 3 that the entire information technology is under progression, and that therefore our system must be progressively developed by continuous construction, it is important that this "evolution" is actually possible.

(28) After the manner in chapter 3, it would be "obsolescence of human resources" (namely, of instructors and administrators.) Also for preventing it, it is important to construct systems continuously.

(29) "Media" means a tool both for transmitting and receiving information. But when people consider about computers as a media, they tend to pay their attention mainly to the receiving feature. The resson might be that they are lead by the business world, which might intend to own the transmit-side by themselves as their own business. As a result, the technology and the market of the equipments for transmitting information (mainly input equipments) have not yet matured enough. As a result of it, partially because of the budgetary reason, NUANCE could not help being biased to receiving features in its beginning. For voice data as an example, although I could install voice I/O boards and speakers, I could not do for microphones (or headsets) and I could not fuse it with telephone systems (so-called "telephonee.") It was similar for image or video data.

Assuming that we receive a new software and we would like to install it on 100 computers. If we must repeat the same operation 100 times, that is, we insert and remove floppies or CDs one after another and type the parameters 100 times, then who will do it actually? Once there arises some little bug, more 100 repetition is necessssary. We must do it repeatedly in each small change of the system. This plan has no reality in any sense. It is mandatory that this kind of constructive and administrative work must be minimized by some kind of centralized-administration mechanism.

5.2.2. Programmed Study

In principle, study is an action that should be self-activated and autonomous. Is is the natural way in studying that he/she is interested in something, acts toward the object of interest, and then gets some knowledge or wisdom as the result. As the way of being interested in and the way of action largely differ depending on each person, and it would be ideal that if we can provide many kind of study opportunities for each. However, unfortunately, the (human) resource is absolutely short for realizzing it. So, in the field of education, teachers are obliged to set and force the materials from their side, with which all students in the classroom should grapple at the same time, and teachers make much invention and effort so that the materials can adopt to as many persons in classroom (students) as possible.

In practical training, these materials tend to rule the students' action closely. That is, at first do XX about YY, and then do ZZ for WW,... Then this matter itself is a program.
As it is executed not by computers but by students, it might mean that we treat students as computers (or something with similar intelligence as computers at most.) From the viewpoint of instructors, it is something like a necessary evil in order to have them overcome the first high threshold (or wall) and to lead them to the position the can take action autonomously. But in addition to it, instructors have some tendency to restrict the range of students' actions unnecessarily for the reasons of teaching side. Sometimes there lies a fear "If any student makes any unexpected action, I will face difficulty" in the bottom of their heart. The (potential) state space of computers is so wide that it is impossible for any single person to grasp the whole. I understand their mind who will fear those scenes where, by some unexpected operation of students, the system goes to down, or there arises some difficulty in teaching or in the operation of someone else, or the instructor is in a cold sweat because he/she does not know the way for restoring it. (30)

Of course, the program-type learning process like this might be sometimes necessary or sometimes effective. However, in addition to it, those places would be also necessary where the students who once sit in front of a computer (desirably he/she comes here from his/her free will from the first) can "play" (31) freely in the information space and the state space constructed inside (?) the computer. That is, we provide a "public-park type" opportunity of studying. Desirably there is no restriction nor prohibition for reasons of system-managers

(30) Although I have made no statistical research for proving this tendency.

or instructors (that is, "Do not remove this file" or "Do not look under this directory" or "Do not execute this program" etc.) The activities there includes making "his/her own environment" (that are manic and non-productive in general) that begins by changing the background image of screen, and also includes being confused because he/she has erased a system file by his/her mistake. Although this is not effective, it is also an education. To make it possible, PCs - Personal Computers - must be "personal" in its literal meaning.

As a result a difficult problem is induced, that is, to provide users being highly free, which is required by the discussion here, and to make the system being easily administrated, which is the conclusion of the previous section.

5.3. Variatization in the layer of users

In addition to the variatization of usage described before, we must also consider the variatization in layer of users. Although, so far, computers are only for some special colleges or divisions in universities (in ours, it means Division of Industry and Information Science,) but now they are also fundamental tools for study (and research.) Also, considering that colleges are directing to "open" such as lifetime study for example, prospective users might extend to the whole of neighboring community. (32) Therefore I regard NUANCE as the infrastructure of our college that should be placed in the position next to classrooms and the library, and I designed it under that assumption.

That the layer of users (33) has a significant variety means the level they expect of information systems vary significantly. People aim at professionals of information need to study deeply including the way to interact with PCs as I described in the previous section, and the hours for learning "fundamentals," which begin with keyboard operation, are in ready. On the other hand, there are users who expect only simple interaction with information systems, (For example, he/she just want to print research papers clean. In general the number of such users is significantly larger.) It is desirable to provide each of them with each way of operation, that is, a quick way leaving his/her fingers on the keyboard for the former kind of people, and a way to show "yes/no" or "this one" by a single finger for the latter kind of people, and some intermediate way for intermediate kind of people. (34)

Although for the former kind of people we must provide "personal computers" so that

(31) I call highly-active activities of study as "play" generally.

(32) We cannot say all of them are Japanese. We must also assume those users who will use languages other than Japanese and English (especially Asian languages will occupy a significant ratio.)

(33) Of course this word has no relationship to the positional hierarchy of those people.

(34) Every current product on sale is not enough. Moreover, although it is also an important issue to provide handicapped persons with the interfaces specialized for them, but unfortunately even the first step for realizing it has not yet begun in NUANCE. Even now, at the starting point, there is a hindrance that the main room for the system is on the 3rd floor in a building without elevators.

they will also study how to work together with machines, on the other hand the latter kind of people do not hope such matters. To "initialize" a "disk," and "install" the "system," and give a "volume name," or "backup" it periodically, or change "CONFIG.SYS" with an "editor"...these kind of matters will never be the purpose they sit in front of a machine, and they do never want to learn incantations like these. (35)

That is to say, as for informtion systems as infrastructure of colleges, computers are not the purpose for most of people, but it is enough if they just serve as a "tool" which will provide some feature. (This might be the average of the whole countrywide society.) As I have already noticed above, also in this case, "PC" they need is not Personal Computers but Personal Computing. Of course, (as readers might have become aware) "C" in NUANCE is also "C" in "Computing." I would like to notice that, although there is Computer Science which is an academic area for researching various activities on computers, now a word "Computing Science" is also becoming to be used according to the increase of those cases that computers are tools, not the purpose. (I do not know any acknowledged Japanese word corresponding to Computing Science.)

On the other hand, there is a layer of users who must learn how to use personal computers and how to keep associated with them regarding them as computers. Therefore we can conclude with the words same as the previous section, that "computing environment administrated and maintained well" and "room for customizing by users" should be realized at the same time.

5.4. Security

Here I look over those matters regarded as "unexpected incidents" which will avoid normal operation of systems. (As far as I predict them here, they are not "unexpected incidents" by definition, and there would be true "unexpected incidents"elsewhere.

5.4.1. Machine failure

Machines should fail. It should be avoided that, for example, a class teaching is suspended for a while due to a fail which should occur sometime. Considering the value of an unit hour of college's teaching class (which would be, considering it in its price, the college annual fee divided by total class hours, that is very significant,) it should be avoided that, for example, no class study can be given for three days because the host machine fails and spare parts will be got ready three days later. If only a single or even a few machines in 100 ones fail, there is a simple way to "move to any unused machine." But care should be taken for the nucleus parts on which the whole system depend.

(35) I write this section as a matter that system administrators should consider about. On the other hand, I recommend other people (especially students) not merely to accept those blackboxes as blackboxes, but to be interested in its phisical and logical structure and "hack" them (and to take such attitude in his/her life.)

In addition to functional suspension, there is another kind of trouble due to machine failure, that is, loss of information. It will occur in the case of disk crush (we cannot say it is rare) etc. I must notice that there are something which cannot be repaired only by changing the failing parts.

5.4.2. Mistakes in operation.

Humans are to mistake. In the reports for analyzing an unexpected incident (failure etc.) of large-scale systems after it, occasionally there are those which easily conclude as "misoperation" or "human error." But it should be said to be some defect of the system in principle. We must construct systems under the assumption that users' misoperation will naturally occur. And in addition, to encourage to dare try to unknown trials, without afraid of misoperation, is even an essential item of "public-park type" environment.

A frequent case is that an user erases some important file. There is no way to avoid it on user' individual files, while, of course, it is effective to do the backup service of the system periodically, for minimizing the users' perplexity. On the other hand, mandatory files for the system should be placed in somewhere guarded from general users. In case this guard is not enough, for example, virus would easily infringe on it. And leak of information should also be considered. As information systems are also personal media, no private information of individuals should be accessible by others (unless the owner has intentionally disclosed it.)

Some misoperations occur due to some ill-will, while others occur due to lack of knowledge or due to mistakes. Security is especially important for the places connected to outside via networks. We cope with it by making "firewalls." (36) We cannot help considering internal invasions, for example, destruction or theft of machines installed in open-spaces, because there is some possibility. Although we cannot keep them in locked-up storage because their purpose is to make use, some kind of brake on it would be necessary.

5.4.3. How strong should systms be forearmed?

It is said that the stronger security incurs the lower availability and usability. Security should be in the extent that will not avoid free accesses to machines and information. And, as the cost becomes very high if one requies perfect security, it needs to be arranged considering the budget and other circumstances.

There is a way called duplex, which is basically an effective way for avoiding systems being suspendee. For example, if we make the central administrating machine duplexed, we can continue the operation of the system even if one of two fails. In this case there can be a couple of candidates; duplication in a machine box, and duplication on the network as

(36) It does not mean a physical wall, but a logical network which acts as a wall that separates the outside and the inside.

shown in Fig. 1 (b). Then there still exists a non-multiplxed part in each, that is, the part connecting the machine to the network in the former case, and the network itself in the latter. Once this non-multiplxed part fails, the whole system will be suspended. So we consider to multiplex the network. With respect to networks, we can increase the reliability by making a loop, which is a kind of "redundancy." (Some routing-control is necessary.) These forearming plans can be said indispensable to make the operation stable.

However this is not perfect yet. As the mechanizm to connect and synchronize duplexed sides each other or exchange their master-auxiliary relationship is necessary, it is almost unavoidable that some non-duplex part appears in it. Moreover, even if we could make it nearly perfect by making much efforts (and paying costs,) effects from those accidents which will arise outside buildings, such as failure of electric power or disasters, are inevitable. However the cost becomes huge if we pursue the perfection by extending the range of our consideration to those events that will arise only in low probability. We cannot help seeking some compromise.

Fortunately colleges are rather magnaimous organizations so that, for example, if the system is suspended for 15 minutes, no effect to the social public will arises, not like banking systems or train-control systems. We can even utilize these kind of short suspension for teaching, regarding them constructively as a good experience. With respect to educational systems, we can consider the social responsibility in keeping the operation continuously to be relatively small (while it will not be permitted if there is entirely no policy nor actions.) Therefore in NUANCE , I did not pursue non-stop operation of the system, but decided to regard short suspension of about 15 minutes as permissible. The redundant reserve-system shall be in cold-standby, not in hot-standby, and in case of failure, a human administrator shall come there, take several cables out and put others on, and startup the reserve system. It shall be allowed if the system will be recovered by these kind of actions (estimated to take about 15 minutes.) In case of troubles in nighttime or holidays, we must wait until the next morning (until someone comes there.) But it would be appropriate to allow these kind of problems considering the cost. (In holidays or nighttime there is the problem of entrance-control. But at least accesses from home can be available in 24-hours basis.)

Practically, the loss of data is more difficult problem. Engineers of the vendor company cannot repair it, nor no recovery will occur just by waiting by. Information is property which is unique in the world, even if it is a garbage programs written as students' exercise. Therefore some sort of requirement would be necessary, by which every data (except temporary ones such as cache or swap) should be so redundant that it will be recoverable in a short time in case of failure. Of course it would be allowable that the recovering time varies according to the level of urgency. (That is, some of data may be stored in removable or non-direct-access media etc.)

It must be noticed that the each requirement items above (on equipments and data) presupposes that only a single failure occurs at a time. If we must also presuppose such events that several failures occur at the same time, which may occur only rarely (according to the probability theory,) then the number of events we should presuppose will increase in square or cubic order, so that it will be difficult to make counterplans in advance both in technical aspect and costs.

At last, I notice users tricks. There is no definitive (low-cost and effective) way to prevent them. In fact, users can do everything if he/she has ill will and prepares for it carefully. Although I have given-up it basically in NUANCE, I included some items which might keep good-natured users from bad temptation, which may be said the idea based on some kind of thought in Christianity. That is, I wrote those kinds of requirement items which include, for example, the plan of arranging cables carefully so as to keep users from the circumstance "I pulled an equipment part just a little, and it came off. As it is fortunate, I took it home and am using it."

5.5. Basic design.

5.5.1. Summary of requirement items.

I can summarize requirement items I described above almost by following keywords.

〈1〉 Price
〈2〉 Stability (Availability of continuous operation)
〈3〉 Security
〈4〉 Attractiveness (Performance in speed. Ease to use)
〈5〉 Extensibility
〈6〉 Centralized administration
〈7〉 Users' freedom

Especially in NUANCE, considering above requirement items that are contradictory one another, I used the design goal that:

*For users: (whichever machine he/she takes, it looks like) his/her own machine.
*For administrators: (all machines look like) a single machine.

5.5.2. Choice of platform.

Platform means the common base for products. To select a specific platform means selecting a group of (available) products that will be spread on it. (It is a distinct problem to choose specific products from the group.) So far, especially in Japan, as hardwares acted as platforms as shown in Fig. 5 (a), to select a platform was almost the same as selecting a model of computer (or a vendor.) As now the market is changed as Fig. 5 (b), there are both the hardware-platform concerned with peripheral equipments and the software-platform concerned with application softwares. While softwares were made to be compatible with hardwares in the past, now it is becoming that hardwares are made to be compatible with

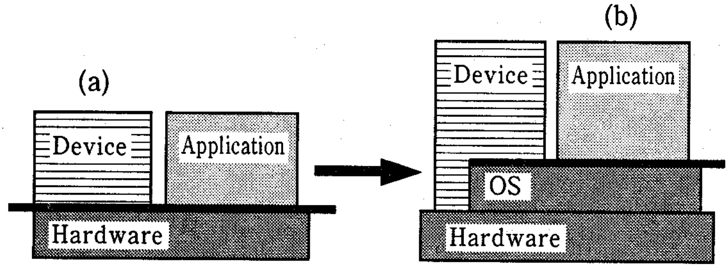

Fig 5. Platform

softwares. And now softwares are already playing theleading part of information systems. Therefore the latter one, software-platform, should be fixed first. It can also be said selecting the operating systems in a broad sense (including window systems that do not have boot or device-management feature by themselves.)

Considering the above discussion collectively, only three of current products (or technologies) existing in the market now remain: (37)

1) MS-Windows(+DOS): I write "Windows" below.
2) MacOS
3) X-window (+UNIX): I write "X" below.

I may choose one from three ones above. But desirably two ones will work compatibly, because each platform works well on some particular usage but not so well on other usage, and because it would be a responsibility of educational environment to provide opportunities to experience various platforms. In practice, also in our former system, two platforms, UNIX and DOS, were provided and have worked complementary each other. This policy will be desirably inherited.

As a result, I chose 1) and 3). Although 2), MacOS, has a benefit in its advanced features, excellence in the user-interface, and especially in the variation of products for artistic area, but I chose 1) as the main system considering issues below.

*2) cannot be compatible with 1). (Although emulating Windows on Mac might be possible, there are only incomplete products in the market.)

*Both 1) and 2), the operating system is owned by a single company. But, while hardware is open and in competitive situation in 1), even the hardware is occupied by a company exclusively in 2).

*Mac strongly tends to be provided as a package equipment. It is the case especially for

(37) In addition to three ones, I was also much fascinated by NextStep. But it was not enough prospective for lack of the variation of applications.

those models in the price appropriate for user machines. It is a fascinated for general users, but is a negative factor for preventing them from obsoleting.

*1) has an advantage to 2) of being more popularized and more extensive market. And transferring Mac applications to Windows is underway to a certain extent.

*I could not find appropriate technology to make it "personal-computing" machine under the system configuration described below.

However I included no statements which will eliminate 2) in the requirement, and therefore included no items which will restrict machine model. I only presupposed Windows-based PC as a model-machine for describing requirement items on features and performance. (But in fact, no other proposals appeared.) And for 3), I kept included it as the sub-platform as far as possible, because:

*It can be compatible with 1) or 2) by emulation.
*UNIX is indispensable for utilizing networks.
*There are much public property for UNIX (that are different from PC culture,) such as excellent technology accumulation or free softwares. (38)

5.5.3. Hardware configuration.

In the discussion I described in previous sections, following candidates for system configuration:
*Host=Terminal configuration.
*Standalone PCs.
have already disappeared automatically as out of the question. (I do not discuss about them in detail.)

Possible candidates for the workstation to be put in front of users are:
1) Engineering Workstations (EWS)
2) X terminals
3) Personal computers (AT-compatible machines or Mac; in fractice, I examined each problem described in this section in parallel.)
(Each is presupposed to be connected to the network.)

Although 1) is the most fascinating as a single equipment, I can hardly select it because:
*Expensive for using 100 units as user machines.
*As a non-preemptive, multitasking, relatively heavy operating system will appear in front of users, the procedure and the reqnirements to boot and shutdown it will be possibly

(38) Practically, it is difficult without free softwares to enrich the software environment in educational organizations.

felt like a burden by users.

As I reported before [3, 4], the latter one might be possibly resolved by some administrative means such as diskless or dataless configuration. But the price problem is unavoidable.

On this point, the solution that uses X terminals is not so expensive, and, as the machines put in front of users are basically diskless, I feel secure on it concerning information security. Its problems are:

*Current Windows-emulation software products on Unix+X have not yet worked stably.

*There are some issues unsatisfactory for those users aiming at professionals on which I discussed in section 5. 3.

On the other hand, concerning PCs there can be two kinds of solution for providing multiple platforms, that is:

*Software products to emulate X-terminal on Windows, which chanced to become stable (just in time for NUANCE .) (It can be used together with other Windows applications simultaneously.)

*PC-UNIX, which was also becoming stable and popularized. (Two systems can be used compatibly by exchanging each other by rebooting.)

And of course, PC is considerably better in price and performance. (But because X-terminal emulators are still rather expensive, there would be only a little differetce in the total price from (real) X-terminals.) Comparing to X-terminals, there might be a drawback in sharing them, on which I describe in the next section. Once we can resolve it, it can be said PC is the best solution.

5.5.4. "Personal Computers"

In general, PCs are made and sold as "personal computers." That is, it is presupposed that a single person owns and uses them. In this case the machine and information may be at the same place. On the other hand, what we desire is the computing for individuals. Although information and information space are owned by each individual user, machines themselves are shared.

Concerning where each user's information should be stored, there were two solutions up to now:

1) Fixed media: hard-disks etc.

2) Removable (carryable) media: floppy-disks etc.

As recently especially harddisks have grown drastically in capacity and become low in price, there are many system-constructors who will, only by this basis, have no question as to the system administration depending on local disks, that is, on disks installed inside each user machines. (They sometimes tell a funny issue that it is not necessary to save the cost in this matter.) But local disks are the very sources of many problems described above. It can be said there is no security in systems depending on local disks. Informations of individual users may leak out freely, and viruses may be get entered freely. Although protection mechanisms are ready in some operating systems, users with a littel skill can see anything by scanning raw devices. Above all, there arises that an user cannot access the document he/she made and saved on the machine A yesterday, because today he/she is using another machine B due to the occupancy of A. It is intolerable inconvenient.

On the other hand, there is no such problem in carryable media, and the problem of their capacity access speed that existed in floppy disks can be considerably improved in recent media such as MO or MD (although now there tend to appear too many kinds of media). But there is another fundamental problem. Carryable means that people must bring it. Once an user leave a media home, he/she cannot access the information. It is not an user's mistake, but is a defect of the system on which an event to occur naturally is not presupposed.

As a result, to solve both problem, the optimal solution available now is:

3) Network disks.

It means that the place information is stored and the machine (workstations) site should be separated physically, which would be connected by networks, and the former is to be placed in closed spaces, and the latter is in open spaces. The feature for it is supported by so-called Network Operating Systems (NOS), or, in ohter words, NOSs have been developed for this purpose. And security problems have been almost solved (at least about the problem of information leaks.)

But there remains a bootstrapping problem (in the literal sense.) Thet is, where user machines should be booted (started-up) from, in other words, where the client-side software of NOS (that works on user machines) should be loaded from. These information resources necessary to startup machines also need to be protected from misoperations or ill-will, and some people possibly would like to administrate them by him/herself. As a result neither 1) nor 2) is appropriate, and 3) is also impossible because of its mechanism.

There is a way to use ROM. In this ROM, called BootROM, the minimum code for downloading the code necessary to startup the machine is included. Therefore only a NOS, which will be able to respond to requestes from computers executing the code in ROM, is necessary. In this way administrating PCs in diskless way is possible, so that problems described above will be almost solved.

This way is generally used in engineering workstations or X-terminals. It is also possible on PCs, although it is not known in general. A socket for this ROM is prepared on major NICs (Network Interface Card: also known as Network Board in Japan) (39) and major NOSs support it. (40) This configuration, called as remote-boot, might be said the the most

(39) Only a few people (in Japan) knew about it at the moment of my research, and my search work began when I saw the socket and wondered what it is.

(40) The product which supported it first in Japan was NetWare3. 12J. By the way, it was about late April 1994 that this feature was announced in Japan (which was after I released the requirement of NUANCE!) It was so risky that I was in a cold sweat.

significant feature of NUANCE for the time.

Although diskless-administration of PCs (41) which does not depend on 1) or 2) is possible in this way, I equipped PCs with local disks. The reasons are that Windows or DOS, which are operating systems for personal computers, will achieve the performance by utilizing local disks for swapping or cashing, and in addition that there often arises the stituation requiring local disks, such as PC-UNIX or other alternative environments. Therefore dataless administration, in which no information resources are put in open space, is achieved (in the main environment by Windows.)

6. Conclusion.

I considered a lot of matters through the designing process. I apologize that this paper becomes long exceeding the expected number of bytes because of this reason. In spite of myself I put something like my passion in this paper. This paper might not be enough for understanding NUANCE, because considerable parts of this paper are abstract. As it has already been in operation, I hope you to use and feel it actually. For the people far, I plan to provide information of NUANCE by WWW etc. via Internet.

In constructing NUANCE, I felt keenly that, although the recent circumstances may be said a blessing for users, on the other side users' troublesomeness and inconvenience, which result from a logic of mass production, are hidden. This paper is the report and the study concerning my small but possible resistance against the large trend.

I have experience of working in a computer vendor. There I did research work in provider's side (especially at the uppermost course) with little contact with general users. It can be said that I am a person grown in the logic of provider's side. Many new matters came in my sight by placing myself in users' side (although it is possible no more to place myself in novice users' viewpoint.)

In my case, I happened to move to my current position by chance, and fortunately could experience both viewpoint as a result. But in society of Japan which has little liquidity among occupations, there are only a few people who will have such good fortune. I also think that the low liquidity might be the very factor that makes it difficult to solve many social problems (conflict of claims from each standpoint.)

Anyway my this experience was (for this once (42)) precious and fortunate. I am grate-

(41) At the moment I write this paper, as we still have problems in some files concerning the Japanese language system, I have not yet succeeded in removing all files from local disks.

(42) For me, a professor, it is a work which is neither research nor educational one, is troublesome, and for which I am paid nothing. Therefore I hope in my mind that some appropriate positions and persons will be got prepared until the next time.

ful to the persons who gave me this chance and supported me. Professor Taniguchi, the then Chairman of Computer System Committee, and Associate Professor Sato, the current Chairman, and other managing staffs of our university supported me with many kinds of "concern as the organization." Associate Professor WADA, who played the leading role in constructing the former system, gave me much advice as the predecessor, despite that I entirely played the role of picking flaws in the former system. In advance of beginning research on NUANCE , people in Nagano National College of Technology and Information Processing Center of Shinshu University gave me advice by courtesy as neighboring higher educational institutions. I feel sorry for the related persons in company "D" and "M" (I do not write their names as a precaution) which cordially cooperated in the research described in section 4. 6. 3., because, as a result, they were not recompensed enough for their much effort (although they did it as a part ef their business.) (43) I am much grateful for those persons, (feeling sorry to do it collectively.)

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(1994. 3. 30 受理)

(43) I will write about the company currently in charge in another opportunity.