Architecture Model and Control Parameter Coding for Graphic Arts (AMPAC)

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Keyword : standard, database, system integration, intelligent system, open production system

Abstract

It is necessary to combine the various kinds of process parameters in production printing process such as design, material used in imaging process, platemaking, printing, post-printing, and some instructions for the operator. Freely exchanging these parameter data to all node in the production process for the printing industries may encourage much progress in constructing an economize and intelligent production system. ISO/TC130/WG2 is developing AMPAC standard in cooperation with Japanese IPTS working group for establishing exact and easy communication among various fields around printing production process.

The purpose of this standard is to prepare a common information exchange base on a global scale that can be accessed freely as a world wide distributed database called AMPAC and can be used to control all parts of the process. This standard can be used in conjunction with other standards such as standardized workflow management systems and/or Digital Network Production System (DNPS).

This paper shows the concept of AMPAC and some examples of its usage and also the recent developments in ISO/TC130/WG2. The basic idea and most interesting application of AMPAC for constructing intelligent printing system was presented at 1994 TAGA meeting.

Target of AMPAC

AMPAC stands for Architecture Model and Parameter Coding for graphic arts and is being proposed for ISO standard. This standard aims to establish a unified communication base of parameter data exchange through out the whole industry, not just specific segments or special interest groups. It consist of four parts:

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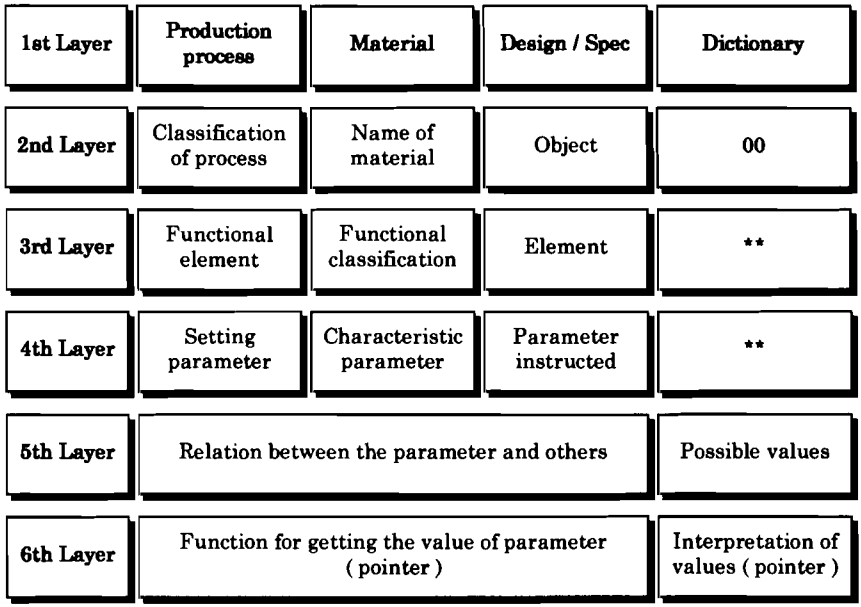
1) A standard architecture model for defining and inter-relating the parameters via a six layer structure of increasingly detailed information,
2) A description of the requirements for the physical and connoting parameters in printing process from design to delivery,
3) Any and all requirements for the relationship between the various parameters, and.
4) Requirements for control parameter coding so information can be sent in a common format.

For achieving the first and second requirements, all the parameters in printing system were taken into consideration and classified by using the layer structure as shown in **Figure 1.** Upper two layers categorize the systems and system elements as shown in **Table 1.** The categorized structure for upper two layers representing the printing system shall be standardized in Part 1. The following Parts of the standard will characterize the detail of the parameters used in the system **(Figure 2).**

Figure 1. Architecture model for classification of parameter on printing system



Requirement for parameter coding

In constructing the database on each site, parameters should be pointed by using code number defined in Part 2 to Part 7 of AMPAC. Before Part2 to Part 7 becomes standard, the English name will be used temporarily for presenting "parameter name".

Table 1. The upper two layers of AMPAC architecture model.

[00] Specification of parameter values *1	[0000]
[02] Design	[0202] outline of products
	[0204] design concept of document
	[0206] page layout
	[0208] comprehensive
	[020A] object(page element)
	[020C] change in object
	[020E] instruction(keyline)
	[0210] selection paper stock
	[0212] instruction for bookbinding
[04] Text processing	[0402] input composing basic layout
	[0404] basic style
	[0406] special style
	[0408] ruby
	[040A] heading
	[040C] cutting note
	[040E] separation
	[0410] commentary
	[0412] table
	[0414] rule
[06] Text processing device	(Under construction)
[08] Image input	[0802] contents
	[0804] schedule
	[0806] preparation of input
	[0808] image input work
	[080A] preparation of line art image input
	[080C] line art image input work
[0A] Image processing	[0A02] disk set-up
	[0A04] platemaking instruction
	[0A06] edit
	[0A08] save
[0C] Image assembly	[0C02] line art image tint making
	[0C04] line art logo input
	[0C06] image combine
	[0C08] line art image combine
	[0C0A] trapping
	[0C0C] registration
	[0C0E] layout sheet
	[0C10] proof

[0E] Output processing	[0E02] output preparation
	[0E04] film output
	[0E06] press plate output
	[0E08] proof
[10] Image processing device	(Under construction)
[12] Material	[1202] paper
	[1204] film
	[1206] presensitized plate
	[1208] blanket
	[120A] ink
	[120C] fountain solution
[14] Web-fed offset press	[1402] paper feed
	[1404] printing
	[1406] dampening
	[1408] image transfer
	[140A] drying
	[140C] cooling web bath
	[140E] folding device
	[1410] stacker bundler
[16] Sheet-fed offset press	[1602] paper feeder
	[1604] press
	[1606] delivery
	[1608] management
	[160A] quality check
	[160C] safety
[18] Gravure printing press	(Under construction)
[1A] Letterpress	(Under construction)
[1C] Screen printing machine	(Under construction)
[1E] Non-impact printing	(Under construction)
[30] Bookbinding	[3002] saddle stitcher
	[3004] adhesive side stitcher
[40] Converting	[4002] flexible packaging laminate
	[4004] flexible packaging extrusion laminate
	[4006] flexible packaging slitter
	[4008] box forming machine
	[400A] carton diecutting and creasing
	[400C] sack
[90] Process evaluation	[9002] image quality
	[9004] image quality control
	[9006] operating controller

Note *1 : Category [00] is the dictionary of the assigned vales and use for defining the values or contents of the special parameter defined in other category. The parameter name (code) of this category is given as 'reference' in data format and the specification of values associated with this parameter is given in 5th layer of this architecture as values. Each AMPAC database can prepare the each dictionary as specified dictionary which shall be given highest priority and replaced in the subset defining the dictionary although standard common dictionary will be prepared for convenience to common use.

AMPAC

[Architecture Model and Control Parameter coding for Graphic Arts]

Part 1 : Architecture model for graphic arts database and standard parameter description in it.
Part 2 : Parameter list and coding – Products of printing
Part 3 : Parameter list and coding – Preprinting
Part 4 : Parameter list and coding – Printing process
Part 5 : Parameter list and coding – Finishing (Bookbinding and other) and converting
Part 6 : Parameter list and coding – Material used in the manufacture of prints
Part 7 : Parameter list and coding – Measurement and evaluation of process and print images

Figure 2. Expected Document set of AMPAC (proposal at present)

The dictionary transferring from English parameter name to code will be prepared immediately after each part and/or whole set of parameter has been established as standard.

When they are written with alphabet name, they should be transferred to the code for convenience of data exchange and easy searching before sending out to another site by using appropriate utility program. The table and the utility program(JAVA) for getting the corresponding code from the alphabet name will be supplied freely through the internet.

Each parameter classified by the upper four layers will have a unique meaning in whole system so that we get enough information from the assignment of it in each layer to distinguish any desired parameter from another. In AMPAC, the assignment in each layer will be done by using two hexadecimal numbers, so that eight hexadecimal numbers are required to destine an arbitrary parameter. The numbers are combined in the order of layer, the significant two numbers means the assignment of first layer. Some examples of the assignment are shown in **Table 2.**

Table 2. Example of layer structure representation of parameter and assigned code numbers.

1st Layer	2nd Layer	3rd Layer	4th Layer
[12] Material	[1202] Paper	[120202] geometrical properties	[12020202] diameter of roll(web) paper
			[12020204] length of roll(web) paper
			[12020206] width of roll(web) paper
			[12020208] thickness,caliper
			[1202020A] size of a sheet(long direction)
			[1202020C] size of a sheet(short direction)
			[1202020E] curl
		[120204] strength properties	[12020402] tensile(breaking) strength
			[12020404] stretch at break,(elongation)
			[12020406] Young's modulus
			[12020408] tensile energy absorption
			[1202040A] compressive strength
			[1202040C] compressibility
			[1202040E] tearing strength,(tearing resistance)
			[12020410] bursting strength
			[12020412] folding endurance, fold number, double fold
			[12020414] internal bond strength, Z-direction (tensile) strength
		[120206] bending properties	[12020602] stiffness/static bending method
			[12020604] bending stiffness/resonance method
			[12020606] bending stiffens/Clark method
			[12020608] bending stiffness/Gurley method
			[1202060A] bending stiffness/Taber method
		[120208] surface strength properties	[12020802] (IGT surface strength), picking velocity/IGT
			[12020804] wax pick resistance
			[12020806] vessel pick resistance
			[12020808] abrasion resistance
		[12020A] frictional properties	[12020A02] static coefficient of friction
			[12020A04] dynamic coefficient of friction
		[12020C] smoothness	[12020C02] smoothness/bekk method
			[12020C04] smoothness/J.TAPPI-A method

Requirement for parameter description in database and communication

The AMPAC database also includes a value, a set of values or a functional representation driving the parameter value (5th and 6th layer in architecture of Fig.1). The data format for describing data contents in database shall be as follows;

manufacturer ; model identifier ;information group ; identifier in parameter ; parameter name [:reference:] ; n1 ; PR1,PR2, ... ,Prn1 ; Q[name] ; DIM { ; DIMname} { ; DIML, DIMM, DIMT, DIMA, DIMK, DIMMOL, DIMCD } ; DIM10 ; n2 ; DATA1, DATA2, ... , DATAn2

In the above notation, meaning and a content of each part are as follows;

;	Separator of data element. This separator is necessary when a content of an element is omitted.
manufacturer	Name of manufacturer for machine, machine element or material, name of designer or creator for design or image.
model identifier	If necessary write numeric number else write "null" which discriminates products when there are two or more products in AMPAC database of a manufacturer.
information group	The name of receptacle which contains a set of parameters such as table or class.
identifier in parameter	Unique ID number (numeric) which discriminates parameters from others having same parameter in same information group. This can be omitted.
parameter name	Parameter code in 8 Hexadecimals defined in Claus 5.1(or parameter name).
reference	This is used to refer or connect to another information group, parameter, and/or identifier in parameter. This is followed by parameter name and written in the form as ***:information group :parameter name :identifier in parameter:*** just after parameter name (parameter ode) if necessary. Whole of this , last one or last two of above form can be omitted. In the case of the parameter having '000000' code, 'reference' is referred as a parameter of dictionary heading word. [see ANNEX B B-5]
n1	The number (integer include 0) of parameters relating to this parameter when the value is calculated.
n2	Number of data. If n2 = 0, the physical dimension and/or the related parameter and/or the functional relation for the parameter are defined in this parameter description.
PR**	The related parameter defined 5th layer of AMPAC (see Figure 1) the parameter code number or parameter name (temporary use). For the parameter with "00" code for first layer, the set of

	PR**s represent the set of the possibly assigned values for this parameter.
Q[name]	The contents of 6th layer of AMPAC (see Figure 1) An algorithm (function) for driving the parameter value by using the relating parameters. The kind of algorithm is represented by the character designated to '*Q* and each character has special meaning. (a) case of single numeric data : VI (integer) or VR (real) in this case, replace *n2* by "1" and put the value in *DATA1* (b) case of Table: TI (integer) or TR (real) in this case , replace *n2* by numeric calculated from the equation of $n2 = n1 + \Sigma Li + \Pi Li$ where Li is the line number for i-th parameter in the table. *DATA*.which consist of two groups of data array. First group consist of n1 values which represent the line number for each related parameter on the table each related parameter and corresponding values in each line. Second group contains array of data value by the last parameter in first order appearance. The example of data array for parameter **a1** as a function in table representation of **b1** and **b2** is as follows; ISO;example;;;a1;2;b1,b2;TI;0;0;16;2,4,$b1_1$,$b1_2$,$b2_1$,$b2_2$,$b2_3$,$b2_4$, D[b1(1),b2(1)],D[b1(1),b2(2),D[b(1),b2(3)],D[b1(2),b2(1)],D[b1(2),b2(2)], ...,D[b1(2),b2(4)] (c) case of Analytic function: IF[name] (integer) or RF[name] (real) **name** represents the name of function (pointer for storage) (d) membership function under examination (e) neural expression under examination (f) CH:character string (2 Byte code or longer such as UNI-code) (g) DAY: year/month/day/hour/minute/second 1998/02/10/18/02/04 (h) For the parameter with "00" code for first layer, given name in this term points to the file name describing the detail specifications or explanations of given possible values as PR**. (i) NON:used for define the physical dimension of parameter.[see ANNEX B, B3]
DIM	The way of description for Dimensions of the parameter, *DIM*= 0 ; column of index number and DIMN are omitted. Physical dimension of this parameter shall be given another line having same parameter definition and containing Q[name]="NON" in same subset. *DIM*= 1 ; index numbers for principal unit *DIM*= 2 ; name for Dimensions (see *DIMN*)

	DIM= 3 ; conventionally used other unit (ex. % ,density, rpm, dpi, etc.) *DIM*= 4 ; special defined unit
DIMN *	The name of unit defined in ISO 1000 ex.) N, Pa, J, V, F etc. **[Note This term is used only when the content of DIM equals to 2,3 or 4.]*
DIML, DIMM, DIMT, DIMA, DIMK,DIMMOL, DIMCD **	index numbers for the base of unit according to ISO 1000 *DIML* (Length :m) , *DIMM*(Mass ;kg), *DIMT*(Time:sec) , *DIMA*(electric current ;A), *DIMK*(temperature:K),*DIMMOL*(mol), *DIMCD*(cd) ex.) *DIML*=1 , *DIMT*=-1 means velocity *DIMS*=1 , *DIMA*=1 means electric charge ***[Note This terms is used only when the content of DIM equals to 1.]*
DIM10	multiply for unit ex.) k (=10^3), M (=10^6), μ (10^{-6}), etc.

AMPAC in open production system

A machine and/or machine element is specified by a set of physical parameter, such as page size and print speed. The material, image and process are also specified by using a set of connoting and physical parameters respectively. The set of parameters specifying an object or process can be regarded as a subset of AMPAC database. The subset of AMPAC database can be stored at each distributed site separately and composed to the contents of other databases, since the data in AMPAC database have the same format and are written in same manner. Any production system can use any database if they are permitted to access into the database through a common communication line. AMPAC assumes INTERNET to exchange their parameter data as the common communication line. The storage and transfer by using AMPAC database can easily construct the OPEN PRODUCTION SYSTEM.

There could be two portions of communication lines in AMPAC (**Figure 3**). One part is the information about the control parameter set including or excluding the relation between them as an intelligent database open to the any clients, printing manufactures and vendors in the world. The other part is closed. If someone would like to get the private information such as know/how, specification etc., it is possible to access with permission, with or without charge, given by each file holder in same manner as conventional file on web of the Internet.

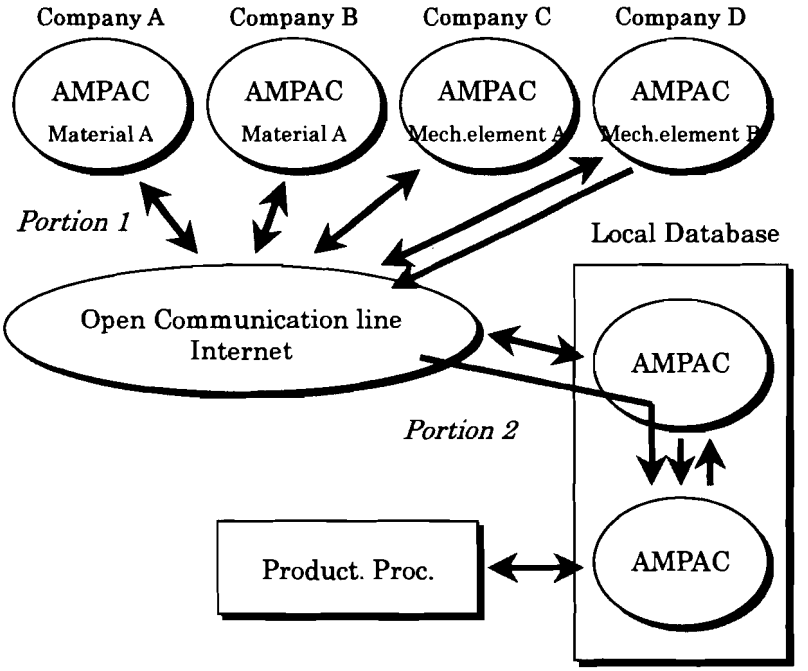


Figure 3. Two type of AMPAC communication

Example of usage

Most important and interest usage of AMPAC for constructing an intelligent production system is shown in present paper[1]. In this paper, some other examples of description for parameters in AMPAC database. These examples give some effective information about AMPAC database such as, how it can work, how it is generated. They also preview how it will be used.

(A) AMPAC coding for the set of parameter of Japanese Standard Paper

JNC (Japan National Committee) for ISO/TC130 defines the standard paper based on Type 1 Printing in ISO12647 Part 1. The specifications of the paper are given in a set of parameters which consist of basis weight (127.9g/m^2), ISO-brightness (80.0%), specular gloss (75), smoothness/Beck (1,182.0sec), oil absorbency (4.7sec), and its color (L*a*b*: 93.5,0.9,1.2).

JNC ;standard_paper_1; ; ;*basis weight*;0; ;VR;1;-2,1,0,0,0,0,0;-3;1;**127.9**
JNC ;standard_paper_1; ; ;*ISO_brightness*;0; ;VR;1;3;%;0,0,0,0,0,0,0,0;0;1;**80.0**
JNC ;standard_paper_1; ; ;*specular gloss*;0; ;VR;4;unit;0,0,0,0,0,0,0;1; **75.0**
JNC ;standard_paper_1; ; ;*smoothness/Beck*;0; ;VR;1;1;0,0,1,0,0,0,0;0;1;
1182.0
JNC ;standard_paper_1; ; ;*oil_absorbency*;0; ;VR;1;1;0,0,1,0,0,0,0;0;1;**4.7**
JNC ;standard_paper_1; ; ;*CIE_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**93.5**
JNC ;standard_paper_1; ; ;*CIE_a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**0.9**
JNC ;standard_paper_1; ; ;*CIE_b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**1.2**

(B) AMPAC coding for the set of parameter of Japan standard ink SF90

JNC for ISO/130 defines the standard ink SF90 based on ISO ink color. The standard gives the color coordinate of basic 4 process inks (CMYK) and second color (RGB) in L*a*b* space.

JNC ;SF90_ink; ; ;*Cyan_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**53.9**
JNC ;SF90_ink ; ; ;*Cyan_a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**-37.5**
JNC ;SF90_ink ; ; ;*Cyan_b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**-50.4**
JNC ;SF90_ink; ; ;*Magenta_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**46.3**
JNC ;SF90_ink ; ; ;*Magenta_a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**74.4**
JNC ;SF90_ink ; ; ;*Magenta _b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**-4.8**
JNC ;SF90_ink; ; ;*Yellow_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**86.5**
JNC ;SF90_ink ; ; ;*Yellow _a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**-6.6**
JNC ;SF90_ink ; ; ;*Yellow _b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**91.1**
JNC ;SF90_ink; ; ;*White_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**93.0**
JNC ;SF90_ink ; ; ;*White _a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**0.5**
JNC ;SF90_ink ; ; ;*White _b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**0.4**
JNC ;SF90_ink; ; ;*Red_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**46.5**
JNC ;SF90_ink ; ; ;*Red_a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**68.5**
JNC ;SF90_ink ; ; ;*Red_b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**48.0**
JNC ;SF90_ink; ; ;*Green_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**49.0**
JNC ;SF90_ink ; ; ;*Green_a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**-73.5**
JNC ;SF90_ink ; ; ;*Green _b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**25.0**
JNC ;SF90_ink; ; ;*Blue_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**21.1**
JNC ;SF90_ink ; ; ;*Blue_a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**20.0**
JNC ;SF90_ink ; ; ;*Blue _b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**-51.0**
JNC ;SF90_ink; ; ;*Black_L**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**12.5**
JNC ;SF90_ink ; ; ;*Black_a**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**0.7**
JNC ;SF90_ink ; ; ;*Black_b**;0; ;VR;1;1;0,0,0,0,0,0,0;0;1;**1.2**

(C) AMPAC coding for the tone value increase given in ISO12647 part5

ISO12647 part5 gives the standard tone value increase of 11%, 18%, and 11% for screen printing at 40%,60%, and 80% tone value on film, respectively. The relation about tone value increase can

also be presented by using AMPAC coding on database, as follows:

ISO12647_part5;Type1;*tone_value_increase*;;;1;tone_value_on_film;TI;3;%;6;
40,60,80,,11,18,11
ISO12647_part5;Type1;*tone_value_on_film*;;;0;;NON;3;%

In above coding, the relation between tone value on film and tone value increase is given as a table. The relation can also be coded by using a set of separate parameters such as:

ISO12647_part5;Type1;*tone_value_increase*;;;1;tone_value_on_film;TI;3;%;2;
40,11
ISO12647_part5;Type1;*tone_value_increase*;;;1;tone_value_on_film;TI;3;%;2;
60,18
ISO12647_part5;Type1;*tone_value_increase*;;;1;tone_value_on_film;TI;3;%;2;
80,11
ISO12647_part5;Type1;*tone_value_on_film*;;;0;;NON;3;%

(D) AMPAC coding for an example of press machine specification.

Since the specification clearly defining parameter values can be put in the AMPAC database, suppliers and vendor as well as users can obtain the information about material, machine and/or machine element etc. An example of specification for press printing machine is shown here.

A_company;TypeA;;;*Max_Paper_size_L*;0;2;VR;1;1,0,0,0,0,0,0;-3;1;**520.0**
A_company;TypeA;;;*Max_Paper_size_W*;0;;VR;1;1,0,0,0,0,0,0;-3;1;**375.0**
A_company;TypeA;;;*Min_Paper_size_L*;0;;VR;1;1,0,0,0,0,0,0;-3;1;**100.0**
A_company;TypeA;;;*Min_Paper_size_W*;0;;VR;1;1,0,0,0,0,0,0;-3;1;**150.0**
A_company;TypeA;;;*Max_Print_area_L*;0;;VR;1;1,0,0,0,0,0,0;-3;1;**505.0**
A_company;TypeA;;;*Max_Print_area_W*;0;;VR;1;1,0,0,0,0,0,0;-3;1;**350.0**
A_company;TypeA;;;*Min_Paper_thickness*;0;;VR;1;1,0,0,0,0,0,0;-3;1;**0.04**
A_company;TypeA;;;*Max_Paper_thickness*;0;;VR;1;1,0,0,0,0,0,0;-3;1;**0.50**
A_company;TypeA;;;*Max_Print_speed*;0;;VR;3;sph;0,0,0,0,0,0,0;0;1;**13000**
A_company;TypeA;;;*Plate_size*;0;;VR;1;1,0,0,0,0,0,0;-3;1;**510.0**
A_company;TypeA;;;*Plate_thickness*;0;;VR;1;1,0,0,0,0,0,0;-6;1;**400**
A_company;TypeA;;;*Min_number_of_unit*;0;;VI;4;number of unit;0,0,0,0, 0,0,
0;0;1;**2**
A_company;TypeA;;;*Max_number_of_unit*;0;;VI;4;number of unit;0,0,0,0, 0,0,
0;0;1;**8**

(E) AMPAC coding of dictionary for assigned value set for each parameter

AMPAC coding includes the method for giving the list

(dictionary) of the possible values for a specified a parameter. The parameters appear in fourth layer of the dictionary having 00 code in first layer with the following possible values in fifth layer. For example, the parameter named 'type_of_stich' appeared in instruction for bookbinding (design process) will have one of the values selected from the dictionary which is given in dictionary with '00' code for first layer in AMPAC database. When there are six type of stitch, the dictionary of the parameter can be explained as follows.

JNC;Dictionary_Sample;;*000000:type_of_stitch:*;6;**sewing,sakkle_stitch,side_stitch,perfect_binding,notch_binding,loose-leaf**;

Conclusion

AMPAC has not yet become a standard, but is ready to be. AMPAC started from a pure academic interest to consider printers knowledge and intelligence. There are some difference between knowledge and intelligence. Knowledge consists of many independent data sets and builds up from bottom of each element data, but intelligence comes from a top-down over-view. The most effective data expression should accept both approaches of top-down and bottom-up. In AMPAC method, knowledge about each parameter of the production process can be gathered from each process element in the way of bottom up way and it can be used in a top down way. The AMPAC standard is a top-down approach standard unlike other very new types of approach, but it should have a great effect on new coming digital and open printing production systems.

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