

KLM Exercise

This exercise uses the KLM to predict the amount of time a user will spend filling out the registration form on the Harry & David Web site. This exercise also suggests simple design changes to the form that are proven by the KLM to reduce user execution time. Finally, some issues encountered by a first-time user of the KLM are discussed.

This exercise is divided into the following sections:

- Overview of KLM
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- Assumptions
- Task Flow
- Calculations Based on Existing Registration Form
- Simple Design Changes
- Calculations Based on Incorporated Design Changes
- Issues With the KLM

Overview of KLM

KLM stands for Keystroke-Level Model, and is the simplest version of the GOMS (Goals, Operators, Methods, Selection rules) technique developed by Card, Moran, and Newell (1983). It focuses on using established execution times for keystrokes, character sequences, mouse points, mouse clicks, homing hands to keyboard/mouse, mental acts of routine thinking/perception, and system wait time to predict how long it will take a defined user to accomplish a specified task. Table 1 describes the KLM execution times that will be used in this exercise.

Table 1 KLM Execution Times

Symbol	Operator	Time (in secs.)	Notes
K	Keystroke	.12 to 1.2	Average is .28 seconds for nonsecretarial typists.
T(n)	Sequence of n characters	(n * K)	Used for a chunk of characters.
p	Point with mouse to a target	.8 to 1.5	Average is 1.1 seconds, but can use Fitt's law to determine actual time.
B	Press or release mouse button	.1	Highly practiced operator. Does not usually require preceding mental operator. A press/release combination is represented as BB.
H	Home hands to keyboard/mouse	.4	Also well practiced operator, requiring little or no mental processing.
M	Mental act of routine thinking or perception	.6 to 1.35	Average is 1.2 seconds. This is the most difficult part of the KLM.
W(t)	Waiting for system response	Wait time	Time the user must wait on the system before proceeding. Wait time is measured from time user action was executed until the next page fully loaded, using a 42,600 bps dial up connection.

About the Harry and David Registration Form

The Harry and David registration form, available at <http://www.harryanddavid.com/cgi-bin/ncommerce3/ExecMacro/msregform.d2w/report> (as of November 19, 2001), is the focus of this exercise. A portion of this form is shown in Figure 1.

Figure 1 Registration Form on Harry and David Web Site

Harry and David Online: Sign In! - Netscape
 File Edit View Go Communicator Help

Harry and David
 America's Favorite Gourmet Food Gifts Since 1934

Keyword Search **GO**

Customer Service | Gift Finder | Gift Services | View Basket | Checkout | Sign In

Returning Customer Sign In:
 If you have previously registered, please sign in below:

E-mail:
 Password:

sign in
[Forget your password?](#)

Register Here for Quicker, Easier Shopping:
 You will enjoy a quicker, easier check-out, access to previous orders and your own personalized address book. After registration, your e-mail address will serve as your sign in name. The street address you provide becomes your default billing address.

E-mail:
(note: this will serve as your sign in name)

First Name:
 Last Name: *

Company Name:
 Street Address: *
 Address 2:
 City or town: *

State or province: Select One for U.S. or Canada * Includes APO and FPO.
 Other State or Province:
 Country: United States *

Home
 Go Shopping
 Gift Assortments
 Gift Baskets
 Gift Towers
 Special Occasions
 Holidays
 Fresh Fruit & Vegetables
 Fruit of the Month Clubs
 Gourmet Foods
 Floral Gifts
 Home Decor
 Serveware
 Great Buys
 Express Catalog Shopping
 International APO/FPO
 My Giftlist™
 Gift Certificates
 Stores
 Corporate Sales
 Free Catalog
 About Us
 Become an Affiliate

Document: Done

Assumptions

The following are assumptions about a user of the Harry and David registration form page:

- The user starts with his/her browser opened and the registration form page fully loaded (that is, no initial download time is taken into consideration).
- The user is working with a desktop resolution of 1024x768, the Netscape browser version 4.76, and a 42, 600 bps dial up connection.
- The browser window is maximized, and no other windows are open or overlapping the displayed registration form. The scrollbar is originally at the top of the browser window. The cursor has not yet been placed in any form field. The mouse pointer is in the top, left corner of the window, near the scrollbar.
- The user is using a regular mouse. That is, not a trackball or joystick pointing device. If the mouse has a wheel, the user does not use it for scrolling operations.
- The user begins with his/her right hand on the mouse, and the index finger in preparation for left mouse button clicking. The user's left hand is lightly resting on the left side of the keyboard, around the ASDFG keys (in preparation for typing).
- The user is average. That is, he/she is an average nonsecretarial typist who takes the average amount of time to point with a mouse to a target, takes an average amount of time in mental acts of routine thinking or perception, and so on. Therefore, average KLM execution times will be used in all calculations.
- The user has not registered or examined the registration form in detail prior to this interaction. This is the first time he/she has seen it, or will read the information on the form. The user, however, may have filled out online forms before.
- The user will fill out the fields on the registration form sequentially, and will attempt to fill out all fields, whether they are noted as required or optional on the form itself. The only fields that will not be filled out are those that are both optional *and* not applicable.
- The user will use the mouse to perform all operations, unless the keyboard is absolutely necessary. In other words, the user will not use the Tab key to move through the form fields, nor press the Enter key to submit the form.

- The user scans the visible view first, and will not scroll until he/she is unable to see and fill out any more form fields.
- The user will use scrollbars to their fullest extent by slowly dragging them until an appropriate value is in view. That is, the user will not repeatedly click a drop-down menu's arrow button to view more items in the list, and will not bypass an appropriate value and need to backtrack when using scrollbars.
- The user will capitalize their names and all proper names according to the rules of English grammar. Caps Lock is assumed to be off, and will remain off. Capitalization using the shift key will be considered a highly-practiced operation and therefore will not require a mental operation.
- The user will not use the separate numeric keypad for entry of numbers. If this was the case, additional homing operations may need to be considered.
- The user will use full names for most entries, rather than abbreviations. For example, if the user's name is Jennifer, she will enter "Jennifer" instead of "Jen." Similarly, words commonly abbreviated in addresses, such as street, avenue, drive, and so on will be spelled out for consistency. The exceptions will be the full legal name of the company to be entered in the form, including "Inc.," "Ltd.," and so on. These values will be abbreviated, and only 5 digit zip codes will be entered.
- The user will try to accept any default values that are displayed on the form.
- If the form provides guidance on value formats, the user will follow that guidance. For example, if the form requests a date in the format MM/DD/YYYY, the user will enter the date in that format. If the form does not provide guidance on value formats, the user will enter what he/she believes to be the most common format, which *may exclude* all extraneous characters. For example, if the form requests a social security number, the user may enter digits without spaces or dashes.
- The user has not recently changed their e-mail address, name or phone number, nor has he/she recently moved residences or changed jobs. Changes in personal information may require additional mental processing until they become highly practiced.
- The user resides in the United States, and uses his/her own residential address (that is, not a post office box address).
- The user has a standard username, password, and password hint/question, which he/she uses for most, if not all, non-business Web use. The username is 6

characters in length, and the password is 7 characters in length. The password includes a combination of letters and numbers. The user will type the password correctly multiple times, if asked to enter it more than once for verification.

Note: If the Web site has specific restrictions that do not allow the user to use this standard combination, the user will have to think about an alternative that would be acceptable. Thus, providing this information may or may not be considered highly practiced, and the level of mental processing may vary.

- When textual instructions or information is provided in the vicinity of the form, the user will read it.
- The user is not performing the registration while multitasking. That is, the user is completely dedicated to the task at hand and is not juggling it with other tasks.

Task Flow

Table 2 outlines the task flow for filling out the Harry and David registration form.

Note: Because Caps Lock is off, each capitalization requires two characters: Shift + the lower case character. Some special symbols, such as “@”, may also require use of the Shift key and thus may be counted as two characters.

Table 2 User Action Sequence

Step	Operator	Execution Time Value
Decide whether to fill in “E-mail” form field.	M	1.2 seconds
Point mouse to “E-mail” form field target.	p	1.1 seconds
Press/release mouse button in “E-mail” form field.	BB	.1 + .1 = .2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “E-mail.” Value entered for exercise is: jhocko@excite.com.	T(18)	18 * .28 = 5.04 seconds
Move left hand from keyboard to mouse.	H	.4 seconds

Table 2 User Action Sequence (Continued)

Step	Operator	Execution Time Value
Decide whether to fill in "First Name" form field.	M	1.2 seconds
Point mouse to "First Name" form field target.	p	1.1 seconds
Press/release mouse button in "First Name" form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for "First Name." Value entered for exercise is: Jennifer.	T(9)	$9 * .28 = 2.52$ seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in "Last Name" form field.	M	1.2 seconds
Point mouse to "Last Name" form field target.	p	1.1 seconds
Press/release mouse button in "Last Name" form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for "Last Name." Value entered for exercise is: Hocko.	T(6)	$6 * .28 = 1.68$ seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in "Company Name" form field.	M	1.2 seconds
Point mouse to "Company Name" form field target.	p	1.1 seconds
Press/release mouse button in "Company Name" form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for "Company Name." Value entered for exercise is: BEA Systems, Inc.	T(22)	$22 * .28 = 6.16$ seconds

Table 2 User Action Sequence (Continued)

Step	Operator	Execution Time Value
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in “Street Address” form field.	M	1.2 seconds
Point mouse to “Street Address” form field target.	p	1.1 seconds
Press/release mouse button in “Street Address” form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “Street Address.” Value entered for exercise is: 1800 Commonwealth Avenue.	T(26)	$26 * .28 = 7.28$ seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in “Address 2” form field.	M	1.2 seconds
Point mouse to “Address 2” form field target.	p	1.1 seconds
Press/release mouse button in “Address 2” form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “Address 2.” Value entered for exercise is: Apartment 7.	T(12)	$12 * .28 = 3.36$ seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in “City or town” form field.	M	1.2 seconds
Point mouse to “City or town” form field target.	p	1.1 seconds
Press/release mouse button in “City or town” form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “City or town.” Value entered for exercise is: Brighton.	T(9)	$9 * .28 = 2.52$ seconds

Table 2 User Action Sequence (Continued)

Step	Operator	Execution Time Value
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in “State or province” form field.	M	1.2 seconds
Point mouse to “State or province” form field target.	p	1.1 seconds
Note: Since the user may target the small arrow icon on the drop-down menu (rather than the entire field), the execution time may be longer than the average used in this calculation. Use Fitt’s law to determine actual execution time.		
Press/release mouse button in “State or province” form field.	BB	.2 seconds
Point mouse to drop-down menu’s scrollbar target.	p	1.1 seconds
Press mouse button in scrollbar area.	B	.1 seconds
Drag scrollbar until appropriate value for “State or province” form field is in view. Value used for exercise is Massachusetts, USA.	p	1.1 seconds
Release mouse button from scrollbar area.	B	.1 seconds
Point mouse to value of Massachusetts, USA.	p	1.1 seconds
Press/release mouse button on Massachusetts, USA.	BB	.2 seconds
Recognize there are no more form fields that can be filled in without scrolling first.	M	1.2 seconds
Point mouse to browser window scrollbar.	p	1.1 seconds
Press mouse button in scrollbar area.	B	.1 seconds

Table 2 User Action Sequence (Continued)

Step	Operator	Execution Time Value
Drag scrollbar to bottom of browser window so remaining fields are in view.	p	1.1 seconds
Release mouse button from scrollbar area.	B	.1 seconds
Decide to skip “Other State or Province” form field because it is both optional and not applicable.	M	1.2 seconds
Decide whether to fill in “Country” form field.	M	1.2 seconds
Note: This may require longer than average mental processing time if user recognizes that “USA” was already part of “State or province” form field value.		
Point mouse to “Country” form field.	p	1.1 seconds
Verify that default value of “United States” is correct.	M	1.2 seconds
Decide whether to fill in “Zip or postal code” form field.	M	1.2 seconds
Point mouse to “Zip or postal code” form field.	p	1.1 seconds
Press/release mouse button in “Zip or postal code” form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “Zip or postal code.” Value entered for exercise is: 02135.	T(5)	9 * .28 = 1.4 seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in “Day Phone #” form field.	M	1.2 seconds
Point mouse to “Day Phone #” form field.	p	1.1 seconds

Table 2 User Action Sequence (Continued)

Step	Operator	Execution Time Value
Press/release mouse button in “Day Phone #” form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “Day Phone #.” Value entered for exercise is: (617) 566-6834.	T(16)	$16 * .28 = 4.48$ seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in “Password” form field.	M	1.2 seconds
Point mouse to “Password” form field.	p	1.1 seconds
Press/release mouse button in “Password” form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “Password.” Value entered for exercise is: snow579.	T(7)	$7 * .28 = 1.96$ seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in “Verify Password” form field.	M	1.2 seconds
Point mouse to “Verify Password” form field.	p	1.1 seconds
Press/release mouse button in “Verify Password” form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “Verify Password.” Value entered for exercise is: snow579.	T(7)	$7 * .28 = 1.96$ seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide whether to fill in “Password Hint” form field.	M	1.2 seconds
Point mouse to “Password Hint” form field.	p	1.1 seconds

Table 2 User Action Sequence (Continued)

Step	Operator	Execution Time Value
Press/release mouse button in “Password Hint” form field.	BB	.2 seconds
Move left hand from mouse to keyboard.	H	.4 seconds
Type value for “Password Hint.” Value entered for exercise is: winter birthday.	T(15)	15 * .28 = 4.2 seconds
Move left hand from keyboard to mouse.	H	.4 seconds
Decide to accept default value in checkbox.	M	1.2 seconds
Decide to submit registration form.	M	1.2 seconds
Point mouse to “Submit” graphic.	p	1.1 seconds
Press/release mouse button on “Submit” graphic.	BB	.2 seconds
Wait for Web site to process form.	W(t)	51 seconds
Note: Page reloads with all values shown, message at top, and “E-mail” form field not editable anymore.	M	1.2 seconds
Read text shown at top of redisplayed registration form.		
Decide to verify each form field.	M	1.2 seconds
Note: User is not sure why form fields have been redisplayed. No error messages have been provided and text previously read provides no rationale.		

Table 2 User Action Sequence (Continued)

Step	Operator	Execution Time Value
Verify each visible and editable form field, searching for errors. There are initially 12 visible and editable form fields. Note: “Password” and “Verify Password” fields contain many more **s than originally typed. However, user notices modifications in other form fields (“Avenue” abbreviated to “Ave” and text shown as all uppercase) so assumes this is okay. This mental processing is included in verification of these two fields.	M(12)	14.4 seconds
Recognize there are no more form fields that can be verified without scrolling first.	M	1.2 seconds
Point mouse to browser window scrollbar.	p	1.1 seconds
Press mouse button in scrollbar area.	B	.1 seconds
Drag scrollbar to bottom of browser window so remaining editable form fields are in view.	p	1.1 seconds
Release mouse button from scrollbar area.	B	.1 seconds
Verify remaining editable form fields. Note: Two editable form fields are visible after scrolling: “Password Hint” and the checkbox.	M(2)	2.4 seconds
Decide to resubmit registration form.	M	1.2 seconds
Press/release mouse button on “Submit” graphic.	BB	.2 seconds
Wait for Web site to process form.	W(t)	23 seconds
User receives confirmation message that registration was successful.	M	1.2 seconds

Calculations Based on Existing Registration Form

The following calculations indicate that the total time the user will take to complete the Harry & David registration form is **3.3 minutes**, as shown in the following lines:

$$\begin{aligned} p(22) + B(38) + W(t) + M(38) + H(24) + T(152) &= \\ 1.1(22) + .1(38) + 74 + 1.2(38) + .4(24) + .28(152) &= \\ 24.2 + 3.8 + 74 + 45.6 + 9.6 + 42.56 &= \\ 199.76 \text{ seconds or } 3.3 \text{ minutes} \end{aligned}$$

Notes: 74 seconds or 1.2 minutes is attributed system wait time (W(t)). This is nearly 40% of the user experience.

Much mental processing (21.6 seconds total M) occurred during verification of form fields in search of errors that did not exist, because the user was unsure of why the form was redisplayed.

Entering keystrokes is more expensive than using drop-downs to select values. The bold rows in Table 2 highlight the time it takes using the “State or province” drop-down menu (5 seconds). Without the drop-down menu, the same operation would have taken 8.26 seconds:

$$\begin{aligned} p(1) + BB(1) + H(1) + T(22) + H(1) &= \\ 1.1(1) + .2(1) + .4(1) + .28(22) + .4(1) &= \\ 1.1 + .2 + .4 + 6.16 + .4 &= 8.26 \text{ seconds} \end{aligned}$$

This suggests that designers should provide drop-down menus when possible.

Simple Design Changes

Harry & David’s designers can change the registration form to be more efficient by:

- Specifying a format for “Day Phone Number” form field, such as “(XXX) XXX-XXXX” by placing this text near the field.
- Specifying any restrictions on formats accepted by the “Password” form field, such as “Passwords must be at least 4 characters long” near the field.

- Not adding to the number of *s in the password field when displaying the confirmation page. The user typically knows the relative length of their password and may be confused.
- Eliminating “, USA” in the “State or province” form field, because the form asks the user for this information in the “Country” form field. If the user notices this duplication, they may become confused. Keeping the “Country” form field separate is a good idea for international users.
- Organizing the form fields in a two column table to eliminate scrolling. The form is currently very narrow for a user with a 1024x768 pixel desktop area. This resolution is also the latest standard for Web development.
- Eliminating redisplay of form fields with user input unless user realizes mistake has been made or a mistake is explicitly noted on the form. For example, redisplay all fields in uneditable format, place buttons that say “Make Corrections” and “Complete Registration.” A more informative note at the top of the page would also help.
- Allowing more expert users to Tab through text form fields and press Enter to submit the form to reduce mouse/keyboard homing values. (User will still use mouse for drop-down menus.)

Calculations Based on Incorporated Design Changes

The last three changes shown in “Simple Design Changes” are taken as examples to illustrate the affect these modifications would have on the total execution time for this user:

- Eliminating browser scrolling by taking advantage of 1024x768 screen real estate subtracts 3.6 seconds (from mental operator of deciding to scroll until release of mouse button from scrollbar area).
- Allowing more expert users to use keyboard operations for the form’s text fields and form submission subtracts 9.6 seconds (24 homing movements) and adds 1 keystroke for tabbing to each field (16 tabs * .28 seconds = 4.48 seconds) for a total time savings of 5.12 seconds.
- Changing the message on the redisplayed form to indicate that it is a confirmation page, displaying the user’s input as text (rather than editable form fields), and adding buttons for “Make Corrections” and “Complete Registration”

saves the user 21.6 seconds in mental operations if he/she feels confident their information is correct.

Issues With the KLM

Some issues that this first-time KLM user encountered are as follows:

- This one form page required summation of little, often repetitive numbers that were sometimes difficult to keep straight. For example, when adding up 1.1 second values sandwiched between values of .1 seconds, it can be confusing.
- As I was creating the task list, I ended up going back and creating many more assumptions that constrained the model even further. Because of all these constraints, it is difficult to know if the KLM really does give a good prediction of execution time for a task. It may, but under a very specific set of circumstances.
- Sometimes the $T(n)$ values seem high, but perhaps that is because I would categorize myself as an expert (rather than average) typist.
- The KLM takes a little while to get used to, in that one must break down the user's task into very minute movements and details. It is easy to forget steps the first time. However, once you have determined a set of steps for a particular process, some of these minute tasks are repetitive and possibly could be chunked for easier review.