Report of 3D-CAD Engineer's Examinations in Japan

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Abstract *— The system, purpose, contents, exam questions and results of the three-dimensional CAD Engineer's Examinations in Japan are described in this report. These examinations started in 2004 and have been administered by the Computer Software Association of Japan. The total number of examinees to date has been more than 10,000. These examinations are divided into three grades: first grade, pre-first grade and second grade. The second-grade examination consists of a written exam, and the pre-first-grade and first-grade examinations consist of a skill test using three-dimensional CAD systems. Commercially available three-dimensional CAD systems, such as Solidworks, Autodesk Inventor, CATIA, NX and Pro/Engineer, were used in these tests. The number of questions in the written exam is 75 and the allotted test time is 90 minutes. The number of questions in the skill test is 17 by the first grade, 11 by the pre-first grade and the allotted test time is 120 minutes. Examinees are directed to calculate the mass property of the developed models and to write the volume and surface area on the answer sheet.*

Index Terms *— 3D-CAD, CAD education, certificate examination, grade, skill test,,*

INTRODUCTION

In mechanical engineering, the use of a three-dimensional computer-aided design (3D-CAD) system for designing is rapidly increasing. When designing using 3D-CAD becomes the main trend, many requests to browse or use 3D-CAD data will appear from beyond the design department, including the manufacturing, quality management, maintenance, and sales departments.

Industrial products, such as automobiles, robots and electric appliances, consist of modules (subassemblies consisting of several components) and parts. Therefore, a product can be represented in a hierarchical structure composed of parts and modules. In 3D CAD, an assembly with the same structure as that of an actual product is represented in the memory of the computer.

Figure 1 shows an assembly structure defined in 3D-CAD. In 3D-CAD, a product and a module are referred to as a top assembly and a subassembly, respectively. The subassembly has several parts (corresponding to components in 3D-CAD), which are defined using several solids (bodies). Each solid is represented on the basis of its boundary (boundary representation, B-reps). The toy car in the figure consists of a body part and two subassemblies, the rear and front axes. Each axis consists of 3 parts, namely, a shaft and two wheels. In each assembly, files of the referred components (linkage to the parts' files) and the position of the components in the assembly space and their degrees of freedom are controlled.

The 3D-CAD Engineer's Examinations started in 2004 in Japan and have been administered by the Computer Software Association of Japan. In this paper, we describe the system, purpose, contents, exam questions and results of the 3D-CAD Engineer's Examinations.

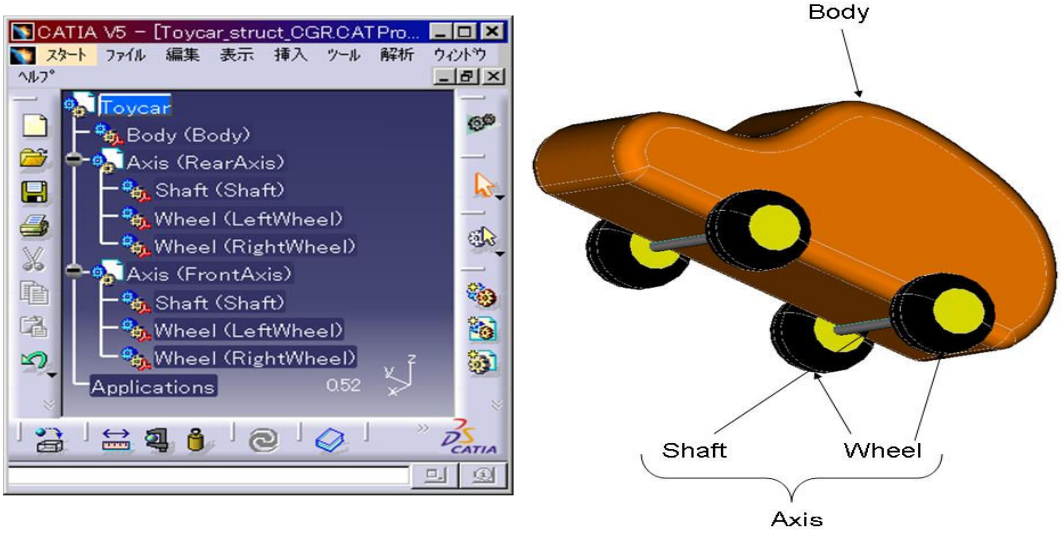


FIGURE 1 3 D-CAD (ASSEMBLY)

SYSTEM OF 3D-CAD ENGINEER'S EXAMNATIONS

The total number of examinees to date has been more than 10,000. These examinations are divided into three grades: first grade, pre-first grade and second grade. Those who have been involved in modeling, design and drawing using mechanical and manufacturing 3D-CAD systems for more than half a year can take the first-grade examination. Applicants are expected to be aiming not only for the ability to operate 3D-CAD systems but also to be in charge of three-dimensional design and the management of designers and operators in the future. Those who wish to engage in modeling, design and drawing using mechanical and manufacturing 3D-CAD systems or those who have newly taken up such work are eligible to take the pre-first-grade examination. The applicants are expected to have acquired a basic level of knowledge and the operation of 3D-CAD systems and to have the aim of assisting in three-dimensional design or becoming an operator of mechanical and manufacturing 3D-CAD systems. Those who are involved in modeling, design and drawing using 3D-CAD systems or those who are involved in the peripheral operations of 3D-CAD systems can take the second-grade examination.

Table 1 shows the results of the examinations in 2008 (first and second terms) and 2009 (first term). The numbers of applicants, examinees and successful examinees and the passing rate of the examinations are shown in this table. The second-grade examination consists of a written exam, and the pre-first-grade and first-grade examinations consist of a skill test using 3D-CAD systems. Commercially available 3D-CAD systems, such as Solidworks, Autodesk Inventor, CATIA, NX and Pro/Engineer, were used in these tests.

TABLE 1 STATISTICS OF 3D-CAD ENGINEER'S EXAMINATIONS

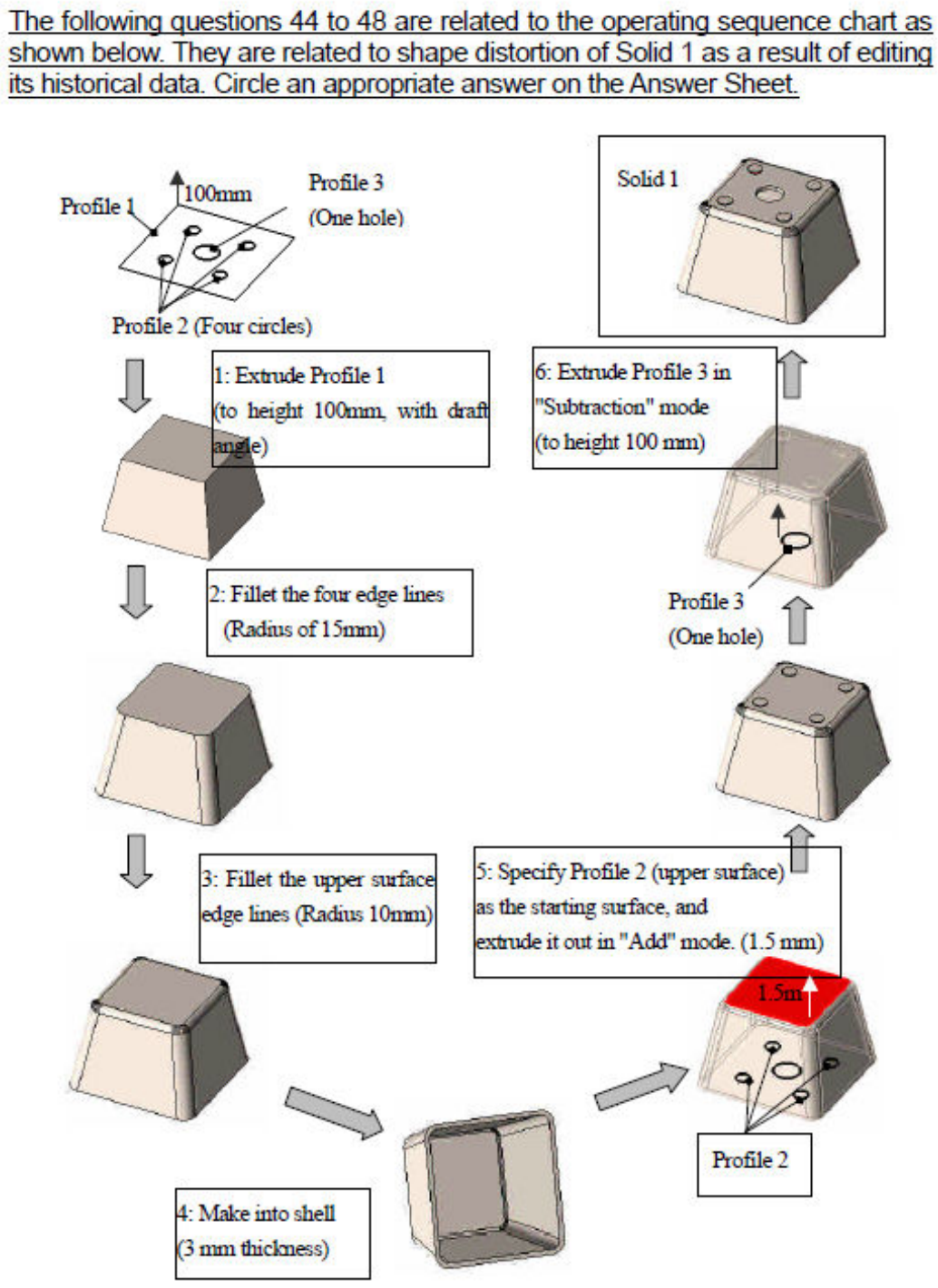
Second grade	Applicants			Examinees			Successful examinees			Passing rate
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	
2009 first term	900	244	1224	896	228	1124	675	180	855	76.1%
2008 second term	722	184	906	653	162	815	450	122	572	70.2%
2008 first term	766	172	938	730	158	888	567	127	694	78.2%

Pre-first grade	Applicants			Examinees			Successful examinees			Passing rate
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	
2009 first term	242	75	314	229	71	300	110	34	144	48.0%
2008 second term	174	45	219	161	42	203	87	26	113	55.7%
2008 first term	137	37	174	133	35	168	67	17	84	50.0%

First grade	Applicants			Examinees			Successful examinees			Passing rate
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	
2009 first term	319	78	395	301	70	371	76	15	91	24.5%
2008 second term	316	78	394	298	72	370	83	7	90	24.3%
2008 first term	227	41	268	217	36	253	72	12	84	33.2%

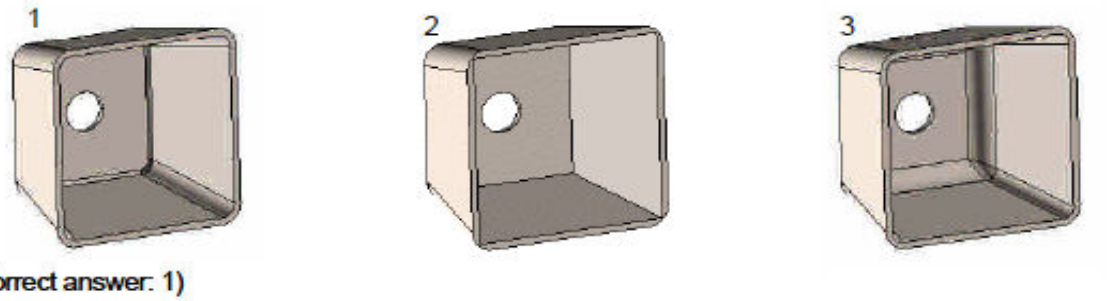
THE SECOND-GRADE EXAMINATION

The following describes the contents of the written exam. (1) The concept of 3D-CAD: the outline of 3D-CAD, advantages of 3D-CAD, 3D-CAD and manufacturing, the data structure of three-dimensional models, the composition of three-dimensional models, and display technologies. (2) Modeling methods: feature-based modeling, parametric modeling, assembly modeling, data exchange, and product data quality (PDQ). (3) Data management: project management, product data management (PDM), network management, and information security. (4) Data utilization: computer-aided engineering (CAE), computer-aided manufacturing (CAM), computer-aided testing (CAT), computer graphics (CG), and rapid prototyping (RP). The number of questions in the written exam is 75 and the allotted test time is 90 minutes. Figure 2 and 3 show examples of the written exam.



Question 44
Which finished shape of Solid 1 is correct as seen from the rear?

1 2 3



(Correct answer: 1)

Question 45
Which answer shows the most appropriate history of Solid 1 if an operating sequence other than that shown on the Operating Sequence Chart is performed?

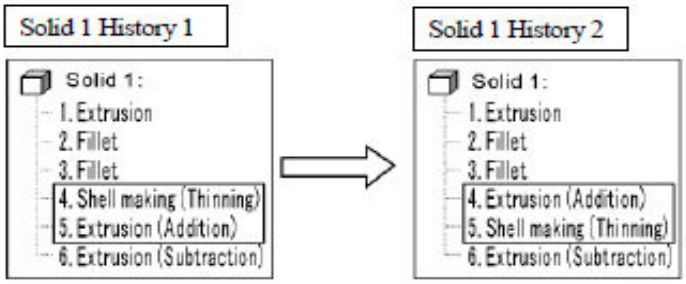
1

2

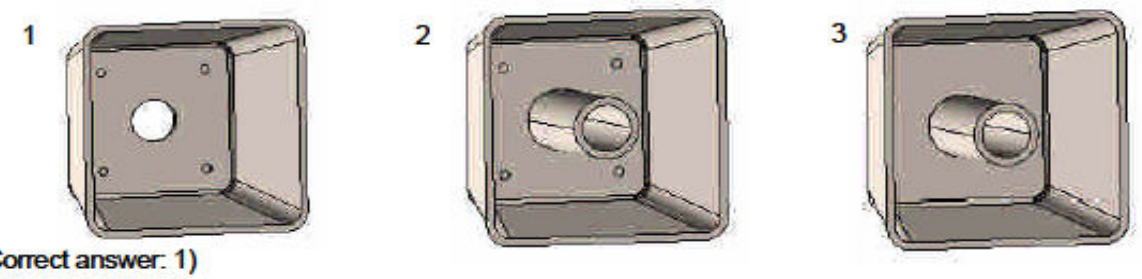
3

(Correct answer: 2)

Question 46
If you invert the sequences of 4 and 5 in History 1 of Solid 1 as shown in History 2 below, and execute ""Update (Renew),"" Which shape is correct after the execution ?



1 2 3



(Correct answer: 1)

FIGURE 2 AN EXAMPLE OF THE WRITTEN EXAM (MODELING)

For the following questions 49 to 75, select the most appropriate answer from the answer group and circle the correct number on the Answer Sheet.

Question 54
Select the most inappropriate explanation on data conversion from among the following answers:

1: If each data format of 3D CAD systems is the same, then the conversion rate is the same for all of them.

2: Some specifications to represent attributes attached to a 3D shape is standardised with standard formats.

3: Some of topology causes failures in conveting data.
(Correct answer: 1)

Question 55
Select the most appropriate explanation on kernel format conversion from among the following answers:

1: Feature trees and notations can also be converted.

2: Assembly trees can be most probably converted.

3: The tolerance factor need not be considered.
(Correct answer: 2)

Question 58
Select the most inappropriate explanation on PDQ and its problems from among the following answers:

1: When data is passed to a CAE system and PDQ is wrong, it may cause a problem such as not being able to cut meshes.

2: Problems may go unnoticed if you use the same 3D CAD systems all the time.

3: PDQ problems can be prevented by improving the use of the standard format.
(Correct answer: 3)

Question 59
Select the most appropriate explanation on Bill of Materials from among the following answers:

1: E-BOM and M-BOM cannot be interrelated and be used at the same time.

2: M-BOM, rather than E-BOM, is used at production when instructing "which parts to use for each process. "

3: M-BOM is used to analyze where a part is used in products.
(Correct answer: 2)

FIGURE3 AN EXAMPLE OF THE WRITTEN EXAM (PDM, PDQ, DATA FORMAT)

THE FIRST-GRADE AND PRE-FIRST-GRADE EXAMINATION

The following describes the contents of the skill test. (1) CAD literacy: a task of modeling a part following the modeling procedure described in a text. (2) Space cognition: a task of modeling a part according to the projected and developed figures. (3) Assembly skills: a task of modeling multiple parts and assembling those parts. (4) Modeling from a two-dimensional figure: a task of modeling a machine part according to a two-dimensional figure. The allotted test time is 120 minutes. Examinees are directed to calculate the mass property of the developed models and to write the volume and surface area on the answer sheet. Figure 4 shows an example of the skill test (modeling from a two-dimensional figure).

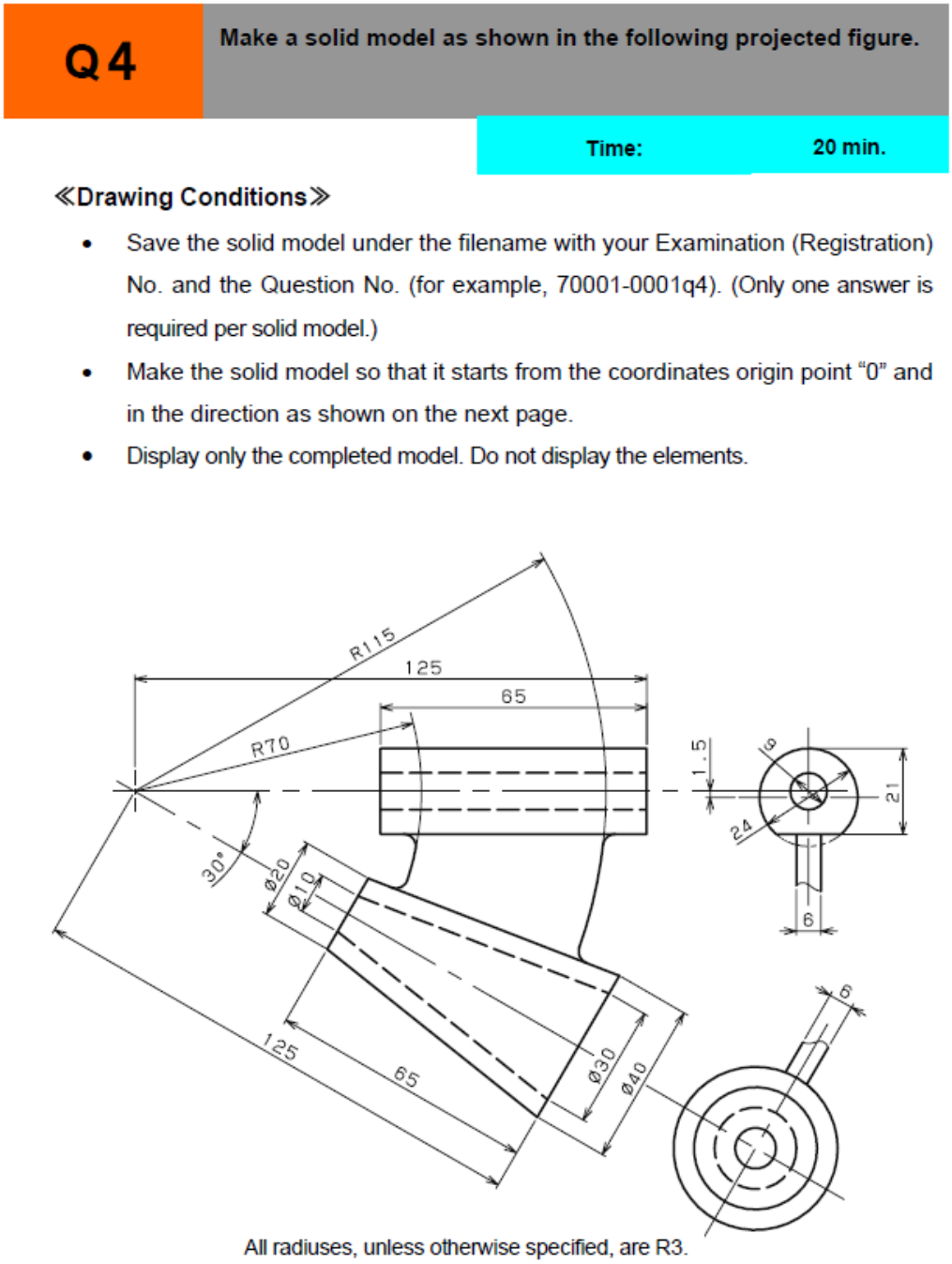


FIGURE 4 EXAMPLE OF SKILL TEST (MODELING FROM TWO-DIMENSIONAL FIGURE)

REFERENCES

[1]Guide Book of 3D-CAD engineer's examination, ISBN978-4-8222-8415-2, 2010