

A Paper Reprinted from

CARTOGRAPHY

Journal of the Mapping Sciences Institute, Australia

Volume 31

Number 1

Date

June 2002

*Experimental Evaluation of the Effectiveness of
Graphic Symbols on Tourist Maps*

Editorial Board, Mapping Sciences Institute, Australia, PO Box 6836 East Perth, Western Australia,
AUSTRALIA 6892, Fax: (08) 9266 2703, International Fax: +618 9266 2703

Experimental Evaluation of the Effectiveness of Graphic Symbols on Tourist Maps

L-F. Leung
Z. Li

This paper describes a series of tests on the effectiveness of graphic symbols on Hong Kong tourist maps produced by three different organisations. One test is on isolated symbols on white background, another test is on symbols in map context, and the third test is on the effect of some selected factors on symbol interpretation. Results show that more than 50 percent of the tested symbols fail to attain the criteria. These ineffective symbols were found to be mainly abstract and geometric, so that they bear a poor resemblance to the object. It was found that the size of a symbol has an important influence upon the recognition and time required for searching symbols. It is also found that inadequate use of text (letters) in the context of a symbol may confuse map users and increase the required searching time.

L-F. Leung and Z. Li
Department of Land Surveying and
Geo-Informatics
The Hong Kong Polytechnic University
Kowloon, Hong Kong
Lszlli@polyu.edu.hk

INTRODUCTION

Tourism is a service industry that has become more and more important to many countries/regions. Hong Kong is no exception. In Hong Kong, according to the statistical review by the Hong Kong Tourist Association (HKTA, 1997), visitor receipts is one of the major sources of foreign exchange. Visitor arrivals reached over five million in the recent five years. Hong Kong has been the most favourable destination in Asia and its tourism industry was the world No. 10 in terms of tourism receipts (HKTA, 1997).

To enhance the tourist industry, quality service is essential and effective tourist maps form an important part of quality service. Effective tourist maps are a very important tool for tourists, especially when visitors come to Hong Kong by their own travel arrangements rather than via package tour. Approximately 50 percent of visitors coming to Hong Kong make their own travel arrangements (HKTA, 1997).

By *effectiveness*, it is meant that map users are able to interpret the meanings of symbols on a map accurately and efficiently. In order to achieve this goal, some kind of analysis is desirable. Such an analysis could be done theoretically and experimentally. In this study, experimental investigations were conducted, which are also referred to as map evaluation.

Map evaluation is a traditional topic in cartographic communication (e.g. Yarnal and Coulson, 1982). Evaluation of tourist maps has been conducted by researchers in various countries. Blok (1987) described a test of symbols on a Dutch tourist map. The aim was to measure the efficiency of symbols without (or with limited use of) the map legend. Ostrowski and Ostrowski (1987) tested the efficiency of symbols used on Polish tourist maps. Clark (1989) analysed the efficiency of symbols in the legends of two comparable published tourist maps using a symbol comprehension method. Relative effectiveness is assessed with respect to the ease and accuracy with which the symbols are understood by subjects (users). It was found that abstract and geometric symbols bear a poor resemblance to the object they are attempting to depict. Forrest and his collaborators (Forrest and Castner, 1985; Morrison and Forrest, 1995) examined the design of point symbols for tourist information. They investigated the effect of colour and size of symbols on the recognition of features, and also developed guidelines for the design of point symbols for CRT display. However, there is no similar literature known to the authors, which describes the evaluation of tourist maps produced by countries/regions in the Eastern part of the world. This paper aims to fill such a gap. Indeed, it will describe an experimental evaluation of effectiveness of tourist maps produced by three different organisations in Hong Kong.

DESIGN OF EXPERIMENTS

Strategy

The experimental component of this study is conducted using a method similar to the one described by Blok (1987). A symbol is considered as a stimulus. Map readers, (i.e. respondents in map evaluation), are asked to interpret the meaning for each symbol. Respondents' answers could be either in *free choice* and *restricted choice*. Here, *restricted choice* means that the respondent has to choose an answer from alternatives, which are provided by the experimenter for

each symbol tested. Respondents would pick up the most appropriate answer from a given set of alternatives. On the other hand, *free choice* means that the respondents are completely free in their response. In this case, respondents are responsible for providing a suitable meaning for each symbol tested.

The effectiveness is measured by the percentage of correct responses and also the reaction time (Remington and Willian, 1986). The reason for timing the answers lies in the fact that the efficiency of a symbol does not depend solely on how often a respondent reaches the correct response, but also on how quickly it is reached (Morrison and Forrest, 1995). This is obvious because such a symbol whose correct meaning is perceived only after great thought is almost as inefficient as a symbol whose meaning is quickly, but incorrectly, perceived (see Morrison and Forrest, 1995).

Map evaluation is a complex process. Different procedures should be used to examine the perception and comprehension of a symbol. In this study, a total of three experimental tests were conducted.

- The first is to test the efficiency of isolated symbols on white background. Three sets of symbol sets were tested. In such tests, symbols are printed in colour on a white background that has a size of approximately 4cm x 4cm. The *free choice* option is employed for respondents' answers.
- The second experiment tests the effectiveness of symbols in a map context. The tested symbols are printed in colour on map context at size of 4cm x 4cm. This is designed to test the readability of the symbols with some visual cluster (as noise) in the background. The procedure is the same as the first test.
- The last experiment is to investigate the possible factors that affect the perception and efficiency of symbols. For example, it is possible for symbol size to influence symbol recognition. It is then designed to test the symbol again with enlarged and reduced symbol size to establish the influence of symbol size on symbol perception.

Selection of symbols

The symbols used for these experiments are selected from three different sets of existing tourist maps in Hong Kong. They are the City Map by Easyfinder Publication Company (1999), *Hong Kong Touring Map* by Universal Publication (no date) and the Official Hong Kong Map by HKTA (1998).

Symbols on tourist maps can be classified into nine categories, such as accommodation, cultural features, entertainment, facilities, recreation, services, transport, unique feature and warning (Stanton, 1989). Common symbols between maps are selected for the experiment. A total of 42 symbols were selected, i.e. 17 symbols selected from City Map, 12 symbols from Hong Kong Touring Map and 13 symbols from the Official Hong Kong Map. These symbols are illustrated in Table 1.

Critical values for assessing effectiveness

Free choice style was used for respondents' answers rather than a multiple choice format. As Morrison and Forrest (1995) state that, in this way, respondents would give their own true response instead of picking up what they thought was the *best* answer from a list. Similar to the methodology used by Morrison

and Forrest (1995), the replies are categorised into four categories as follows:

- Correct;
- Correct associative meaning, but not entirely accurate;
- Incorrect; and
- No response

The question arising is *What is the critical percentage of answers falling into categories A and B?* Clarke (1989) states that a symbol should be classed as effective, if the percentage of answers falling into categories A and B is greater than 50 percent. However, if the symbols are seen against a plain background with no visual search involved, the percentage of answers falling into categories A and B should be greater than 80 percent (Morrison and Forrest, 1995).

As stated previously, time duration is also a critical factor for assessing the effectiveness of map symbols. In this study, this factor is also taken into consideration to produce an overall indicator for effectiveness. The criterion of *five seconds* set by Morrison and Forrest (1995) was used. This is because this time period is long enough for a little thought if a response is not instantaneous, but not too long to think about every response (Morrison and Forrest, 1995). Table 2 shows the criteria used in this study for assessing the effectiveness of symbols.

Symbols	City Map [Easyfinder Publication 1999]	Hong Kong Touring Map [Universal Publication, nd]	The Official HK Map [HKTA, 1998]
1. Telephone			
2. Notice Board			
3. Toilet			
4. Information Centre			
5. Camp site			
6. Police Station			
7. Hospital			
8. Beach			
9. Railway & Station			
10. Tramway & Terminal			
11. Main Road			
12. MTR Station & Access			
13. MTR Entrance			
14. Ferry Pier			
15. Pedestrian Bridge			
16. Bus Stop			
17. Viewing Site			
18. Building			
19. Special Shopping Point			
20. Airport Express & station			
21. Street Market			
22. Peak Tram			
23. Ocean Park			

Table 1. *The symbols used for experimental testing.*

Type of Experiment	Percentage of responses falling into categories A and B	Reaction time
Symbols on white background	80 %	5 seconds
Symbols in a map context	80 %	5 seconds
Factors that influence the effectiveness	80 %	5 seconds

Table 2. *The criteria of the experiment.*

THE FIRST EXPERIMENT: ISOLATED SYMBOLS ON WHITE BACKGROUND

The first experiment: execution and results

As stated previously, this experiment aims to measure the effectiveness of symbols on a white background. In this experiment, three sets of symbol were tested. There were 17 symbols selected from the City Map, 12 symbols selected from the Hong Kong Touring Map and 13 symbols selected from the Hong Kong Tourist Map. In total, there were 37 responses collected for this test. The characteristics of the respondents are shown on Table 3 for general information, although no further analysis against that factor will be conducted. It could be noted that except for age, the other characteristics are well balanced.

Symbols were printed in colour on a white background at a size of approximately 4cm x 4 cm, and were placed in random order. Respondents were asked to read an instruction on the experiment before starting. If the respondents found any confusion and/or misunderstanding, the experimenter would explain and describe it orally. This ensured each respondent had the same initial information. The symbol cards were placed face-down to ensure only one symbol was seen at a time as the cards were turned over. Respondents were asked to turn the card and to try to give an appropriate meaning for the symbol. They were allowed to think as long as necessary. Time measurement began when the respondent started to turn over the card and continued until s/he produced an answer. The procedure was repeated until all the symbols had been tested. The results are summarised as Table 4.

Characteristics of map readers		Test 1	Test 2	Test 3
Age	15 - 30	37	36	36
	>30	---	---	---
Sex	Female	20	19	17
	Male	17	17	19
Education	<Primary	---	---	---
	Secondary	10	8	6
	Tertiary	17	28	30
Frequency of map use	Never	3	---	---
	Once every year	9	3	3
	Once every 6 months	10	8	8
	Once every one month	9	9	11
	Once every two weeks	5	11	9
	Almost everyday 3	---	5	5

Table 3. The characteristics of the respondents of experimental tests.

Symbols	City Map				HK Touring Map				The Official HK Map			
	A (%)	B (%)	C (%)	D (%)	A (%)	B (%)	C (%)	D (%)	A (%)	B (%)	C (%)	D (%)
1. Telephone	72.2		8.3	16.7		89.2	5.4	5.4	100			
2. Notice board			36.1	63.9								
3. Toilet	19.4		50	14.4					97.2		2.7	
4. Inform. centre					70.5	5.4	10.8	13.5	80.5	2.7	13.9	2.7
5. Camp site	11.1		63.9	25			91.9	8.1				
6. Police station	33.3		52.8	27.8	13.5		86.5					
7. Hospital	25	2.7	47.2	25	78.4	13.5	8.1					
8. Beach	16.7		80.6	2.7	13.5		81.1	5.4				
9. Railway & station	91.7		11.1		62.2	5.4	8.1	10.8				
10. Tramway & terminal	13.9	44.4	30.6	11.1					2.7		77.8	19.4
11. Main road	91.7	5.4	2.7		81.1	8.1	8.1	2.7				
12. MTR station	94.4		5.4		13.5	5.4	59.5	21.6	16.7		47.2	33.3
13. MTR entrance									100			
14. Ferry route & pier	86.4		10.8	2.7	2.7		91.9	5.4	2.7	2.7	80.5	16.6
15. Pedestrian bridge	63.9		16.7	19.4							58.3	41.7
16. Bus stop	33.3	58.3	5.4	2.7					61.1	27.8	11.1	
17. Viewing point	5.4		66.7	27.8	8.1	2.7	40.5	48.6				
18. Building	5.4	2.7	19.4	72.2	2.7		32.4	51.4				
19. Special shopping point	72.9	8.1	10.8	8.1								
20. Airport express route									61.1	19.5		19.4
21. Street market											52.7	47.2
22. Peak tram											75	25
23. Ocean peak									100			

Table 4. Results of testing on efficiency of symbols on white background.

Analysis of the first experiment

For the three symbols for *Telephone*, two of them achieved above 90 percent correct responses, i.e. the ones from the HK Touring Map and the Official HK Map. These two symbols are pictorial symbols and the size is relatively large. The failed telephone symbol is designed similar to that of the Official HK Map, but its size is relatively small and difficult to read. A small pictorial symbol for *Notice Board* from the City Map was also tested. Surprisingly, a 0 percent correct response was received. The *Toilet* symbol of the City Map failed the criteria with nearly 50 percent incorrect responses. The common misinterpretations were a hole and a tunnel. The other toilet symbol, a conventional representation, passed the criteria with a response above 97 percent correct. Both of the symbols for *Information Centre* attained the criteria with a response about 80 percent correct. The first is an abstract symbol while the other one is the logo of the Hong Kong Tourist Association that is widespread and has conventional use in the society. Both symbols for *Camp Site* failed with low correct response ratio. The symbol used on the Hong Kong Tourist map contains a text "H" inside, and is commonly interpreted as hotel, house and hospital. Both symbols for *Police Station* did not attain the criteria with a low rate of recognition. The symbol containing a letter "P" is commonly interpreted as parking. The symbols for *Hospital* from the City Map failed with less than a 30 percent correct response. This is a small pictorial symbol, with some close interpretations being clinic, health centre and red cross club. However, some other interpretations are far away, such as candy, pencil and so on, due to its small size. Both symbols for *Beach* did not pass the test with nearly 80 percent incorrect response. The common interpretation for both is a swimming pool.

There were two symbols for *Railway & Station* being tested. The symbol from the Hong Kong Touring Map did not attain the criteria, but the percentage of correct responses is nearly 70 percent, much higher than 50 percent. Both linear symbols for *Tramway* did not pass the criteria, but the symbol from the City Map attained over 55 percent correct responses. Both of the symbols for *Main Roads* attained the criteria with over 90 percent correct responses. Two out of three symbols for *MTR Station & Access* did not attain the criteria. The effective symbol has a rich symbol context. It contains a logo of the MTR and text inside. The symbol for the *MTR Entrance* scored 100 percent correct response. The logo of the MTR is a conventional sign, and is commonly used in society. Only one (from the City Map) out of the three symbols for *Ferry Pier & Route* attained the criteria with over an 85 percent correct response, which is a large complex symbol. The other two symbols achieved less than 5 percent correct. They are also linear symbols without induction. Among the two areal symbols for *Pedestrian Bridge*, the one from the City Map achieved a 64 percent correct response, while the other had a 0 percent correct response. Both symbols for *Bus Stop* passed the test with over a 90 percent correct response.

Both symbols for *Viewing Point* are abstract and geometric. They failed the test with less than 10 percent responses. The two areal symbols for *Building* achieved only less than a 10 percent correct response, but over 50 percent no responses. Symbols for *Special Shopping*, *Air Express* and *Ocean Park* all attained 80 percent correct responses. All are conventional signs and widely used in the community. No correct responses were received for *Street Market* and *Peak Tram*.

THE SECOND EXPERIMENT— EFFECTIVENESS OF SYMBOLS IN MAP CONTEXT

The second experiment: execution and results

In the previous experiment, the tests are on isolated symbols. They are on white background, i.e. without other symbols around. It is clear that many symbols cannot be interpreted correctly. It is then of great interest to determine whether the situation can be improved if these symbols are put into a map context. This is the objective of the second experiment and thus the symbols tested in this experiment are only those that failed in the first experiment.

In this experiment, each respondent was asked the meanings of all the symbol sets. A total of 36 responses were collected for this experiment. Each symbol was bounded with a thin line. The tested symbols were printed in colour and placed on a 4cm x 4cm card in a map context. It also assumed the map context can provide useful additional information so that the symbol could be easily distinguished from the map context. The cards were placed in random order.

The respondents, whose characteristics are summarised in Table 3, were asked to read a statement about the test before the test began. The procedure for the experiment is similar to that of the first. The results are summarised in Table 5.

Analysis of the second experiment

In this experiment, a total of 24 symbols were tested, but only 13 symbols surpassed the 80 percent threshold. Generally speaking, a better level of interpretation is achieved after symbols are placed in a map context.

The symbol for *Notice Board* from the City Map again failed. It seems that the recognition of the symbol is significantly affected by the additional information surrounding the symbol. Two symbols for *Camp Site* again did not reach the criteria. The symbol from the City Map was commonly interpreted as a rehabilitation centre, since the camp site shown in the map context was associated with the rehabilitation centre. The symbol on the HK Touring Map was commonly interpreted as hotel and hospital due to the confusion caused by the text "H" inside the symbol. Both of the symbols for *Police Station* again failed to pass the acceptance threshold in

Symbols	City Map				HK Touring Map				The Official HK Map			
	A (%)	B (%)	C (%)	D (%)	A (%)	B (%)	C (%)	D (%)	A (%)	B (%)	C (%)	D (%)
1. Telephone	83.3		8.3	8.3						11.1	55.6	33.3
2. Notice board	5.5	16.7	52.7	27.8								
3. Toilet	33.3		22.2	44.4								
4. Camp site	22.2	8.3	69.4		8.3	5.6	83.3	2.8				
5. Police station	38.8	2.8	50	8.3	11.1		88.9					
6. Hospital	88.9	5.6	2.8	2.8								
7. Beach	94.4	5.6	10		97.2		2.8					
8. Railway & station					63.7	16.7	25.1	11.1				
9. Tramway & terminal									58.3		38.9	8.3
10. MTR station					75	5.6	19.4		83.3		11.1	5.6
11. Ferry route & pier					80.6		19.4		86.1		13.9	
12. Pedestrian bridge	83.3	11.2	5.6						100			
13. Viewing point	8.3	5.6	38.9	47.2	11.1		55.6	33.3				
14. Building	69.4	16.7			83.3	16.7						
15. Peak tram									52.8		38.9	8.3

Table 5. Results of testing on efficiency of symbols in map context

this test. The symbol on the City Map was still commonly interpreted as parking. The symbol for *Hospital* from the City Map showed a great improvement with over a 93 percent correct response. This appears to be due to some useful information, such as the hospital name, near the symbol. Two symbols for *Beach* scored nearly 95 percent correct recognition. The map context of the symbols indicated they were adjacent to the sea.

In total, there are five linear symbols tested, one for *Railway & Station* from the HK Touring Map, two for *MTR Station & Route* and two for *ferry route* from the Hong Kong Touring Map and the Official Hong Kong Map. A great improvement in recognition has been made for each of them. The main reason could be due to the induction for the linear symbols in a map context. The two linear symbols for *Tramway & Station* and *Peak Tram* from the Official Hong Kong Map failed again, but their correct responses show slight improvement with the aid of map context.

Four areal symbols, two for *Pedestrian Bridges* and two for *Buildings*, have passed the criteria due to the useful information provided in the map context. Although one areal symbol for *Street Market* still failed in this test, its improvement in correct recognition is also noticeable.

Symbols for *Street Market* and *Peak Tram* from the Official Hong Kong Map failed again. The symbol for *Peak Tram* showed increase of correct recognition, but the symbol for *Street Market* maintains 0 percent correct responses.

THE THIRD TEST— FACTORS AFFECTING THE EFFECTIVENESS OF SYMBOLS

The third test was designed to investigate factors that influence the effectiveness of symbols. This test was built upon the results of the previous tests. During previous tests, possible factors were noted and highlighted so they could be further examined. A total of 36 responses were collected for this test. The characteristics of the respondents of the third test are also included in Table 3.

Based on the results of the previous tests. There are several possible factors identified that could influence the effectiveness of symbols:

- Familiarity: i.e. conventional or widely used;
- The size of symbol;
- Symbol type, i.e. pictorial or geometric.

Four symbols were used to examine the influence of size, conventional use and symbol type on symbol interpretation. They were *MTR Entrance*, *Ocean Park*, *Telephone* and *Bus Stop* from the Official Hong Kong Map. The first two symbols are conventional and familiar to the society. The other two were pictorial symbols. All of them achieved good results in the previous tests. These four symbols were tested with a 50 percent reduction in size. All of them were well interpreted regardless of the reduction in size.

Another four symbols were used to test the effect of symbol type, (i.e. abstract or geometric symbols), on symbol interpretation. Two geometric symbols, *Viewing Point* from the Hong Kong Touring Map and *Cinema* from the Official Hong Kong Map (the latter is very similar to the former) and two abstract symbols, the *Viewing Point* and the *Hospital* from the City Map, were tested. These symbols were enlarged by 50 percent. However, still 0 percent correct responses were received for the two geometric symbols even after the enlargement.

Two relatively small symbols, i.e. *Toilet* and *Police Station* from the City Map, were tested for the effect of symbol size. They were enlarged by 50 percent. Results show that there is a slight improvement.

CONCLUSIONS

In this paper, experimental tests on the effectiveness of symbols on Hong Kong tourist maps have been conducted. Effectiveness was measured by the percentage of correct meaning and also by using reaction time assigned to each symbol for a sample of respondents. A score of

80 percent correct response was taken as a critical measure. From the results obtained in these tests, some conclusions can be drawn as follows:

- Generally speaking, symbols that have a widespread and conventional use, such as the logo of Hong Kong Tourist Association, *Ocean Park* and *MTR*, were found to be more effective due to their familiarity. However, there were some exceptions, e.g. the symbol for *Airport Express*.
- Symbols that have rich context can help in comprehension. However, the symbol size should increase with an increase in the complexity.
- One should avoid the use of ambiguous text inside a symbol because it can confuse and mislead the comprehension of the symbols for users.
- Pictorial symbols are usually more effective than abstract and geometric symbols. Abstract symbols perform relatively better than geometric symbols.
- The effect of size has a significant influence upon the recognition and speed of searching for a symbol. The significance of the effect of symbol size is reduced by the comprehensiveness of the symbols. Therefore, the design of the symbol context itself is most important.
- Linear symbols and areal symbols are difficult to interpret without additional text information and induction. Mostly they rely on the information provided from map context.

ACKNOWLEDGEMENTS

The work described in this paper was supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region (Project No. PolyU 5094/97E). The constructive comments by A/Prof Graeme Wright of the Curtin University of Technology (Australia) and two reviewers are very much appreciated.

REFERENCES

- Blok, C. (1987) Testing Symbols on a Dutch Tourist Map, scaled 1: 50000. *ITC Journal*, Vol. 1, pp.67–71.
- Clarke, L.M. (1989) An experimental investigation of the communicative efficiency of point symbols on tourist maps. *The Cartographic Journal*, Vol 26, pp.105–110.
- Easyfinder Publication Company (1999) City Map. Easyfinder Publication Company, Hong Kong.
- Forrest, D. and Castner, H.W. (1985) The Design and Perception of Point Symbols for Tourist Maps. *The Cartographic Journal*, Vol. 22, pp.11–19.
- Hong Kong Tourist Association (1997) *A statistical reviews of tourism (1988–1997)*. Hong Kong Tourist Association, Hong Kong.
- Hong Kong Tourist Association (1998) *The Official Hong Kong Map*. Hong Kong Tourist Association, Hong Kong.
- Morrison, C. and Forrest, D. (1995) A Study of Point Symbol Design for Computer based Large Scale Tourist Mapping. *The Cartographic Journal*, Vol. 32, pp.126–136.
- Ostrowski, W. and Ostrowski, J. (1987) Pragmatic aspect of cartographic language on the examples of tourist maps. *Proceedings of 13th ICA Conference*, Mexico. 1987.
- Remington, R. and Willian, D. (1986) On the selection and evaluation of preferred shapes for warning labels. *Human Factors*, Vol.28, No.4, 407–420.
- Stanton, G. (1989) *Public information symbols library for tourist and recreational mapping*. Australian Key Centre for Land Information Studies, Queensland University of Technology, Brisbane.
- Universal Publication (n.d.) *Hong Kong Touring Map*. Hong Kong.
- Yarnal, C.M.M. and Coulson, M.R.C. (1982) Recreational Map Design and Map Use: An Experiment. *The Cartographic Journal*, Vol. 19, No.1, pp.16–27.