PROFILE MODEL OF PROCESS FOR INTELLIGENT SYSTEM IN PRINTING

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Abstract: The idea of CIM is recently introduced gradually in printing factory. For getting successful result on CIM and growing to higher level of IMS(Intelligent Manufacturing System) than CIM, it is required that any information about parameters controlling prepress instruments, press machine, drier and forming machine are accessible and can be handled by any machine element any time. These information consist of the various characteristics of original image and/or image data, and material used in the printing system, direction manuals and so on.

This paper proposes a profile model of system in which all characteristics parameter stated above are treated under same base. By using the proposed profile model, the computer controlling the printing process can obtain any parameter value or parameter linkage in order to calculate new parameter values for initial machine operation settings and holding a stable operation. The profile model proposed here has also great advantage for accumulate the technical knowledge.

If this profile model is standardized in world wide scale, the information about press machine control can be used commonly in the world. This would make a machine easy to connect another machine and/or machine element.

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Introduction

The effort has been paid widely to automate and rationalize each process element in the printing system. These elements play important role for constructing a stable high speed machine and keeping good environment of printing factory for worker. Some trials have been carried out to integrate printing machine to achieve further automation connecting with the concept of FA (factory automation) in recent year. Factory automation is not only to aim the automatic operation of machineries but to be necessary to develop the system to CIM which includes sales information, stock control and total information of the operation.

Furthermore there is a trend to drive it IMS that combines overall technical information widely not to restrict in only a factory or company. IMS is a kind of open system in manufacturing and needs the cross communication about control parameter between different factories and even between deferent companies.

In order to achieve such high level rationalization, it is essential not only to automate each equipment and element at each factory but to eliminate the difficulties of interface when various automated equipment are combined with the printing machine.

This paper proposes a rule to represent the control parameter, characteristics of material and functional relations between a parameter and other parameters, systematically. The base of this proposal is on the promotion of high level automation of press machine by removing the difficulties of the control system in present printing machine, but this proposal can be applied to wider objection to construct new concept of printing system.

By using this rule, the technical information for operating machine can be also easily integrated. Furthermore, the some suggestions are given to create a coded system on basis of the layer model together with the way of use. The construction of the open system of the layer model proposed here will also promote the complete automatic control of printing system since all parameter values and the technical information accumulated in the system as the data base will be used widely in the decision of new setting of machine operation.

Hurdles for complete automation in the printing system

The printing machine is becoming the automated machine gradually, but it still contains a lot of difficulties in full automation. There are many hurdles to jump over for machine designer who wants to construct higher level automated printing machine. The first step to do this is to know what the hurdles are. In this section, it will be shown that the highest hurdles contained in printing system is the lack of the smooth flow of information relating with machine setting and control as shown below.

In recent printing process, quality design of image for print is mostly figured out at the stage of color separation process in which the several kind of image processing equipment are used under mutual cooperation. The communication about image data and related information between these equipment become gradually easy even in high grade CEPS by using standard format and open system.

With present CEPS, the characteristics of image can be easily modified with so high degree of freedom that the constant deviation of image characteristics in press process such as dot gain are able to carry over to image data with high accuracy at the time of the design in CEPS. In this situation, only freedom of initial setting and keeping stabile operation are required for press process. Automatic initial setting and automatic control for keeping stability need various type of information such as image data, paper, ink, dampening water, temperature, and humidity etc..

In the press process usually change some of these parameter time by time. The press operator decides the setting point and value of setting according to the change of these parameter.

It is necessary to know whole information about parameter and knowledge about the way of giving decision by using the information for full automation. In printing process, full automation will be achieved by setting up automatically at initial and keeping stable operation of whole process in running without any affect from environmental change as shown in **Figure 1**. The main job of operator is the initial setting, inspection and correction of working condition according to the inspection.

There are some behinds in present press process

control for complete automation in printing factory as follows.

(1) The enough information of deciding initial settings for press machine is not given, then the operator should give the decision in his experience and perception.

(2) The functional relation between setting and various parameters is not always clearly given. The solution should be given by operator decision.

(3) The functional relation between setting or changing environment and the defects of the print is not always clearly given, too.

(4) The experiences of the expert have not been accumulated as data base that can be used for press control.

(5) The information about image data carrying the concept of design is not transferred to machine as the technical data, and cannot be used for direct machine setting and control.

For achieving full automation in printing factory, a systematic parameter categorization and the model of system description by using the parameter are required. In this model, the parameter setting will be deduced completely by using the parameter inside the system and the derived setting become new parameter describing next stage of system when some changes in system parameter have occurred. The model constructed here requires the standardization in wider scale for easier communication of information among various machine elements.

Requirement of profile model for printing process

In order to become convenient system model, it

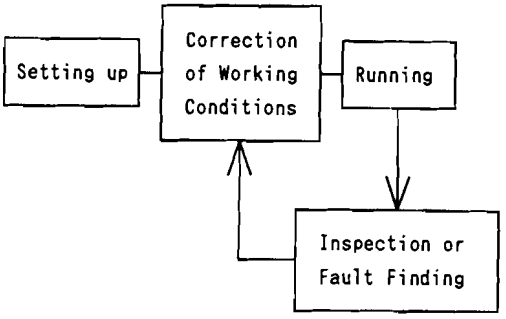

Figure 1 Outline of setting in printing process

(1) has well-ordered structure and is applicable to machine control,
(2) has the structure for easy search and reference,
(3) can defined the relation between the parameter and machine setting for operation,
(4) can be used for defining the control function,
(5) can accept the result of scientific analysis,
(6) can accept various type of representation of control function,
(7) can accept addition new parameter and control function,
(8) has no significant affection to whole system structure in changing a part of it,
(9) has consistency with accomplished rule and standard,
(10) can extend easily to higher level system such as CIM and IMS.

The input information in printing process are divided three categories that are image data, material and instruction as shown in **Figure 2.** These parameters come into printing process from outside the press process, so these may call external information.

The press and postpress process contain various control parameter such as press pressure, printing

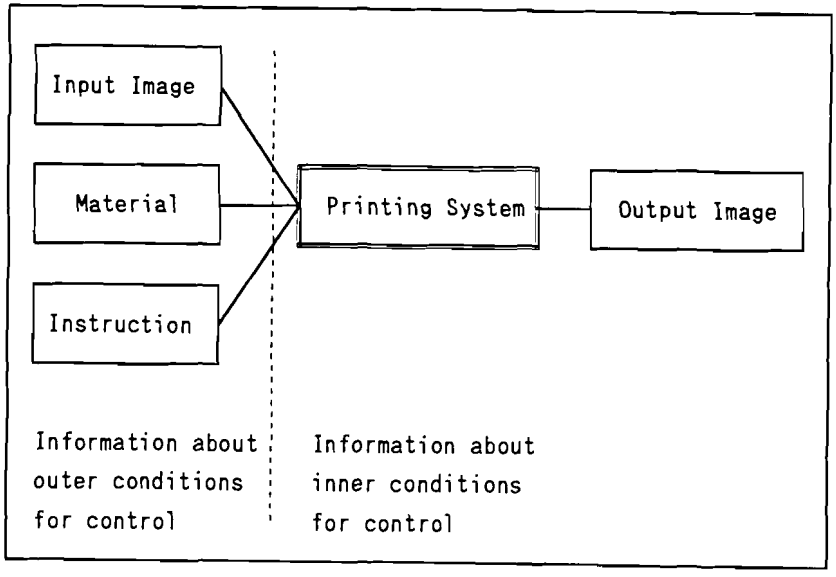

Figure 2 Information relating with system modeling

velocity, opening of inking key, cut and holding positions, etc., that show the location of setting and also need to indicate the value of setting.

These parameters decide the printing condition directly and set up machine directly so these may be called internal information of process.

It is necessary to transmit all of the information to any part of the printing system, including both of the external information and internal information indicating the present situation of the equipment. Prepress process generating input image data and sending it to press process also needs the information about present press situation for giving a decision of plate making condition. Then some of the information should be sent from press to prepress, and others from prepress to press. Some information can be used from both side, too.

As shown in above statements, each data of parameter may use so many elements in various location of process that admission whole parameter in same manner become essential.

For initial machine setting and stable operation of machine, the control parameter(internal parameter) have to be set up suitable value by using the entire related parameters. The related parameters for setting may be used for setting other internal parameters in some case, as well as external parameters. This means that both of external and internal parameters are used for setting, simultaneously.

For this reason, it may be convenient that entire parameters including external and internal has the same type of data structure.

Hierarchical layer structure model for printing system

There is a possibility overcoming many difficulties for achieving perfect automation in printing system by promoting smooth circulation of the information in the system, as explained above.

As far as the image data format, the considerable effort has been done for the international scale. The interchangeability of different data format of picture image by different vender is gradually being achieved.

The internal information exchange in the printing system also need to include all of the information

such as system operation and control, situation of the machine operation, history of the operation and the characteristics of the various materials. This rather of comprehensive information system is required to include the information about all of picture image data and control parameter, and also to be capable to include the standardized rules readily exist at the same time.

The layer structure model is suitable for expressing both of internal and external parameters in same manner. **Figure 3** shows the outline of layer structure expression of internal and external parameter.

For the printing process concerned, it is suitable to have the categories of printing process in order at the higher level with having the content of operation to be followed, the items of setting to be next level, then the setting value with its factors(variable of function) list to be followed and the pointer of decisional function structure at the bottom. A real expression of function in bottom layer is only pointer that shows the leading header address of the description block of function.

The parameter value for setting is calculated from the variable pointed as parameter list in 5th layer according to functional expression that can be described in any way of description such as analytical function, neuron-structure, and/or fuzzy expression.

The material concerned should have the expression in layer structure with material classification as the 2nd layer, a name assorting each material, producer and product code as the 3rd layer, the parameter name as 4th layer and the related variable list as the 5th layer. The address pointer of functional relation or measured data table is also given in 6th layer as same manner as press process.

The content of instruction being input together with picture image concerned is also expressed in same manner, in which the target being instructed is in the 2nd layer and the classified content of instruction is in the 3rd layer and so on. The instruction tree structure, however, have not been studied in detail.

Figure 4 shows the first and second layer for printing system as an example of layer model. **Figure 5** indicates the layer model for paper above 4th layer, and **Figure 6** is a part of structure modeling for web-offset press above 5th layer. With arranging the information in this kind of hierarchy system, coding

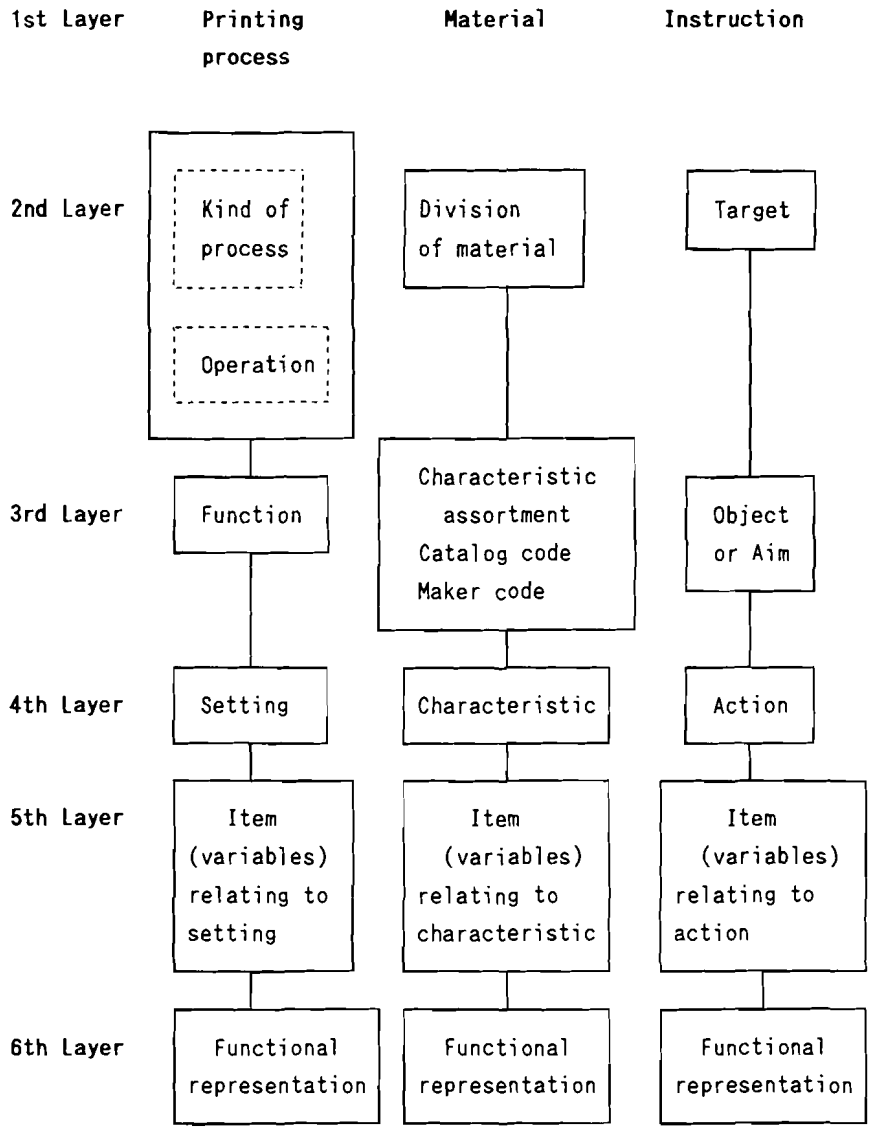

Figure 3 Layer structure model for printing process parameters

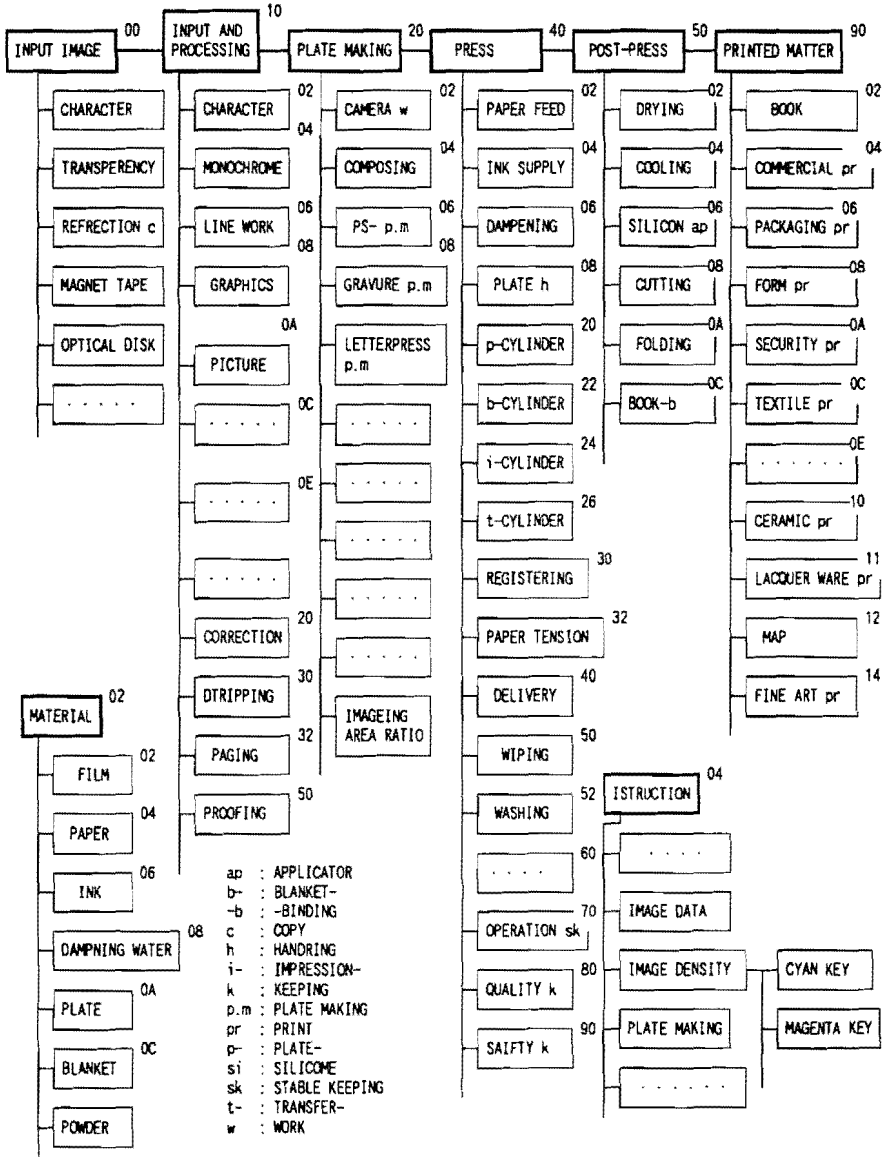

Figure 4 Example of parameter contents for first and second layer in basic model

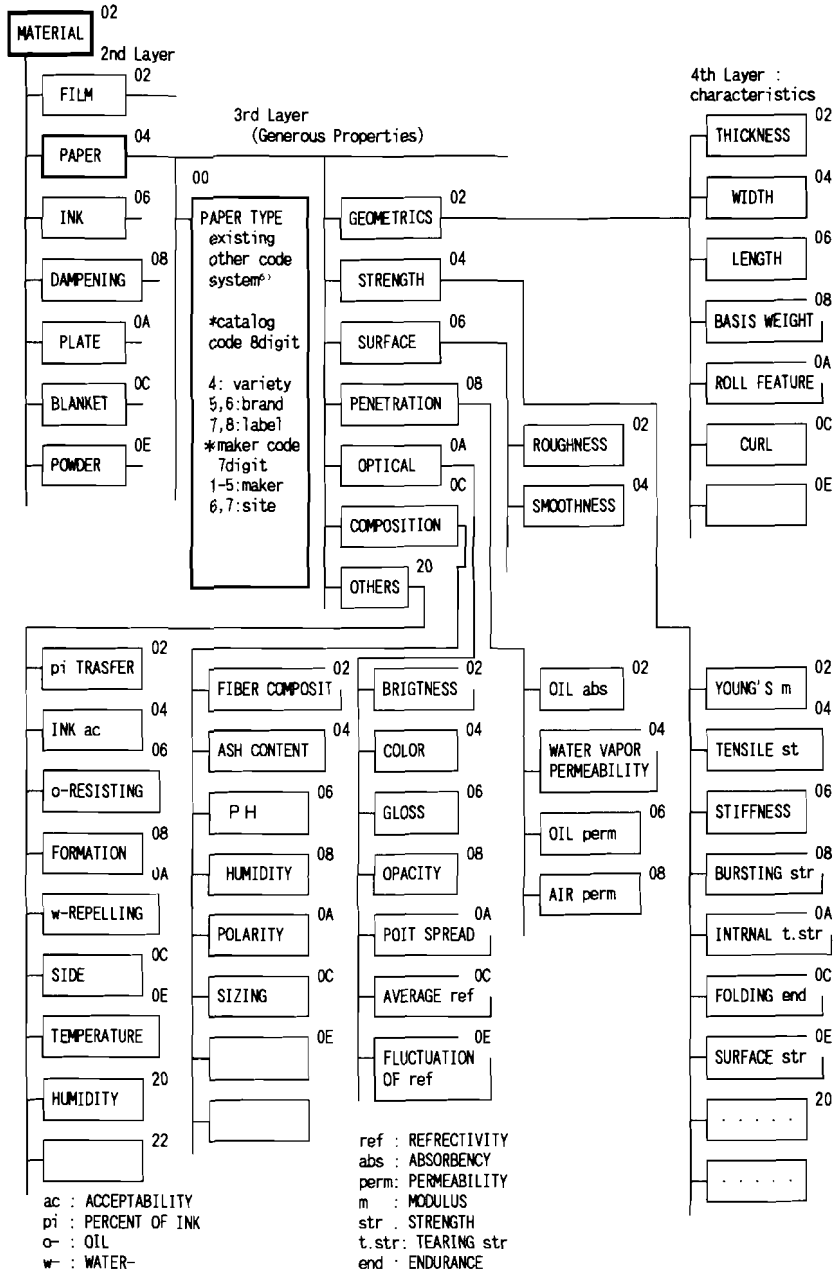

Figure 5 Example of parameter contents above 4th layer for paper

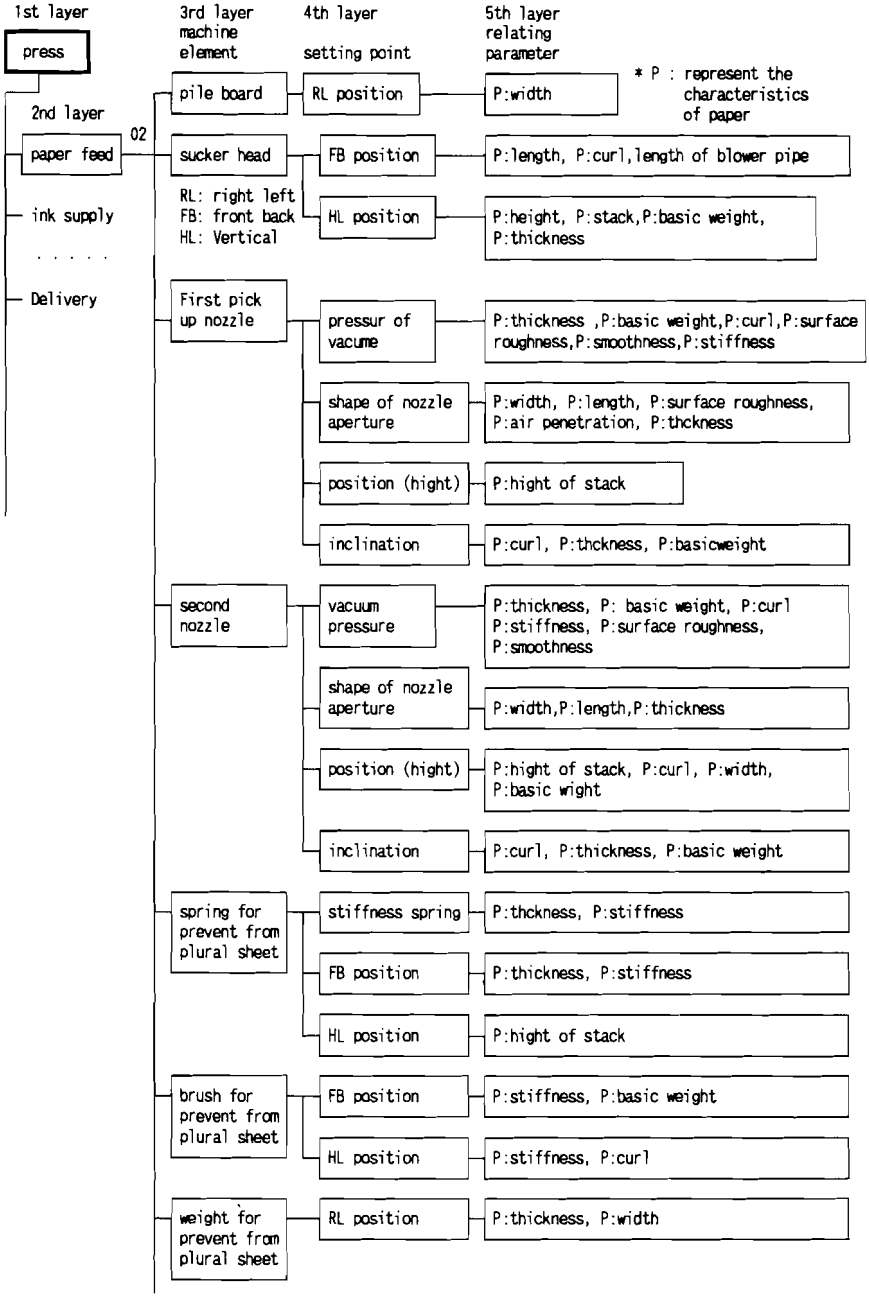

Figure 6 A part of control parameter contents above 5th layer for web offset press

of the item in each tree can be achieved at each level and combined in series for entire coding .

Application of layer model to process control

The hierarchical layer model proposed here can be applied effectively to process control in printing factory. The initial setting of each equipment in printing process is the most important job when the image in print is changed. The image contents and material characteristics include size strongly affect on setting. The system has to know all of the setting been affected by the changing parameter and decides the setting value completely for perfect automation.

Figure 7 shows the steps of search for the location of setting and driving the value of setting. This figure also shows the example for changing paper at initial stage.

When the process receive some indications for some change from the operator or controller(computer), the computer in the system can find out the location of setting to search the 5th layer(see Figure 3) in which all of the related parameter shall appear. The search will be done perfect if the related parameters in the 5the layer(see in Figure 3) are arranged very well. The point needed setting on equipment can be given in the 4th layer(see also Figure 3) in the same tree.

The value of each setting is decided by using the function pointed in 6th layers(see also Figure 3). In driving the setting value, the other parameters appear in 5th layer are also necessary. Those parameters appearing in 5th layer become the variables of the function in calculation.

Figure 8 shows the example that the indication of selected location of new setting (black painted part) by using this model and searching system constructed when the thickness of paper in print is changed. This is achieved by using the data base constructed by using the concept of this model and specially arranged search program of 5th layer and display program.

Figure 9 is also shows the case of changing the ink characteristics. These examples have not been completed yet, but by using these displayed result operator can indicate the precise position of setting and teach it to system. The system can grow more intelligent when the more precise information accumulated in the system. It is very useful to

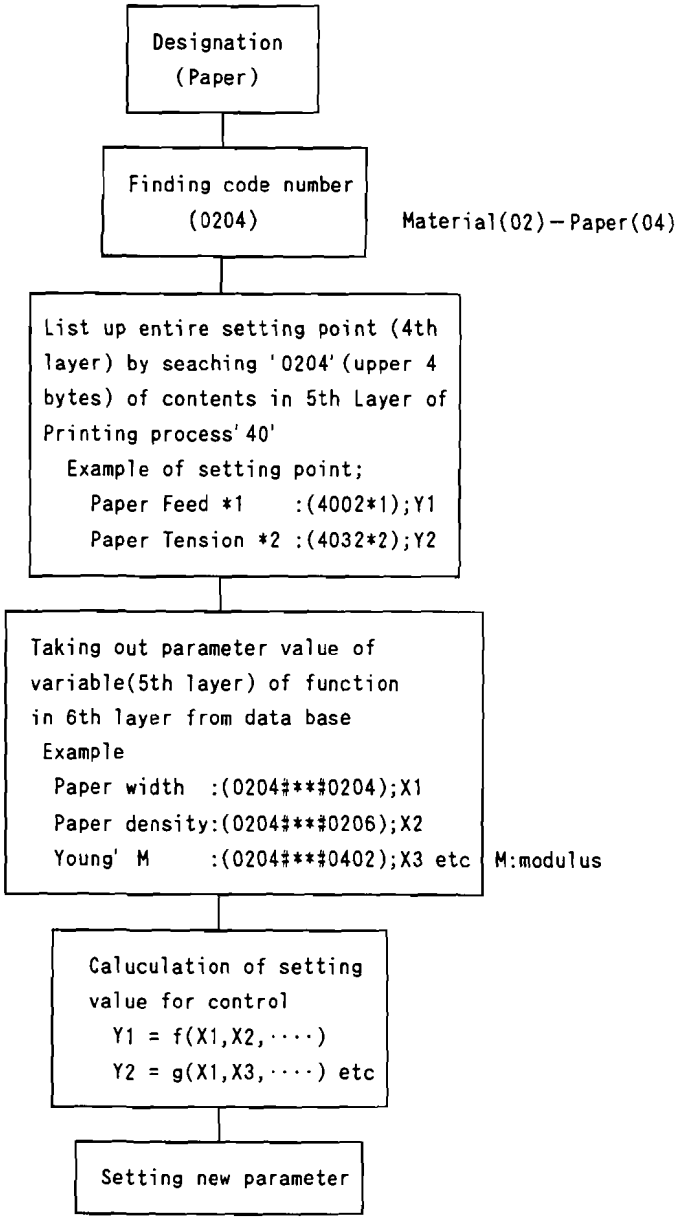

Figure 7 Finding and setting procedure for new control parameter value by using proposed proposed layer model

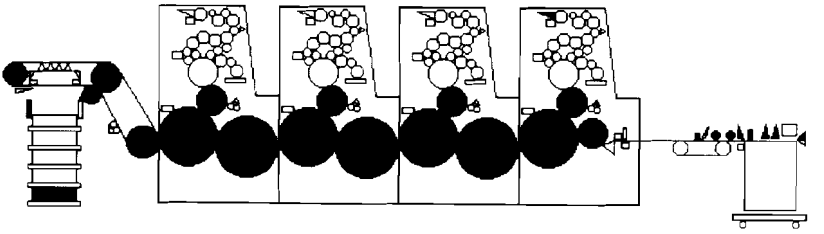

Figure 8 An example of result for searching the setting points in the case of paper thickness changed

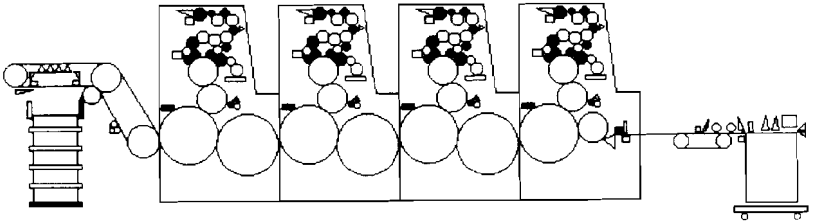

Figure 9 An example of result for searching the setting points in the case of ink changed

accumulate the knowledge of operator and engineer, since this system can accept easily these information and accumulate.

Proposal of coded system and standardization

Using this proposed model, the characteristic of material, instruction, image character, and control parameter can be treated in same manner, so the same algorithm can be used for searching the parameter about material and control etc. Furthermore, all of the equipment for automation can develop easily the application software in same base and use same database, if the method of description in database about material characteristics, instructions, and control parameter is standardized.

If this method become international standard, the whole printing machines and machine elements in any country can access same database for setting and operating. This brings great advantage for printer, machine manufacture, paper and ink maker etc., since they can use huge database by small labor when the database is accomplished.

It should be convenient for constructing database that the layer model constructed is transferred to code system. All of the parameter have the each code and this code can be used for searching and setting value, and even the functional representation. An example of a set of code number is given in Figure 4 and 5 which can find on upward right corner of box enclosing each specification. For holding the compatibility among all instrument and printing machine, these code number should be standardized under world wide agreement.

Conclusion

The profile model of printing process consisting of layer structure are newly proposed. By using this profile model, there are a possibility to construct high level intelligent automatic printing system. An example of the adaptation of real printing process is shown for web offset printing.

The promotion of constructing database of material, instruction and control parameter about press machine is required for more intelligent use. The profile model can be used effectively for achieving highly intelligent printing factory and accumulating the technical knowledge under world wide cooperation when the world wide agreement of the system model and expression of parameter is given as well as image transform format.

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