Visual Chart Design by Japanese Researchers and Engineers

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ABSTRACT

In this study, we examined the actual quality of Japanese visual chart design and the basic elements that Japanese researchers and engineers need in order to improve this quality. An online survey was conducted in August 2015 to seek opinions regarding the quality of charts designed by the Japanese. Responses were received from 209 Japanese researchers and engineers, including graduate and undergraduate students. The survey results were as follows. Most Japanese respondents (85%) used Microsoft Excel to design their charts. They most often used bar & column charts (75%), followed by line charts (74%) and scatter diagrams (66%). Most of them used presentation slides (86%), followed by documents such as papers, reports, and applications (83%) and posters (75%). The main targets of the charts were researchers and engineers, and therefore these charts needed to be highly specialized. The most important chart design criteria for them were identified as "comprehensibility" (96%) and "scientific correctness" (80%). As per many respondents, a visual design guidebook for chart design should include instructions on how to ensure a chart's "comprehensibility" (66%) and "attractiveness, with good esthetics" (62%). Many respondents felt that, if available, they would use a reference website (67%) or guidebook (62%). The Japanese graduate and undergraduate student respondents had a strong awareness of the need to improve. Of the Japanese research and engineering respondents, 94% thought that improving their chart design skills would be useful to further their research and 41% were dissatisfied with the charts they had designed. From these results, the chart design needs could be clarified, which will be very useful for the development of a chart design guidebook and website for especially graduate and undergraduate students.

1. INTRODUCTION

From 2010, through the Japanese Society for Science Visualization (JSSV), we have been examining visual design for researchers (TANAKA et al., 2011, 2013) and we are understanding that charts play a vital role in Japanese research and engineering materials such as articles, presentations, and posters. However, as many of these charts are often "incomprehensible," "unattractive, with bad esthetics," chart design needs improvement. There are excellent chart design books written by TUFTE (2001), ZELAZNY (2001) and NAGAYAMA (2012) intended for designers and office workers. But these don't cover chart design for researcher and engineers. There are visual design books which were written by FRANKLE & DEPACE (2012), CARTER (2013) intended for researchers and engineers. These books also mention chart design, but aren't enough for actual quality of Japanese researchers and engineers. Actually we published a visual design guidebook for researchers and engineers (TANAKA, 2013), but it couldn't show enough useful information about chart design. Therefore, in this paper, we sought to determine the actual quality of research and engineering chart design and to confirm the basic elements that required improvement. From this information, the final goal of this research is to develop a useful chart design guidebook to improve the quality of Japanese research and engineering chart design.

2. METHOD

An online survey was conducted in August 2015 to gather information about the actual quality of Japanese research and engineering chart design. Responses were received from 209 Japanese researchers and engineers who were approached through JSSV and other organizations.

2.1 Content of the Questionnaire

The questionnaire's content focused on 10 main areas. 1) Software used to design charts, 2) Software improvement requirements, 3) Design chart's types, 4) Important chart expression criteria, 5) Content desired for a chart design guidebook, 6) Chart Media use, 7) Chart targets, 8) Satisfaction with personal chart design, 9) Benefits of improving chart design technology, 10) Desired method for improving chart design technology .[1]

2.2 Respondent characteristics

Respondents came from the following fields. Bioscience (biology, agriculture, medicine and dentistry, and pharmacy), 56%; physics and engineering (mathematics, physics, chemistry, and engineering), 28%; humanities and sociology (literature, humanities, social science, psychology, pedagogy), 10%; and others, 6%.
54% of respondents were researchers and teachers in universities or research institutes, 21% were engineers in universities and research institutes (including university research administrators, science communicators, and other staff), 15% were graduate or undergraduate students and 10% were from other professions.
In terms of age, 24% were under 30, 38% were between 30 and 40, 24% were between 40 and 50, and 14% were over 50.

3. RESULTS AND DISCUSSION

Software used to design charts: A majority of respondents used Microsoft Excel (85%) to design their charts. Other software programs used were R (11%), Gnuplot (7%), KaleidaGraph (7%), MATLAB (7%), GraphPad Prism (6%), Numbers (6%) and SPSS (6%).[2] The respondents gave several suggestions for improvements in Microsoft Excel including an improvement of the default design color schemes (including universal color design) and the label layouts. Therefore, overcoming current problems with Microsoft Excel and possible improvements could be a valuable inclusion in the proposed guidebook.

Design chart types: Figure 1[3] shows that the main types of chart used were bar & column charts (75%), line charts (74%), and scatter diagrams (66%). Therefore, examining the best practice designs for these types of charts could be informative. Table 1[4] also shows that the main chart types varied depending on the respondents' academic backgrounds. Therefore, design samples from a range of fields need to be included in the guidebook.

Important criteria and expected guidebook contents: Respondents thought that the most important chart design criteria were "comprehensibility" (96%) and "scientific

[1] 1),3),4),5),6),7),10): Respondents had multiple choices; 2): Respondents gave a free description; 8),9): Respondents only had a single choice.

[2] We confirmed use of the 26 kinds software except for these software (less than 5%).

[3] More than 20% of the charts are shown in Figure 1. We confirmed use of the 16 kinds charts except for shown in Figure 1 (Figure 1 was designed using Microsoft Excel except for the left hand pictures).

[4] More than 60% of the charts are shown in Table 1 (Table 1 was designed using Microsoft Excel).

correctness" (80%).[5] Respondents expected from a chart design guidebook, the most important of which was instructions on how to ensure a chart's "comprehensibility" (66%) and "attractiveness, with good esthetics" (62%).[6] Therefore, such guidebooks need to focus on the development of "comprehensible," "scientifically correct," and " attractive, with good esthetics" charts.

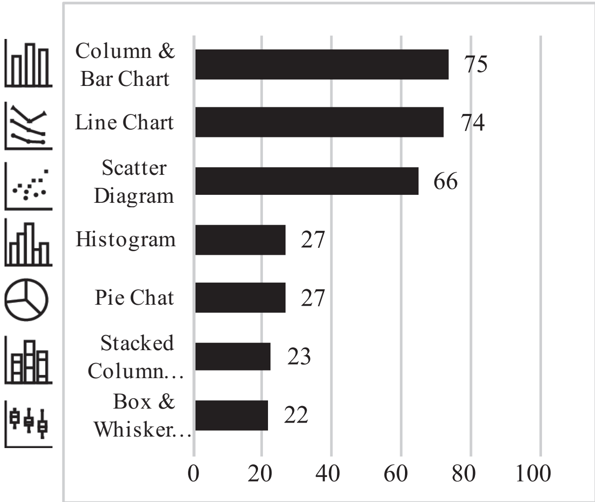

Figure1. Design chart types (%)

Table1. Design chart types by fields

	1	2	3
Bioscience	Bar & Column Chart (89%)	Line Chart (78%)	Scatter Diagrams (69%)
Physics & Engineering	Scatter Diagrams (75%)	Line Chart (63%)	
Humanities & Sociology	Line Chart (86%)	Bar & Column Chart (76%)	Pie Chart (62%)

Media used: The main media used by respondents were presentation slides (86%); documents such as articles, reports, and applications (83%); and posters (75%). As articles are quite different from presentation slides, each chart's use and purpose needs to be included in the proposed guidebook. For example, as most articles are black and white, both black and white and colored chart designs need to be included.

Targets: The main targets identified by respondents were fellow researchers or engineers (91%), graduate and undergraduate students (60%), and ordinary citizens. It is therefore important that the guidebook examine chart design for highly specialized audiences rather than just simple charts for ordinary citizens (29%).

Charts design improvement methods: To improve their chart design, respondents preferred to refer a website (67%) or a guidebook (62%). Further, 33% preferred to learn from a class and 26% preferred to receive private expert guidance. The Japanese graduate and undergraduate students showed strong improvement awareness, which was evident from their high choice rate of improvement methods.

Degree of usefulness and self-assessment: 41% of the respondents were not satisfied with the charts they had designed, and 94% felt that improving their chart design skills would be useful for their further research. This result confirmed the need for the comprehensive guidance that will be provided by the proposed guidebook.

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5 The other answers were "color scheme" (54%), "attractive, with good esthetics" (50%), "appropriate choice of charts kind" (44%), "chart size" (39%), "font styles" (35%) and "impact, impression strength" (31%).

6 The other answers were "scientific correctness" (46%), "appropriate choice of charts kind" (42%), "impact, impression strength" (38%), "error line" (34%) and "color scheme" (33%).

4. CONCLUSIONS

In this paper, we clarified the quality issues for scientific chart design and confirmed what researchers and engineers needed for improving their own visual design skills. Based on the information collected in this research, we aim to develop a focused useful guidebook and website for researchers and engineers.

1) The main software used was Microsoft Excel. However, respondents had many suggestions for improving Excel's visual design. Therefore, the guidebook will include improvement plans for the problems faced while using Microsoft Excel for chart design.

2) The main chart types used were bar charts, line charts, and scatter diagrams. Therefore, best practice designs for these types of charts need to be included.

3) It is also important that the guidebook include guidance on how to ensure charts are "comprehensible and scientifically correct" and "attractive, with good aesthetics."

4) The results of this research identified the concerns of Japanese researchers and engineers about scientific chart design and gathered suggestions regarding the information required to improve their own designs. These results will be used to develop a focused chart design guidebook and website for use by graduate and undergraduate students.

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