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INVESTIGATING LAYOUT COMPLEXITY

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ABSTRACT

This paper presents work-in-progress in assessing the usefulness of the layout complexity metric in evaluating the usability of different screen designs. The metric is based on the Shannon formula from communication theory. Initially the metric was applied to thirteen Windows applications where thirty subjects were asked to rank screens on the basis of "good" design. A significant negative correlation was found between the subjects' rankings and the complexity ratings, indicating that users do not like "simple" screens. For the next stage a pilot application, "Launcher", was developed in Visual Basic to calculate complexity and collected usability data. Seven subjects provided some evidence that complexity could be of benefit to the screen designer. However, though Launcher proved useful in collecting data, some problems needed to be overcome, namely more concise data collection and a better method for building screens, before more data can be collected. The final version of "Launcher" should provide conclusive evidence of the worth of the layout complexity metric as well as showing that usability metrics can be built into the design environment.

KEYWORDS

layout complexity, GUI, interface, usability

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ABSTRACT

This paper presents work-in-progress in assessing the usefulness of the layout complexity metric in evaluating the usability of different screen designs. The metric is based on the Shannon formula from communication theory. Initially the metric was applied to thirteen Windows applications where thirty subjects were asked to rank screens on the basis of "good" design. A significant negative correlation was found between the subjects' rankings and the complexity ratings, indicating that users do not like "simple" screens. For the next stage a pilot application, "Launcher", was developed in Visual Basic to calculate complexity and collected usability data. Seven subjects provided some evidence that complexity could be of benefit to the screen designer. However, though Launcher proved useful in collecting data, some problems needed to be overcome, namely more concise data collection and a better method for building screens, before more data can be collected. The final version of "Launcher" should provide conclusive evidence of the worth of the layout complexity metric as well as showing that usability metrics can be built into the design environment.

INTRODUCTION

Computer systems usually rely on visual display terminals (VDT) for essential interaction between humans and computers. Users' acceptance of a computer system and performance with that system can be greatly influenced by the presentation of information on the computer screen (Tullis, 1988b). Shneiderman (1992) agrees stating that successful screen design is essential to most interactive systems. However, despite the importance of screen displays, there are few empirical studies relating to modern, bit-mapped screens, (Tullis, 1988a, Galitz, 1993) even though clearly most new computer systems use some form of GUI (Nielsen, 1990).

Authors of guidelines eg (Galitz, 1993, Hix & Hartson, 1993) admonish the interface designer to keep the interface simple and well-organised but does this apply to a GUI? Are simple interfaces the most usable? And, how can the designer know that a simple interface has been achieved?

One answer is to use complexity theory to provide a numerical measure of the quality of the layout design. The complexity metric provides a measure of the horizontal and vertical alignment of objects and their positional alignment (Bonsiepe, 1968). Layout complexity has been applied to alphanumeric displays on computer terminals with results that do show an effect on usability (Tullis, 1981, 1983, 1988a, 1988b) but no effort has been made to determine if complexity theory can be usefully applied to more complex GUI's even though screen design guidelines frequently recommend that design goals should be to minimise the complexity of a display or make screens as predictable as possible (Galitz, 1993, Shneiderman, 1992, Hix & Hartson, 1993). The screens that Tullis studied only displayed information and his research looked at information retrieval and users' preference. GUI screens can display information but they also present a dynamic interface to the underlying software and tend to be object-oriented and event-driven.

Firstly a survey was used to determine whether complexity theory could be applied to GUI design and if indeed it measured some aspect of design "quality" (Comber & Maltby, 1994). This was followed by a pilot experiment (Comber & Maltby, 1995) with layout complexity as the independent variable and effectiveness, learnability, and attitude as the dependent variables. The dependent variables are collectively referred to as "usability". The final version of "Launcher" should provide conclusive evidence of the worth of the layout complexity metric as well as showing that usability metrics can be built into the design environment.

THE HISTORY OF COMPLEXITY THEORY

Shannon: Mathematical measure of information flow

Shannon (1962) investigated mathematical measures for the amount of information produced by a communication process and derived the formula for H, the measure of uncertainty in the occurrence of an event:

$$H = -K\sum_{i=1}^{n} p_i \log p_i \qquad (1)$$

where:

K = a positive constant
n = number of events
p*i* = probability of occurrence of the *i*th event

The minus is present to make H a positive number because probabilities are expressed as less than or equal to one and the logarithms of numbers less than one are negative. The constant K is just the unit of measure.

Shannon pointed out that the formula for H is the same as that for entropy in statistical mechanics. The formula for two possibilities with probabilities *p* and *q* = 1 - *p*),

$$H = -(p \log p + q \log q) \qquad (2)$$

is plotted in Figure 1 as a function of *p*.

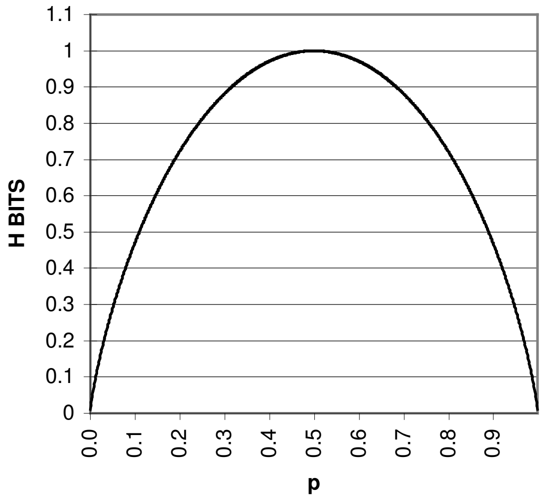


Figure 1: Entropy in the case of two possibilities with probabilities p *and (1 -* p*) from (Shannon & Weaver, 1962)*

It can be seen from Figure 1 that there is the least uncertainty when the probabilities of one or the other event are highest and the most uncertainty when the probabilities are equal.

Shannon lists the advantages for using the *H* quantity:

- *H* becomes zero when there is no uncertainty and except for this case is always positive.
- For any number of events, *H* is at its largest and equal to log *n* when all the probabilities are equal.
- Where there are joint events *H* is less than or equal to the sum of the individual *H*.
- As the probabilities approach equality *H* increases.

- The entropy of a joint event is the uncertainty of the known event plus the uncertainty of the remaining event.
- Knowing the uncertainty of one event does not increase the uncertainty of another joint event.

Weaver's contribution to Shannon's theory

In his commentaries on Shannon's mathematical theories of communication, Weaver (Shannon & Weaver, 1962) points out that communication includes not only speech but also pictures, music, ballet and so on. A GUI can be viewed as a communication system between CPU and user (see Figure 2).

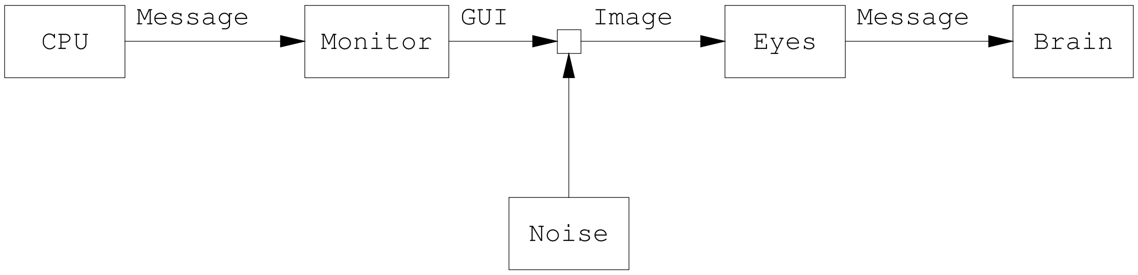


Figure 2: Diagram of a GUI communication system (after Shannon 1962)

Understanding this communication process has three levels (Table 1). These levels overlap. It may appear that the theory only applies to the technical level but closer thinking reveals that problems at the technical level affect the semantics and effectiveness of communication. For example, a button with too small a font may not convey meaning and thus prevent the user from completing a task.

	Weaver	**GUI**
Technical	accurate transmission of data	Layout, screen resolution etc
Semantic	attachment of meaning to the data	Meaningful labels, error messages
Effective	changes in the recipient by the data	Enables task completion

Table 1: Levels of the communication process

Information

In both Shannon and Weavers' writings, information is defined as the freedom of choice when selecting a message and in turn can be measured by the logarithm of the number of possible choices. The logarithm of the number of choices is used because it is the most appropriate. For instance, using a GUI example consisting of just a radio button, the user is equally free to select or de-select the button. Thus the amount of information the radio button carries is unity ie H is at its largest and each choice is equally probable. The logarithm of the 2 choices to the base 2 is 1 or unity. Furthermore, if there were three radio buttons there would be eight possible choices and we would expect three times the amount of information and indeed $\log_2 8 = 3$. This applies to more complex situations. When a user runs a GUI based program, the GUI designer has used the basic building blocks of the GUI environment to communicate to the user. The user can start at one point and continue till a task is completed. When the users begins any interaction object can be chosen but once the first object has been chosen then probability can be used to "guess" the next choice. For instance, if the user reads the label "Help" then the odds would be high that the user would next press the "Help" button. The user's choice of objects is dependent on the prior objects chosen.

Entropy in the physical sciences is a measure of the state of disorder of a system, the more disorder the higher the entropy. In communication theory, entropy describes the amount of uncertainty in the progress of a message. In a highly organised transmission the amount of information (entropy) is low and there is little randomness or choice.

The figure for the entropy of a message can be compared to the maximum possible with the same elements to give the relative entropy. Subtracting this figure from one gives the redundancy of the message. This is the amount of the message that is determined by the statistical rules of the message system and not due to free choice. The loss of this amount of the message would not destroy the message. It is easy to conjecture just how much of a GUI interface is redundant. For instance, a common guideline is to place the "Exit" button on the bottom right-hand corner of the screen. If this guideline is followed then labelling the button "Exit" is redundant. If an icon is also placed on the button then that it is redundant as well. Redundancy is important.

Weaver points out that about 50% of the English language are redundant, that is about half of the letters or words used are open to the free choice of the user. Of course, the main virtue of redundancy in the English language is that it allows the listener or reader to still get the meaning of a message even when much detail is missing eg:

1. Omit much words make text shorter.
2. Thxs, wx cax drxp oxt exerx thxrd xetxer, xnd xou xtixl maxagx prxttx wexl.
3. Thng ge a ltte tuger f w alo lav ou th spce. (Lindsay & Norman, 1972) p135.

Without this redundancy we could not afford to miss a word or syllable. A command language interface is a low entropy interface much like the third example for the English language. For example, in the Unix operating system, cp stands for copy, ls -l means give a long listing of the files in the directory. The commands are often abbreviated and there is frequently only one way to do things. This lack of redundancy is one feature that makes command languages difficult to learn and remember. In contrast, GUI's have a much higher entropy. Often a task can be completed using different methods such as direct manipulation, menus or keyboard shortcuts. However, it is important to remember that entropy is increased both by increasing the lack of order and by increasing the number of objects. Weaver observes that the best measure of the capacity of a communication channel is the amount of information that can be transmitted not the number of symbols.

Bonsiepe: application of complexity theory to typography

One statistical interpretation of entropy is that it is a measure of the disorder of the system. This interpretation provides a justification for Bonsiepe (1968) to use the Shannon formula as a measure of the order or complexity for the typographic design of a printed page.

Bonsiepe believed that mathematics could provide design with "a series of instruments for the conscious and controlled generation of forms" (1968, p. 204). This idea is now being extended for computer supported design (Vanderdonckt, Ouedraogo, & Ygueitengar, 1994, Sears, 1993, Hudson & Hsi, 1993) for example. However, Bonsiepe does take it for granted that "order is preferable to a state of disorder" (1968, p. 205) and offers no justification other than that creating order is the business of designers.

According to Bonsiepe there are two types of order; system order and distribution order. System order is determined by classifying objects according to common widths and common heights and distribution order is determined by classifying objects by their distance from the top of the page and from the left side of the page. This, of course, is based on the top-to-bottom, left-to-right pattern of reading evidenced in Western culture.

Bonsiepe's technique is to draw contour lines around each typographical object. The proportion of objects in each class is then used to determine the complexity, C, of the layout using a modified version of the Shannon formula to arrive at a figure for complexity. This C corresponds to Shannon's H, the measure of the uncertainty in the occurrence of an event. Bonsiepe's formula states that the complexity of a system C is given by:

$$C = -N \sum_{i=1}^{i=n} p_i \log_2 p_i \qquad (3)$$

where:

$$C = -N \sum_{i=1}^{i=n} p_i \log_2 p_i$$

and

$$p_i = \frac{n_i}{n}$$

where:

N = total number of objects (widths or heights, distance from top or side of page)
n = number of classes (number of unique widths, heights or distances)
n_i = number of objects in the *i*th class
p_i = proportion of the *i*th class.

Bonsiepe tested the applicability of this formula by comparing two versions of a printed catalogue. It was found that the new version was 39% more ordered than the original version. Subjective observation agreed with the mathematical theory, and the formula gave a measure of the difference in perceived "complexity" or "orderliness" between the new and old versions. In essence, Bonsiepe's work offers a justification for the grid system commonly advocated for the layout of printed documents eg (Porter & Goodman, 1983) and for computer screens eg (Hudson & Hsi, 1993).

Tullis: complexity theory applied to computer screens

Tullis (1983) reviewed the literature dealing with computer-generated, alphanumeric monochromatic screen displays to understand how formatting affected the processing of the information by the viewer. One metric he used was Bonsiepe's layout complexity. Minimising layout complexity with tables, lists and vertical alignment increases the user's ability to predict the location of items and thus improves the viewer's chance of finding the desired information. In other words, Tullis was attempting to lower the entropy of the system; to lower the freedom of choice of the viewer. When Tullis applied Bonsiepe's technique to screens that had been identified in the earlier study (Tullis, 1981) as narrative and structured, he found that the structured screen returned a lower complexity figure than the narrative screen.

Tullis (1988b) later decided to determine if the complexity measure was a useful usability metric. Again using alphanumeric data, he prepared 26 formats that were viewed by ten subjects in different trials. He found that layout complexity did not help in predicting the time it takes for a user to find information. This is an interesting result. If there is less uncertainty about the placement of objects then it should be easier to find information. However, he did find that it was an important predictor of users' rating of the usability of screens. In a second experiment using different displays and subjects, Tullis (1988b) attempted to predict the subjective ratings. He found that, along with other measures, layout complexity helped to predict the users' rating of the usability of the different screens.

THEORY

This research aims to develop a metric for evaluating object placements in a graphical user interface based on complexity theory or to put it simply "where is the best place to put things". This metric should be capable of being incorporated into the software environment so that the software developer can have immediate feedback on the layout quality of the GUI. The formal hypothesis is that there is a trade off between usability (U) and complexity (C) with a relationship of the form U = f(C) where U is a maximum for some intermediate value of C (Figure 3).

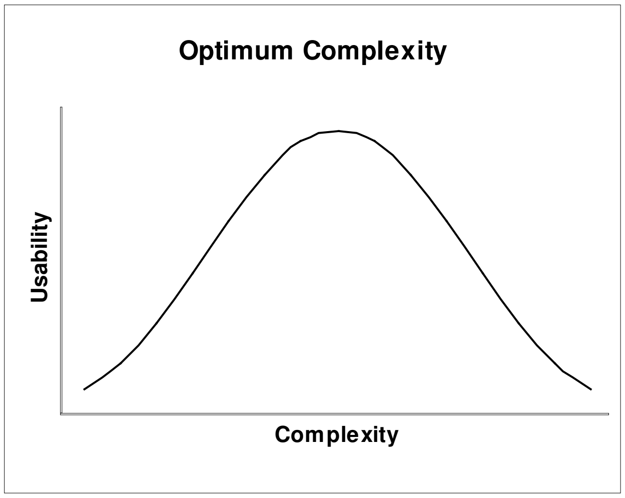


Figure 3: Relationship between complexity and usability

As the complexity figure becomes smaller, it becomes more difficult to distinguish different interface objects and the interface takes on an artificial regularity. On the other hand, the interface becomes more predictable. At the other extreme as the interface approaches maximum complexity, it looks artificially irregular. What is more important, it becomes impossible for the designer to group objects with similar functions on the basis of size or position. However, the increase in entropy means that the user has more information and more choice and less interference from "noise".

RESEARCH

Initial investigation

Table 2 shows the results of applying Bonsiepe's technique to thirteen different Microsoft Windows applications. The total complexity, C, is given by $C = C_S + C_D$. The complexity per object C_O is also computed and is given by $C_O = C/N$. It is seen that there is a large variation in complexity figures for the thirteen displays, with the complexity of the most complex display screen (from Rockford) being some 66 times greater than the complexity of the least complex screen (from Microsoft Recorder).

Application	Obj. No. N	System comp. C_S	Dist. Comp. C_D	Total C	Ratio C_O
MSRecorder	5	10.46	13.22	23.68	4.74
MSCalendar	17	76.59	101.28	177.87	7.54
Arachnid	60	96.22	388.89	485.11	8.09
MSCardfile	11	36.82	53.35	90.17	8.20
STW	23	50.75	122.60	173.35	8.60
Chartist	31	85.67	199.94	285.61	9.21
MSSolitaire	14	64.24	69.44	133.68	9.55
MSObjectPackager	23	89.73	143.55	233.28	10.14
ObjectVision	20	57.19	114.82	172.01	10.46
MSPaintbrush	61	239.61	467.89	707.50	11.60
MSWord	74	305.86	591.79	897.65	12.13
MSExcel	79	312.55	656.06	968.61	12.26
Rockford	104	582.42	989.56	1571.98	15.12

Table 2: Comparison of thirteen different screens in ratio order

Discussion

Both system order and distribution order are difficult to calculate manually. One good empirical measure of complexity might be the time it took to analyse an application. The more complex the layout of an interface, the more difficult it can be to determine the class of object. Ideally a development environment such as Borland's IDE or the Visual Basic editor would calculate the size and position of objects and return a complexity figure automatically. Shneiderman (1992) points out the lack of a computer program to do these computations for text screens though his recent work is attempting to remedy this (Shneiderman, Chimera, & Jog, 1995).

Conclusions

The simplest measure of the layout complexity of a GUI screen is to count the number of objects. A screen with more objects is more complex than one with fewer objects. This does not take into account the difference between an ordered display and one where objects are scattered. The number of objects is also determined by the functionality of the interface. An application that provides more functions needs more objects. Clearly layout complexity measures something but the question remains … Does layout complexity matter? In other words, how is usability affected by interfaces exhibiting differing degrees of layout complexity?

Screen Complexity and User Design Preference in Windows Applications

Method

Both Bonsiepe and Tullis have indicated that designs with high values of C are less desirable than designs with low values of C; this would also intuitively seem to be the case. On this basis, it would be expected that if users were asked to rank application screens in order of "goodness" of their design, then the ranking would be similar to that given in Table 3, ie Microsoft Recorder would be considered to be the best design and Rockford the worst.

A survey was therefore carried out to determine whether Bonsiepe's technique would provide a predictive measure for users' ranking of different designs. Subjects were recruited from the local campus (both students and staff) and from off-campus. All subjects were volunteers and no rewards were offered. The survey took between 5 and 10 minutes to conduct. A grey-scale 300dpi laser print was made of each screen and inserted in a plastic envelope. They were asked to sort the screen prints from best design to worst design, with no ties. No attempt was made to define what was meant by "goodness" of design, this interpretation being left up to the subject.

Results

There was found to be a significant agreement in screen rankings among all thirty subjects, with Kendall's coefficient of concordance giving $W = 0.25$ and $\chi^2 = 91.1$ at a significance level of < 0.00005. The results indicate that there was a common interpretation of "goodness" of design. However, the distribution of the results was unexpected. The least complex screen for either C or C_O is from MS Recorder. This screen was ranked as being the second *worst* design by 12 out of the 30 subjects. The most complex screen for either C or C_O is from Rockford. This screen was ranked as being the *best* design by 4 subjects, although 9 other subjects ranked it as the worst.

The rankings by user perception are compared with the rankings by complexity in Table 3 and in Figure 4. Whilst the rankings by C_O show some positive agreement with the rankings by C, it is seen that there is lack of such agreement between either of these rankings and the rankings by user perception. The Spearman correlation between ranking by perception and ranking by C gives a *negative* coefficient of $r_s = -0{\cdot}52$ at a significance level of 0.07, and a Spearman correlation between ranking by perception and ranking by C_O gives a negative coefficient of $r_s = -0{\cdot}47$ at a significance level of 0·11. Both of these correlations indicate that users show a greater preference for the *more complex* screens.

Application	ID	Mean Perceived Rank	Rank by total C	Rank by C_O
MS Paintbrush	1	4.4	10	10
MS Excel	2	4.5	12	12
MS Word	3	5.2	11	11
MS Solitaire	4	5.5	3	7
STW	5	6.0	6	5
Arachnid	6	6.1	9	3
ObjectVision	7	6.8	5	9
Chartist	8	7.0	8	6
MS Calendar	9	7.9	4	2
Rockford	10	8.1	13	13
MS ObjectPackager	11	9.5	7	8
MS Recorder	12	9.6	1	1
MS Cardfile	13	10.3	2	4

Table 3: Expected ranks compared to mean ranks

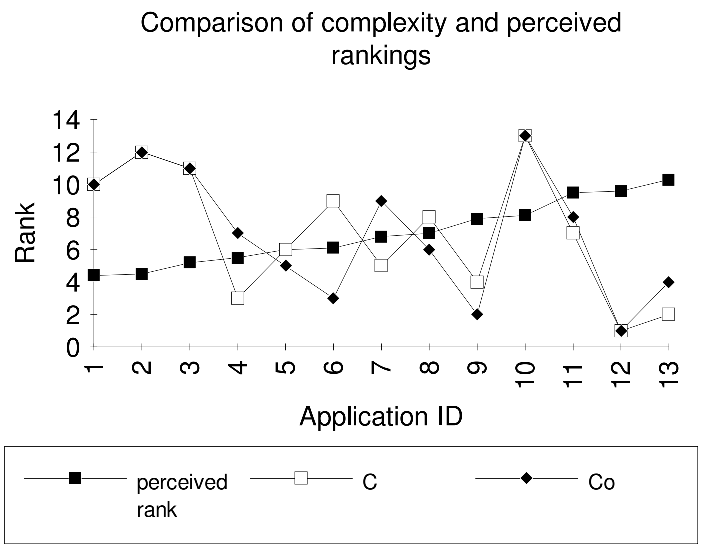


Figure 4: Mean ranks compared to expected ranks

Discussion

The expectation based upon the work of Tullis and Bonsiepe was that good layout design strives to be simple. This was not borne out by the results. A number of applications, including Microsoft Word and Excel, received rankings opposite to that expected. This suggests that users prefer more complex layouts.

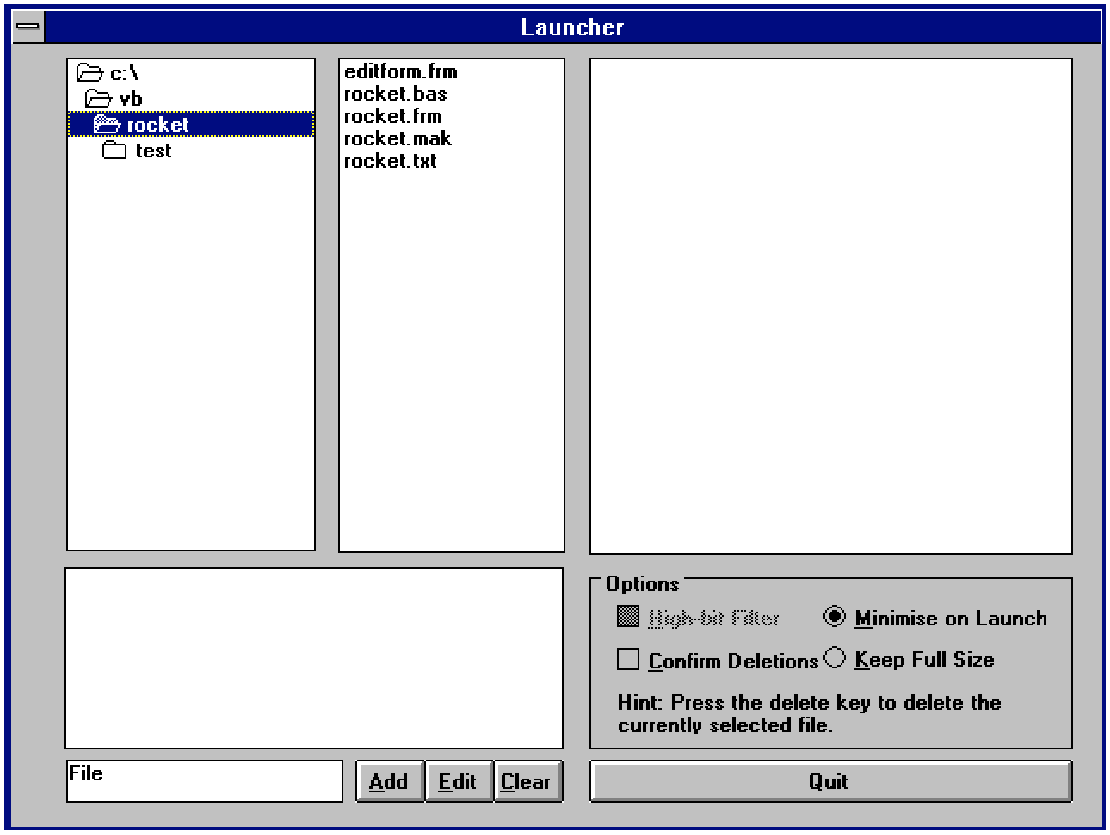
There are clearly a number of problems with comparing screen designs for different applications. Some users reported being more familiar with certain designs and judged them better because of familiarity, suggesting that screens may be judged to be "good" because users can map them to what they know the applications can do. However, as we have seen, the results show a high degree of correlation in screen rankings between all thirty subjects ($\chi^2 = 91.1$, $\alpha = 0.00005$), indicating that familiarity with the screen was not a major factor in the ranking.

Conclusions

The most interesting result is the degree to which people like complex interfaces. At first glance this is counter-intuitive but further thought indicates that people usually do tend to judge a tool by its perceived functionality. This research suggests that it would be a good idea for interface designers not to open an application with a simple interface. Having shown that layout complexity is both measurable for GUI's and that at least one aspect of usability, attitude, is affected by the metric, the next stage was to determine the metric's utility by building an application and measuring the effect of layout complexity on usability.

Launcher

Usability has been defined as consisting of effectiveness, learnability, flexibility, and attitude (Lindgaard, 1994). The pilot experiment was designed to test three of these components of usability; effectiveness, learnability, and attitude. The pilot consisted of a simple application, *Launcher* (Figure 5), running under Microsoft Windows that calculated layout complexity for each design iteration. Launcher was originally designed as an example application for a Visual Basic tutorial and provides an alternative to the Window's "Program Manager" and "File Manager". Visual Basic (VB) was chosen to build the application and collect data as it could provide the necessary information about the dimensions and positions of most objects. It also could be used to track the user's progress with a task, keeping a record of each event and time taken.



Hint: Press the delete key to delete the currently selected file.

Figure 5: The application, "Launcher", used in this experiment

Screen Layouts

Four different screen layouts were designed, each with a different complexity score. The screen with the lowest score consisted of objects arranged in a neat grid with almost uniform sizes. The next two screens consisted of almost normal layouts and the final screen had every object with a different size and position. Table 4 shows the complexity ratings for each of the four screens used in the experiment. The theoretical minimum was not achievable in VB, when using different objects, as some objects could not be resized to match other objects ie objects in VB have a fixed size relationship to other objects.

Complexity Scores for 17 Objects						
	Theory min.	Scr. 1	Scr. 2	Scr. 3	Scr. 4	Theory max.
C	71	156	170	186	228	272
%	0%	42%	49%	57%	78%	100%

Table 4: Complexity scores for 17 objects

Procedure

Seven experienced computer users volunteered to take part in the pilot study. Each subject was asked to read an ethics disclaimer and answer some basic questions about computer usage and experience. They were then requested to select a file, add it to a list, change its name and quit for each screen. At the completion of the first stage they were asked to indicate their preferences for the different screens. They were given the choice of looking at printed copies of the screens or selecting images of the screens. The application was designed to record the time it took users to complete each step in a task and to record any errors. The subjects were then asked to run through the experiment again thus giving a second set of data for the same task and screen. It was expected that any improvement in performance for the second run would indicate an interface that was more learnable and memorable.

Results and Discussion

Each subject scored 1 if the screen was completed correctly and 0 if any mistake was made. This provided a simple measure of error rates. Table 5 shows the percentage correct for each screen design and for each run of the experiment.

	Percentage error-free screens			
Run	Screen1	Screen2	Screen3	Screen4
First	29%	71%	100%	71%
Second	43%	86%	71%	71%
Mean	36%	79%	86%	71%

Table 5: Percentage of screens that were completed without errors

There were no errors for Screen 3 in the first run and in the second run Screen 2 had the least errors. The two screens at either end of the complexity scale exhibited more errors, however the results for Screen 1 were confounded by confusion about the task and which object to choose.

The total time spent on each screen is presented in Table 6. It can be seen that there was an overall improvement in task completion time from the first run to the second run. Screen 1 and Screen 4 were slower to complete. The times for Screen 1 were possibly affected by the same problems as mentioned previously.

Total Time Spent (s)					
Run	Scr. 1	Scr. 2	Scr. 3	Scr. 4	Total
First	221	165	147	145	678
Second	133	125	129	148	535
Total	354	290	276	293	

Table 6: Time spent completing the task for each screen and run

The subjects were asked to choose the most preferred screen (Table 7). The votes for re-design are shown as minus figures to highlight the negative nature of the statement. Some subjects changed their minds on the second run. The reasons for this were not explored.

User Preferences					
	Scr. 1	Scr. 2	Scr. 3	Scr. 4	None
Attractive	4	3	3	4	0
BestDesign	2	4	7	1	0
EasyToUse	5	0	7	1	1
ReDesign	-7	0	-1	-6	0
Rating	4	7	16	0	1

Table 7: Users evaluation of the different screen designs

Both the least and most complex screens were rated poorly even though more users found them attractive. It is also interesting, that even though it was a small homogenous group, there was still quite a divergence of preferences.

Table 8 summarises the results. The screens with a mid-range complexity, screens 2 and 3, rate better overall than the screens at either end of the complexity scale. However these results do need to be treated cautiously because of the small number of subjects and the limited number of screens.

Summary				
Usability	Scr. 1	Scr. 2	Scr. 3	Scr. 4
Complexity	156	170	186	228
Error-free	36%	79%	86%	71%
Time	354	290	276	293
Rating	4	7	16	0

Table 8: Summary of usability

VB did prove a useful tool for calculating complexity though there were some problems. It was also useful for collecting data about the user's interaction with the application. However one shortcoming in this pilot was using different forms for each screen. The results from this pilot showed differences in usability between screens differing in complexity. Graphic design manuals (Galitz, 1993) stress the importance of using a grid to layout objects. Complexity theory offers a means for determining if objects have indeed been laid out in a grid but is a perfect grid pattern the best way to layout a screen? The least complex screen, which most followed an exact grid, was not the most usable though the limited number of subjects, tasks and screens do suggest treating the results with caution.

The application will be extended to present more screens and more tasks and a wider cross-section of users will be involved in the next iteration. Extra metrics will also be added including "layout appropriateness" (Sears, 1993), percentage white space and sampling of mouse pointer position to determine whether the user has "wandered" looking for the correct button.

CONCLUSIONS AND FURTHER RESEARCH

The designer of a GUI application is exposed to many guidelines, standards and rules (see (Vanderdonckt, 1995)). How the screen is actually designed depends on the designer's interpretations of these rules. A popular admonition to interface designers is to keep the screen simple and well organised (Galitz, 1993, Hix & Hartson, 1993). In his influential and popular book on interface design, Galitz (1993, p.244) asserts that graphical interfaces can reduce usability because of the "variety and complexity" of interface objects. He indicated that an important requirement of users is that screens have "an orderly, clean, clutter-free appearance" (Galitz, 1993, p. 60) to not reduce usability. Shneiderman (1992 p.315) even goes so far as to state that "dense or cluttered displays can provoke anger". These authors have in common an idea that the interface designer agrees with them in what makes a simple, ordered interface. This research attempts to quantify this concept to enable objective design decisions to be made.

There are two groups that require a method of evaluating GUI applications.

1. Application designers need to be able to choose between competing layouts.
2. Prospective purchasers need to be able to compare different applications for design quality.

Bonsiepe's technique enables the designer to compare two versions of the same application and allows for an objective measure of their complexity. For this to be a practical technique would require the development environment to calculate the complexity figure as manual calculations are slow and prone to error. Recent work by Shneiderman (1995) shows it is possible to produce reports on the usability of an interface but I believe that it is a better approach to give feedback to the designer while work is in progress. To this end the layout complexity metric (and others) will be developed as functions that can be added to the software (VB) and removed when development is complete. However, the most important aspect of this research is determining the effects that layout complexity has on the user so as to ascertain the usefulness of the metric.

If such a metric was provided to the prospective purchaser of software it would allow for an objective comparison of the interfaces. Ideally the measure would be calculated either for some standard subset of the interface or for all screens in the interface. It should be possible for software publishers to state the results of usability tests as a selling point.

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