BENTLEY UNIVERSITY

Prior Knowledge and Expertise

A Case Study on Autodesk 3D Studio Max from an Autodesk Maya Expert's Perspective

Michael Andryauskas

11/14/2016

People are dependent on their past experiences to understand the present situations they encounter. While in the wild, various species use prior knowledge to determine where food can be found (Clayton & Dickinson, 1999) and to navigate the environments they have previously explored (Salwiczek et. al, 2008). With enough experience with similar scenarios, users become experts in those scenarios, introducing a wide range of benefits for their understanding of the concept as a whole (Sweller et. al, 1998). After briefly explaining the case study as well as where in the brain long-term memory is encoded, this paper presents a review on how the brain stores and recalls information, as well as the influence of one's expertise in these processes. With this knowledge, UX designers should consider what the user may possibly know even before he begins to use their product.

This paper will analyze some of the issues an expert of Autodesk Maya 2016 encounters when he is attempting to learn Autodesk 3D Studio Max 2017 (See Figure 1). While both software packages focus on 3D modeling, texturing, and animation, the toolkits provided by each program lead to the professional consensus that Maya is better suited for animated films while Max is better suited for asset generation for digital games. It is not uncommon for professional artists from one industry to transition over to the other industry. However, there is a difficulty curve when transitioning from one software package to the other. This would cause an artist's expertise in one program to backfire when learning the other program.

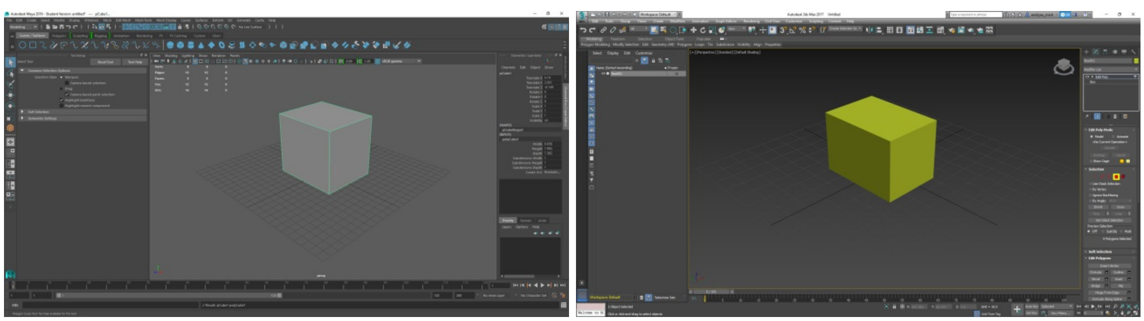

Figure 1: Main screens for Maya 2016 (Left) and 3D Studio Max 2017 (Right)

The right hippocampus plays a significant role in memory retrieval (Burgess et. al, 2002). The right hippocampus specializes in informational memory while the left hippocampus specializes in episodic memory (Burgess et. al, 2002). Meanwhile, several parts of the right hemisphere, such as the Inferior Parietal Lobule, are responsible for evaluating mental models (Filipowicz et. al, 2002).

Structures of Long-Term Memory

When people are learning a process or scenario, their minds construct a mental model of the situation. From a cognitive science standpoint, a mental model serves as a cognitive map detailing how a process works (Carroll & Anderson, 1987). When encountering a new scenario, a mental model is formed from either continuous usage, analogies to other mental models, or training in that specific scenario (Sein & Bostrom, 1989). Novices make a lot of assumptions when constructing initial mental models of a scenario (Carroll & Anderson, 1987). As a person becomes more familiar with a particular scenario, the corresponding mental model becomes more refined and more accurate (Carroll & Anderson, 1987). A mental model describes a scenario and the actions, tasks, and goals for that scenario (Carroll & Anderson, 1987). The knowledge structure of these mental models is made from schemas and the processes required to manipulate these schemas (Merrill, 2000).

The mental model for the process of creating and manipulating geometry between Maya and Max would make the transition from one program to the other a bit more difficult. Creating a primitive such as a cube in either program has slight differences that would leave an expert in one program confused when using the other. While Maya requires the user to press the left mouse button to initialize the manipulation of each customizable component, subsequent customizable components are editable as soon as the user completes the previous one in Max. In addition, Maya experts, who are accustomed to being able to manipulate individual features of any piece of geometry on the fly, would be thrown off by the constraint of individually selecting a single model or group to manipulate before any features could be altered (See Figure 2). Because of this, Max is limited when compared to Maya, as users cannot change the features on two separate geometries simultaneously without the two features being grouped together first. Maya experts need to adjust their mental models of geometry manipulation while learning Max because of this restriction.

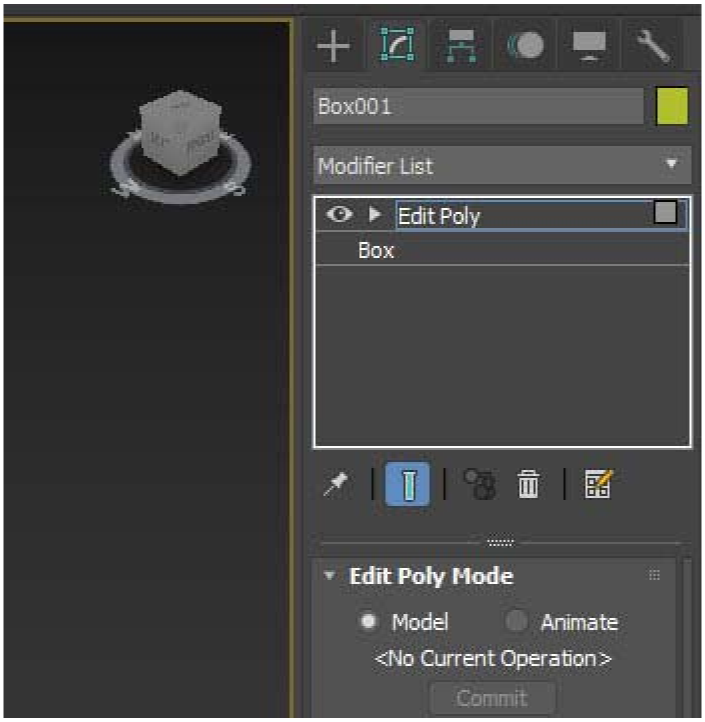

Figure 2: The Geometry Edit toolbar that Max uses to edit geometry, which doesn't exist in Maya

Schema Theory is another method scientists use to theorize how the brain stores, refines, and recalls information and relationships of a particular subject or concept in long-term memory (Rumelhart & Norman, 1978; Alba & Hasher, 1983). The brain initially breaks concepts down into schemas rather than remembering each concept separately in order to reduce the cognitive load of recalling and encoding these concepts (Van Merriënboer et. al, 2010). When a new concept is introduced, schemas from other subjects start to be recalled (Rumelhart & Norman, 1978). Once a strong relationship with a particular schema is established, the patterns that compose the recalled schema get applied to the initial schema of the new concept (Rumelhart & Norman, 1978).

Higher-order schemas are composed of lower-order schemas, and these lower-order schemas are categorized depending on their role in the higher-order schema (Rumelhart & Norman, 1978). The categorization of the lower-order schema allows the higher-order schema to be applicable to a large number of concepts (Rumelhart & Norman, 1978; Rousseau, 2001). Once a schema is deemed inadequate for a certain concept, a new schema must be created to compensate for the missing information (Rumelhart & Norman, 1978).

For a Maya Expert, the schema involved in the keyboard shortcuts for Max would need to be reworked in its current form. The mouse and keyboard shortcuts for common functions, such as camera positioning and object interaction, are mapped out differently depending on the program. For example, the Maya expert, who would be used to pressing down the Alt key before pressing one of the mouse buttons to move the viewport camera around, would be surprised to find that the Alt key only rotates the camera. Instead, a right-click menu appears regardless of whether or not the Alt key is pressed at all. In this case, the expert is making assumptions on the functionality of the program that are inaccurate, and their schema for using the program is not as complete as they thought.

A schema for a given subject starts out as incomplete, and the person with the incomplete schema makes assumptions to fill in the holes in their schema (Rousseau, 2001). These assumptions made can be attributed to any bias the person might have based on the specific subject matter and the perceived relationships, and these biases affect their schema of the subject matter (Alba & Hasher, 1983). As the person becomes more familiar with the subject matter, the schema becomes larger and more accurately tuned, and the person begins to gain expertise in the subject (Rumelhart & Norman, 1978; Sweller et. al, 1998; Rousseau, 2001).

Relationships between schemas and mental models can be structured on a semantic network, with the concept acting as the nodes in the network (Collins & Loftus, 1978; Ericsson et al, 1995). The methodology of how the network is organized can be determined by the concept being analyzed at the time: a hierarchical tree, an unstructured graph, or a scale-free world model

(Steyvers & Tenenhaum, 2005). When new concepts are added to a semantic network, a new node is created within what the brain perceives to be the best neighborhood of clusters, and connections are made from one cluster to another (Steyvers & Tenenhaum, 2005).

When a certain concept is presented, the semantic network rapidly searches for the concept through the relationships of recently presented concepts in a process known as Spreading Activation (Collins & Loftus, 1978). The speed and likelihood of the connection being made is dependent on the number of nodes on the semantic network that need to be traversed between the two concepts (Collins & Loftus, 1978; Steyvers & Tenenhaum, 2005).

Experts on a subject tend to have more robust semantic networks and higher spreading activation potential than novices do. Experts on a concept have more relationships on that node than a novice does, having more options for the brain to traverse (Raufaste et. al, 1998). In addition, experts are more capable of ignoring irrelevant information than novices, thus allowing them to make connections faster and more accurately (Ericsson et. al, 1995).

If no immediate connection between the two concepts exists, the semantic network builds a new connection between the two concepts (Steyvers & Tenenhaum, 2005; Raufaste et. al, 1998). Raufaste and his collegues (1998) call this new link an Operative Link, and the strength of this link will decline if left alone. However, if the link is referred to repeatedly over time, the connection becomes reinforced, eventually becoming an Activatable Canonical Link. Activatable Canonical Links are the links that experts traverse often enough that they are able to make connections more quickly than novices are able to make them.

Factors in Long-Term Memory

As the number of relationships among concepts increases, the phenomenon known as the fan effect takes place. According to the fan effect, as more connections are made, both the amount of time to recall specific information related to the concept and the number of errors in recalling a specific relationship increase (Anderson & Reder, 1999). However, if there is a preexisting relationship between the two concepts, the influence of the fan effect is lessened (Radvansky & Zacks, 1991). Because certain relationships become ingrained into a person's long-term memory due to continuous exposure to the relationship, experts usually retain the rapid and accurate recall of well-established relationships (Ericsson et. al, 1995).

When a person is exposed to a concept, the brain will invoke related concepts, allowing for quicker recall of those concepts. This is a process known to scientists as priming (Collins & Loftus, 1979; Herr et. al, 1983; Bar & Biederman, 1998). The act of priming indicates to the semantic network that it should get ready to traverse paths as a stream of ideas flow into the person's perception (Raufaste et al, 1998). If the concept is new to the person, the brain will categorize it with other concepts that have been recently presented to the person (Herr et. al, 1983). The amount of time required for an item to be properly primed depends on the complexity of the concept, with items being primed far faster than scenarios (Ericsson et. al, 1999). While comparing several related concepts, choosing the wrong order to present concepts may alter the overall perception of the characteristics of these concepts (Herr et. al, 1983).

An issue that 3D Studio Max has which is caused by priming is the shared names of different menus, specifically with the word “Edit” (See Figure 3). Several buttons are labeled “Edit” which all have their own sets of options in their respective dropdown menus depending on their position on the screen. If a user is searching for a specific function to perform, the word “Edit” by itself would potentially prime all possible submenus that use that label.

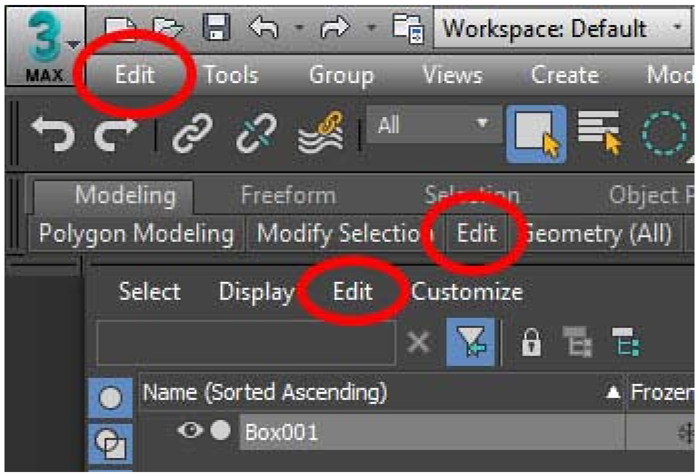

Figure 3: The various edit buttons that are context-sensitive.

There are two major factors that determine how strongly certain concepts are imprinted into long-term memory and get recalled when related concepts are primed (Hasher & Zacks, 1979; Anderson & Milson, 1989). The first of these factors is frequency, which refers to how often the concept is referred to (Hasher & Zacks, 1979; Greene, 1984; Anderson & Milson, 1989). The more often a concept is visited, the more likely the concept will be imprinted into memory (Greene, 1984). When a person is learning, the effectiveness of frequency is dependent on how the material is presented and the intent of the person to learn the subject (Greene, 1984).

The second major fact that determines how likely a person will remember things is recency, which refers to how much time has passed since the concept has been referred to (Anderson & Milson, 1989; da Costa Pinto & Braddeley, 1991; Jacoby & Wahlheim, 2013). People are more capable of remembering even small details regarding what just occurred than the detail of what happened a long time ago. As the amount of time a person refers to a concept or memory increases, the less likely he is to accurately recall the information (da Costa Pinto & Baddeley, 1991).

Closing Thoughts

There are a few steps that the Autodesk 3D Studio Max UX team can take to better accommodate the professionals who already know Autodesk Maya. The Max UX team could place a setting in the startup menu to remap the navigational hotkeys to mimic that of Maya. This would allow the hotkey schema to remain consistent between the two programs for professional artists. If this is implemented, it opens up the possibility for guided features for Maya experts when using Max. After the user sets the first customizable component for a primitive shape, a message could appear informing the user that he doesn't need to press down while manipulating the primitive's second customizable component. Meanwhile, if the user is trying to select features of the geometry but is not making progress, a message could appear informing the user to select the parent geometry first. Maya already has messages similar to this to guide the user in model manipulation (See Figure 4), and laying out the messages in a similar way would invoke memories that the message is helpful in Maya and should be acknowledged.

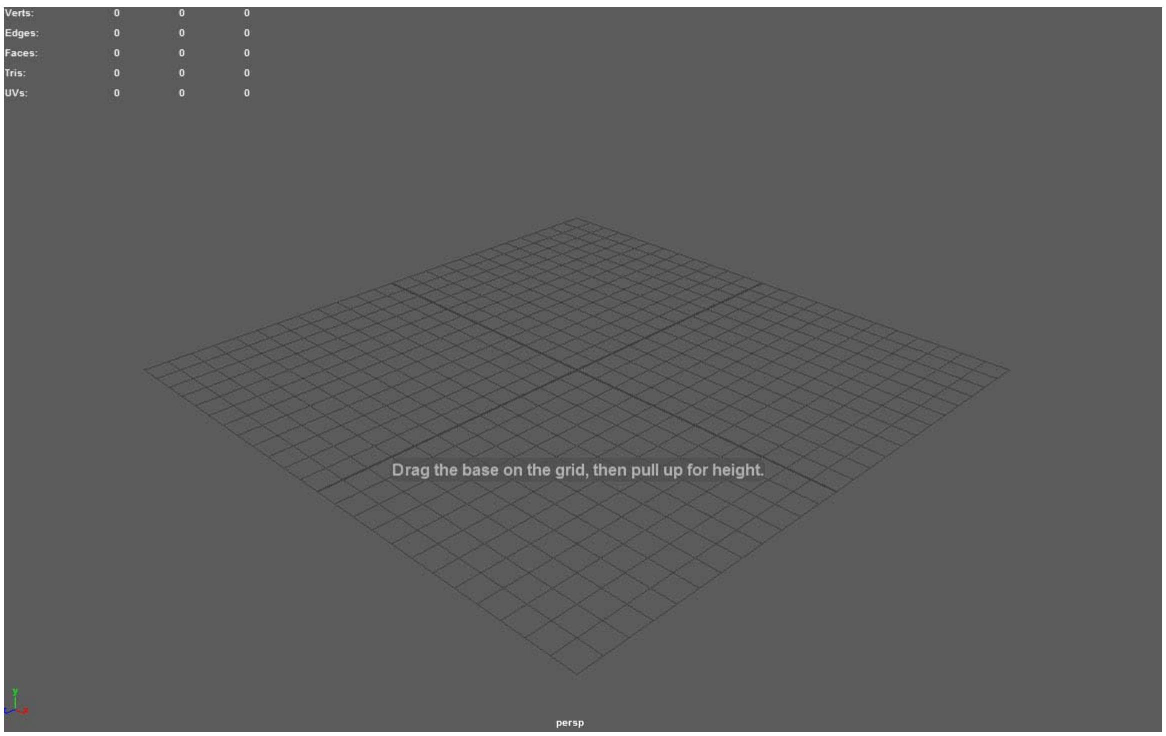

Figure 4: Maya's help message that appears when the user starts to make a cube or box.

In addition, Max's UX team should consider altering the labels of the "Edit" buttons to include what feature would be edited, such as making the "Edit" button in the modeling subpanel "Edit Model." This would differentiate the edit buttons and would lessen the excessive priming effect for simply seeing the word "Edit" on a button label.

Humans spend a good amount of their lives learning and encoding things into memory. Understanding how the brain stores and retrieves information is useful to UX designers, especially when they are considering how to design for users with a varied knowledge base.

Bibliography

Alba, J. W., & Hasher, L. (1983). Is memory schematic?. Psychological Bulletin, 93(2), 203.

Anderson, J. R., & Reder, L. M. (1999). The fan effect: New results and new theories. Journal of Experimental Psychology: General, 128(2), 186.

Bar, M., & Biederman, I. (1998). Subliminal visual priming. Psychological Science, 9(6), 464-468.

Burgess, N., Maguire, E. A., & O'Keefe, J. (2002). The human hippocampus and spatial and episodic memory. Neuron, 35(4), 625-641.

Clayton, N. S., & Dickinson, A. (1999). Scrub jays (Aphelocoma coerulescens) remember the relative time of caching as well as the location and content of their caches. Journal of Comparative Psychology, 113(4), 403.

Carroll, J. M., & Anderson, N. S. (1987). Mental models in human-computer interaction: Research issues about what the user of software knows (No. 12). J. R. Olson (Ed.). National Academies.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. Psychological review, 82(6), 407.

da Costa Pinto, A. A. N., & Baddeley, A. D. (1991). Where did you park your car? Analysis of a naturalistic long-term recency effect. European Journal of Cognitive Psychology, 3(3), 297-313.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. Psychological review, 102(2), 211.

Greene, R. L. (1984). Incidental learning of event frequency. Memory & Cognition, 12(1), 90-95.

Hasher, L., & Zacks, R. T. (1979). Automatic and effortful processes in memory. Journal of experimental psychology: General, 108(3), 356.

Herr, P. M., Sherman, S. J., & Fazio, R. H. (1983). On the consequences of priming: Assimilation and contrast effects. Journal of experimental social psychology, 19(4), 323-340.

Jacoby, L. L., & Wahlheim, C. N. (2013). On the importance of looking back: The role of recursive remindings in recency judgments and cued recall. Memory & cognition, 41(5), 625-637.

Merrill, M. D. (2000). Knowledge objects and mental models. In Advanced Learning Technologies, 2000. IWALT 2000. Proceedings. International Workshop on (pp. 244-246). IEEE.

Radvansky, G. A., & Zacks, R. T. (1991). Mental models and the fan effect. Journal of Experimental Psychology: Learning, Memory, and Cognition, 17(5), 940.

Rousseau, D. M. (2001). Schema, promise and mutuality: The building blocks of the psychological contract. Journal of occupational and organizational psychology, 74(4), 511-541.

Rumelhart, D. E., & Norman, D. A. (1976). Accretion, tuning and restructuring: Three modes of learning (No. 7602). CALIFORNIA UNIV SAN DIEGO LA JOLLA CENTER FOR HUMAN INFORMATION PROCESSING.

Salwiczek, L. H., Dickinson, A., & Clayton, N. S. (2008). What do animals remember about their past. Learning theory and behavior, 1, 441-460.

Sein, M. K., & Bostrom, R. P. (1989). Individual differences and conceptual models in training novice users. Human-computer interaction, 4(3), 197-229.

Steyvers, M., & Tenenbaum, J. B. (2005). The Large-scale structure of semantic networks: Statistical analyses and a model of semantic growth. Cognitive science, 29(1), 41-78.

Sweller, J., Van Merrienboer, J. J., & Paas, F. G. (1998). Cognitive architecture and instructional design. Educational psychology review, 10(3), 251-296.

Van Merriënboer, J. J., Kirschner, P. A., & Kester, L. (2003). Taking the load off a learner's mind: Instructional design for complex learning. Educational psychologist, 38(1), 5-13.