GNG1103

Deliverable C

Group F2

Lauren da Luz 8805144

Lauren McDermaid 5256108

Karly Piro 8584926

Dennis Sun 300111813

Maude Tremblay 8862732

February 2nd 2020

The final task in the ‘Define’ stage of the Design Thinking Process is to develop target specifications to assist in the ‘Ideation’ process. After a problem statement has been defined and a design criteria has been determined, one must benchmark with products and solutions that are currently in the marketplace and considered a competitor. Benchmarking is the process of comparing readily measurable data based on the design criteria, known as metrics, with competing solutions. This process allows the designer to know how to compete in the marketplace based on set principles. Upon completion of the process, the designer will have target specifications for the proposed solution. This paper will demonstrate a prioritized list of design criteria for the Virtual Reality organic chemistry learning unit that will then be benchmarked to competing solutions and utilized to create target specifications.

Prioritized Needs and Corresponding Design Criterion

Table 1.0: Functional Needs Statement and Design Criterion

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Needs Statement** | **Design Criterion** | **Importance** |
| **4** | The VR environment respects the 12 principles of multimedia learning | Multimedia learning effectiveness | 3 |
| **5** | The interface lets the learner know they have achieved the learning outcomes | Communication between user and software | 4 |
| **7** | The interface informs the learner what the learning outcomes are | Communication between user and software | 3 |
| **8** | The interface must teach the user how to rank objects depending on their size | Ranking based on size | 4 |
| **9** | The interface must teach the user how to rank events depending on their time | Ranking based on time | 4 |
| **10** | The interface must teach the user the relationship between time and size | Time vs Size Relationship | 4 |

Table 1.1: Non-Functional Needs Statement and Design Criterion

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Needs Statement** | **Design Criterion** | **Importance** |
| **1** | The interface is interactive, engaging and dynamic | User-friendliness | 4 |
| **2** | The interface is designed for 1st year 2nd semester chemistry students | User Adaptability | 5 |
| **3** | The information is scientifically accurate | Scientific Accuracy | 5 |
| **6** | The interface respects the chemistry colour convention | Respect of chemistry colour conventions | 5 |
| **11** | The interface is under the Creative Commons designation | Appropriate Classification | 5 |

List of Metrics

Table 2.0: List of Metrics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | **Metric** | **Applicable Need Statement** | **Identifiable Unit** | **Relative Importance (/5)** |
| **1** | Controller Type used | - | Type | 3 |
| **2** | Accuracy of speed of VR simulation | 3, 9, 10 | Time (s) | 5 |
| **3** | Accuracy of the size of Individual molecules | 3, 8, 10 | Nano-meter (nm) | 5 |
| **4** | Accuracy of size of “Human” Objects | 3, 8, 10 | Centimeter (cm) | 5 |
| **5** | Total Cost | - | Dollars (CAD $) | 4 |
| **6** | Computer system RAM | - | Gigabytes (GB) | 4 |
| **7** | Accuracy of Molecule colour convention | 6 | Visual Conformance | 4 |
| **8** | Ease of program use | 2 | Subjective (X/5) | 4 |
| **9** | Engagement of user | 1, 4 | Subjective (X/5) | 4 |
| **10** | Identification of user achieving goals | 5 | Success Statement Prompts | 4 |

Benchmarking

Table 3.0: Benchmarking Properties

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Importance** | **MEL VR** | **Molecular Model Kits** | **Odyssey Software** |
| **Cost** | 3 | $100 per device/year | ~$30 | ~starts at $25 |
| **Physical Size** | 2 | Computer, Headset, Handheld remotes | ~ 1 ft^2 | Computer |
| **“Hands on” interaction** | 4 | Visual stimuli, handsets to move/touch objects | Building Molecules by attaching balls and sticks | No “hands on”, visual interaction |
| **Scientifically Accurate Modelling** | 5 | Yes | No | Yes |
| **Differentiating Molecules based on size** | 4 | Yes | No | Yes |
| **Displaying Movement of Molecules in real time** | 4 | No | No | Yes |
| **Accessible to all ages/skill types** | 4 | Yes, used in Elementary School classrooms | Yes | No, need some software experience |
| **Feedback on Student Progress** | 4 | Red/Green Light Indicator for correct answers | No Automatic feedback, instructor to manually check | N/A |

Table 3.1: Benchmarking Numerical Ranking & Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Importance** | **MEL VR** | **Molecular Model Kits** | **Odyssey Software** |
| **Cost** | 3 | 2 | 4 | 4 |
| **Physical Size** | 2 | 3 | 2 | 4 |
| **“Hands on” interaction** | 4 | 3 | 5 | 1 |
| **Scientifically Accurate Modelling** | 5 | 4 | 2 | 4 |
| **Differentiating Molecules based on size** | 4 | 4 | 2 | 3 |
| **Displaying Movement of Molecules in real time** | 4 | 4 | 1 | 4 |
| **Accessible to all ages/skill types** | 4 | 4 | 4 | 3 |
| **Feedback on Student Progress** | 4 | 5 | 2 | 1 |
| **Total** | - | **112** | **82** | **88** |

Target Specifications:

Table 4.0: Functional Requirements

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **#** | **Metric** | **Unit** | **Relative Importance (Out of 5)** | **Optimal Value** | **Marginal Values** |
| **1** | Accuracy of speed of VR simulation | Time (s) | 5 | <1 | <300 |
| **2** | Accuracy of the size of Individual molecules | Nano-meter (nm) | 5 | <1 | <5 |
| **3** | Accuracy of size of “Human” Objects | Centimeter (cm) | 5 | <2 | <5 |
| **4** | Complies with standard molecule colour convention | Visual Conformance | 4 | Yes | N/A |
| **5** | Clear learning goals | List of objectives  prensted | 5 | Yes | Yes |
| **6** | Identification of user achieving goals | Success Statement Prompts | 4 | Yes | Yes |
| **7** | Engages the User | N/A | 5 | Yes | Yes |

1. The main learning goal was for students to rank the relative time of events. With quicker reactions and events, a small margin of error can be significant. With longer events, a larger margin of error will not have a great impact on the relative time difference between different events.
2. When we are working with sub-microscopic molecules even small errors can change the size significantly.
3. Larger objects are not affected significantly by small variances in size. Because the main concern is for the relative size of objects, we can allow more freedom when it comes to the accuracy of large objects.
4. Since this program will be used as a tool for an official university chemistry course, the correct colour conventions must be respected.
5. The learning goals must be presented to the user so they have a clear idea of the content they are supposed to learn.
6. The user should be notified of the goals they have achieved and what they could improve on. Good feedback can really help students to identify gaps in their knowledge and assist them in future courses.
7. The user needs to be engaged otherwise this game will feel more like a chore and students won’t be willing to invest time into it.

Table 4.1: Non-Functional Requirements

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **#** | **Metric** | **Unit** | **Relative Importance**  **(Out of 5)** | **Optimal Value** | **Marginal**  **Values** |
| **1** | Controller Type used | Type | 2 | HTC Vive | HTC Vive compatible |
| **2** | Tutorial Time Required | Minutes (Mins) | 4 | <45 | <80 |
| **3** | Bilingual Support | N/A | 1 | Yes | No |

1. The University of Ottawa uses the HTC Vive VR headsets so the game should be optimised for the Vive controllers. If it is not possible, the controller used still must be compatible for use with the HTC Vive.
2. With 45 minutes of instruction, students will still have plenty of time to use and explore the game in a standard 80 minute class block. The tutorial time should not exceed 80 minutes as the tutorial will then have to be split into 2 or must take place during a 3 hour lab section.
3. The principal objective is to have a functional game, however, since the University of Ottawa is a bilingual institution, bilingual support would be good to have.

Table 4.2: Design Constraints

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **#** | **Metric** | **Unit** | **Relative Importance**  **(Out of 5)** | **Optimal Value** | **Marginal Values** |
| **1** | Total Cost | Canadian Dollars (CAD $) | 3 | <100 | <100 |
| **2** | Computer system RAM | Gigabytes (GB) | 4 | <8 | <16 |
| **3** | Open Source | Creative Commons Designations | 4 | Yes | Yes |
| **4** | Interactive | N/A | 5 | Yes | Yes |

1. Our budget for the course is $100 and we can not exceed the budget given.
2. When looking at a hardware survey of computers capable of running games from steam, it was found that 33.10% of computers had 8GB of ram while 40.52% had 16GB of ram. While 46.50% of users have at least 16GB of ram, 84.24% have 8Gb or greater. Therefore a program that uses less than 8GB is optimal, however 16GB will be acceptable.[[1]](#footnote-0)
3. The client was adamant we make the program open-source under the creative commons designation.
4. The client was very specific the user had to be able to interact with elements inside the game.

Reflections on client meeting #1

Prior to the client meeting, it was understood that a virtual reality experience was needed to assist in teaching university students organic chemistry. Therefore, the design criteria and specifications focused on the course material and the concepts in which students would be evaluated. The FRG presentation did not touch base on the course material, but focused instead on broader concepts not taught in the course, such as: frequency of reactions, proportionality of reactants and solvents required to initiate a reaction, how macroscopic and microscopic scales affect time scales, and the constant motion of molecules. These concepts change the overall vision of the design criteria because it is less restrictive, the audience is not restricted to the first-year organic chemistry syllabus and the potential virtual experiences is expanded by emphasizing how chemistry surrounds our lives. The specifications for the FRG virtual reality experience emphasizes the student’s understanding of broad chemistry concepts, incorporating the twelve principles of multimedia learning, and one or two of the four concepts must be incorporated. The current products available in the market do not have a testing feature that informs the user on their progress which is essential for the FRG project. Therefore, this is a top priority in the virtual reality gaming chemistry experience.

In conclusion, the functional and non-functional needs of the client have been established and assigned a relative importance. Subsequently, the non-functional needs are identified as slightly more important than the functional needs, but are still needed for benchmarking purposes. The MEL VR when benchmarked to the modular model kits and Odyssey software scores much higher and demonstrates that there is a great need for the device in learning environments. As shown, benchmarking the MEL VR has enabled the ability to set target specifications for the product and has allowed for the next phase of the Design Thinking Process, ‘Ideate’, to commence.

1. *Valve Corporation. “December 2019.” Steam Hardware & Software Survey : December 2019,*

   *Valve Corp., Dec. 2019, store.steampowered.com/hwsurvey/.* [↑](#footnote-ref-0)