INDIANA UNIVERSITY SCHOOL OF INFORMATICS
Human-Computer Interaction Program

Effectiveness of Isometric Hierarchical Sitemaps

Sepideh Ansari
seansari@iupui.edu

INFO I575 Informatics Research Design

Contents

Introduction

Overview

We are living in an era of time that everything is constantly changed and developed. In order to cope with a better understanding of communication with the rest of the world, we should be organized and experienced about the new technology. Beside the traditional communication channels such as print, newspaper, radio, and TV, we have newly added the Internet. The presence of computers in our daily life in a sense of digitalization of mass communication on one hand and the expansion of the Internet on the other hand are cycling changes in our life.

Nowadays, the growth of the Internet is going to face the human experience of employing several of our senses, such as sight, hearing, and touch. A good design is based on understanding the users' need and helping them to grasp the meaning of the design with less effort and in a more pleasurable way and thus facilitating the comprehension of complex processes with normal human perception. A common approach to achieve this is by designers envisioning information for users in ways to east the understanding and perception of a complex and challenging form of information.

Problem Statement

The new concept of communication through computer behaves as a permanent active meeting place between users and the virtual space. Therefore, it is very important to develop a new kind of spatial imagination and memory, to help users navigate their path successfully through a virtual space. On the other hand, presence of too much information has greatly overwhelmed the users by the explosion of the web. The assumption that sitemaps can be visualized to assist users to find their path is the basis for my study.

Conceptual mapping can be used to address the problem of information overload on the web. It helps to increase the ability of users for searching quicker and eventually experience complex design architectures more efficiently. In this research, I would like to address how effective, efficient and satisfying working with conceptual mapping can be for users. Likewise, I would like to use isometric concept maps as a tool to organize and represent the embedded hierarchical knowledge of a website.

Significance of Study

As I mentioned before, the presence of information overload in our today's life on one hand, and the number of variety of ways to access the information through the web on the other hand makes us to spend a considerable amount time exploring websites to find specific information on the web. To reduce the overwhelming aspect of the information presented on the web, navigational systems are quite effective. Navigational systems represent the hierarchy of structure in a way that can save a considerable amount of time for users.

Isometric sitemap structures may significantly reduce the time required to interact with websites in order to find a specific page and retrieve the information that is desired; however, prior research lack any studies exploring this application. If effective, the isometric sitemap interaction will eventually save the interactive – information seeking time required to find any specific pages of a website.

Purpose of Study

The web has become an important communication medium. Therefore to increase its information value we need to decrease information overload. The openness of web is one of its greatest strengths. So it is very important to highlight the information that would influence the process of finding the information easier. This study is intended to evaluate the effectiveness of the isometric sitemaps compared to 2D flat sitemaps.

Common Definitions

Visualization Map

Paul Kahn (Kahn, Maps and Diagrams, 2009) describes a visualization map as special form of visual communication, a representation of the three-dimensional world in a coded two-dimensional form.

Concept Maps

A concept map is a diagram showing the relationships among concepts. They are graphical tools for organizing and representing knowledge (Wikipedia, 2010).

Sitemaps

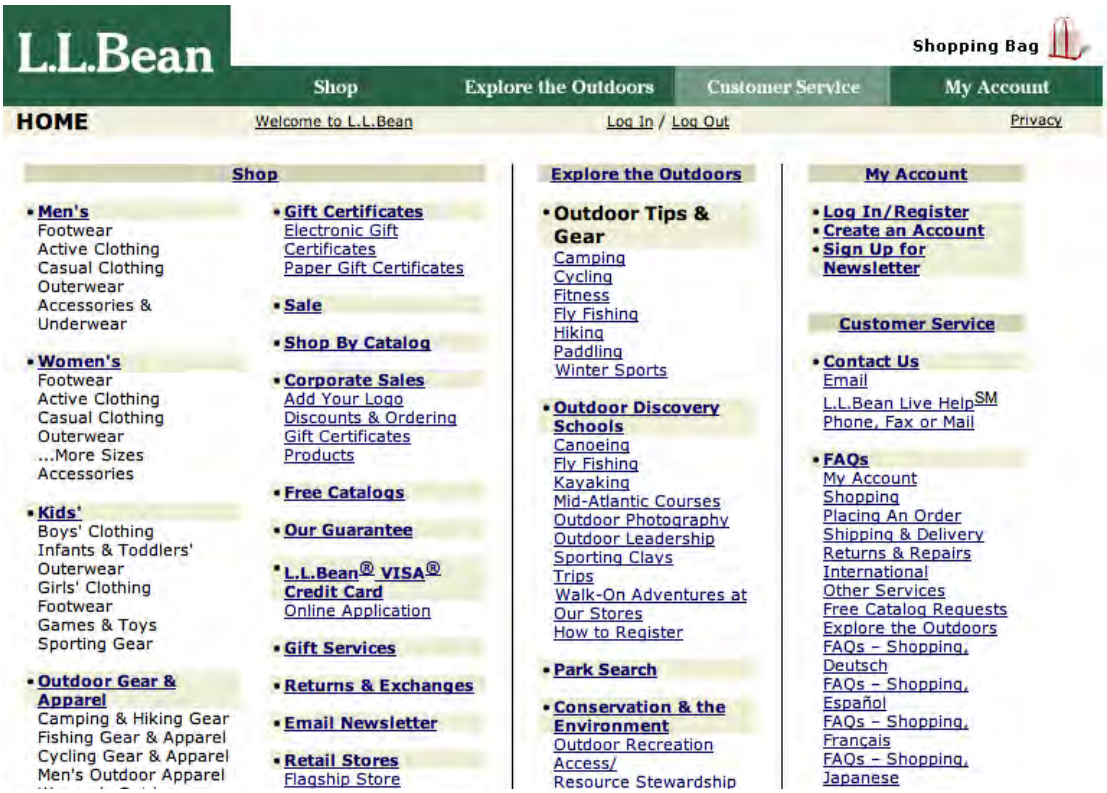
Sitemaps provide a broad view of a website's content (logical structure and not physical) and facilitates access to segmented portions of the content (Brunk, 1999)

Isometric

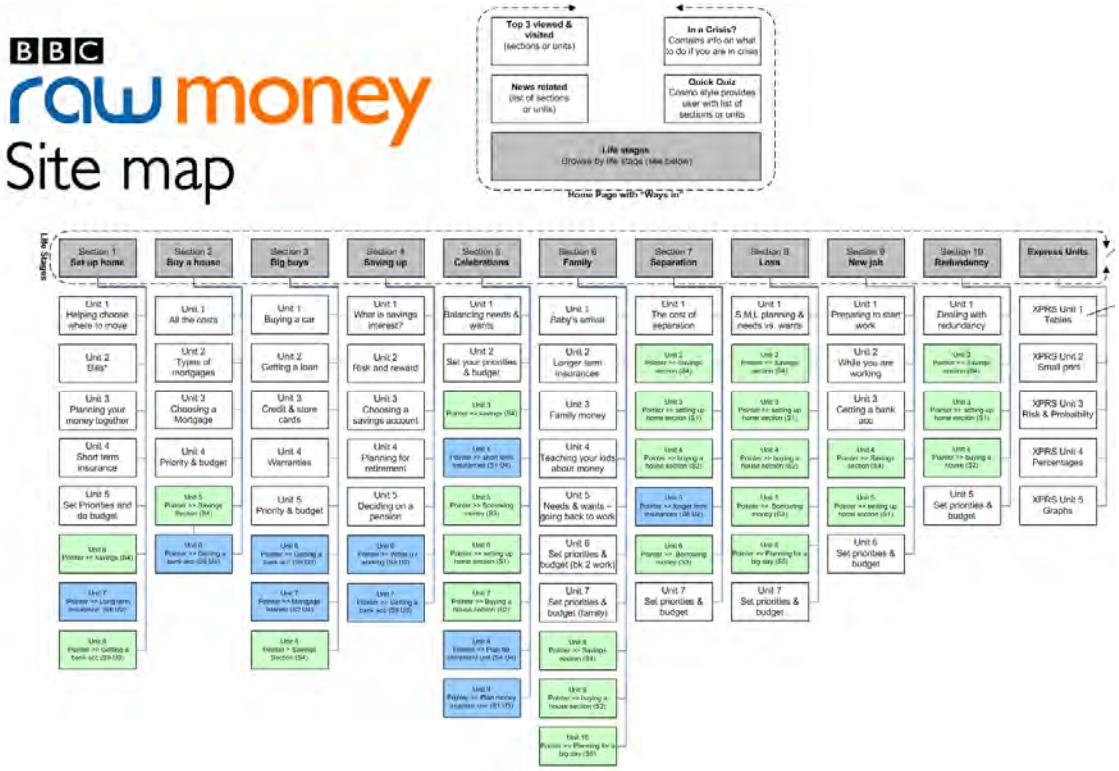
According to Wikipedia (Wikipedia, 2010), it is a form of graphical projection that represents three-dimensional objects in two dimensions. "Isometric" itself comes from Greek language, which means, "equal measure". It reflects the scale along each axis of the projection in a same way.

Flat sitemap

A flat sitemap is a hierarchical list of web pages that belong to a website. Indeed, this kind of sitemap helps the viewer to locate themselves in the website (Mazza, 2009). Flat sitemaps could be represented in different formats such as table based sitemaps or 2D flat sitemaps. The following figure depicts a sample table based sitemap:

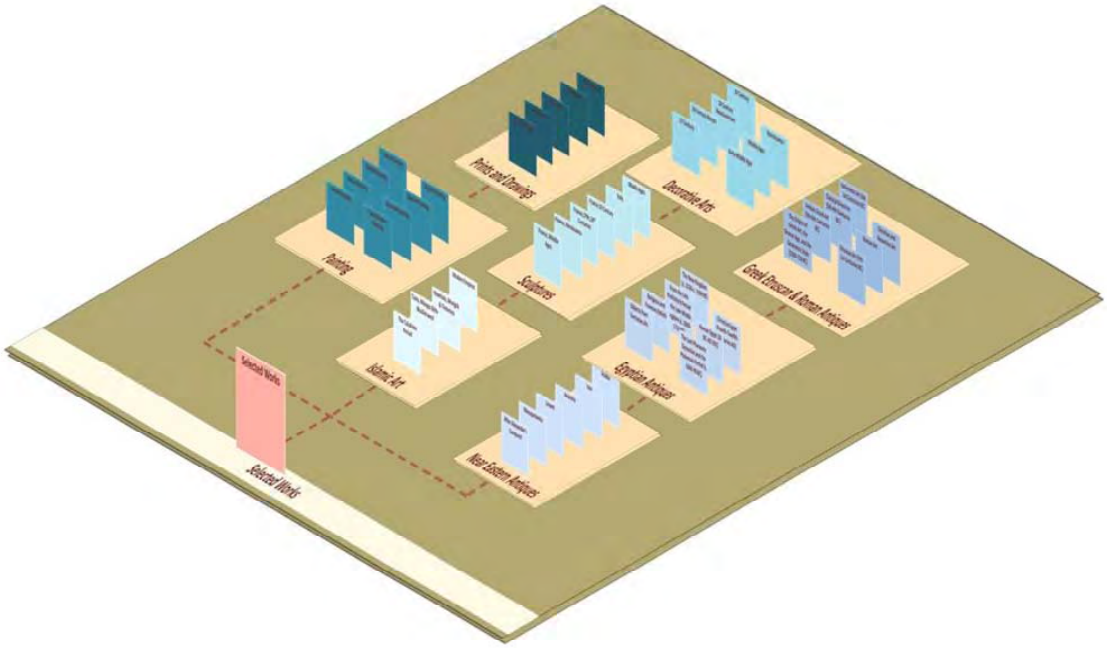


The following figure depicts a sample 2D flat sitemap:



Isometric sitemap

An isometric sitemap is a 2D flat sitemap that employs isometric views and additional conceptual mapping to represent broader and more complex mapping information. The following figure shows a sample isometric sitemap:



Literature Review

Past Studies

There are only a few past researches related to isometric sitemaps and none of them have studied the effectiveness of such sitemaps compared to the traditional 2D flat sitemaps. The following background review, discusses different literature on sitemap conceptualization in general, definition and specification of 2D flat sitemaps, and eventually the limited studies available for isometric sitemaps.

Sitemap categorizations have been accomplished by different researchers based on various theories:

- Kahn and Associates (Kahn, What Is Information Architecture, 2009) describes 'Information Architecture' (IA) as a way to discover site content, matching this information to the needs of the user, and determining meta-data to represent such a structure. Kahn expands on IA models and shows how IA must understand data and the user mutually not exclusively. Kahn introduces five ways to use IA to organize data called 'LATCH': Location, Alphabet, Time, Category, and Hierarchy. These categories have introduced

new approaches into traditional web navigational tools, such as sitemaps, to represent and organize information on a website based on the IA theory.

- Another presentation by Kahn and Associates (Kahn, Maps and Diagrams, 2009) includes the history of maps and diagrams and how they have evolved over time. Kahn takes different historical factors and collects them into the Isometric concept mapping approach. These variables are: dimension of plane, size, value, grain, color, orientation and shape. The slides briefly introduce the techniques used to develop isometric sitemaps as well.

- Another study (Cahill, 2005) reviews the history of knowledge storage concept and graphical representation of such concepts. It further reviews the origins of sitemaps and the more advanced version of it such as isometric concept maps. The study discusses various concepts such as: Semantic Networks, Mind Maps, and Spreading Activation Theory as different approaches to develop sitemaps.

- The 'Organization Systems' chapter of the 'Information Architecture for the World Wide Web' book (Rosenfeld & Morville, 2002) has employed 'Organization Structures' as a theoretical approach to identify sitemaps. This chapter categorizes sitemaps into ones that have boundaries for exact and ambiguous information represented on websites.

- Finally, but not last EightShapes (EightShapes Unify, 2008) has categorized sitemaps as: Text-Based, Table/Image-Based, Flat-2D Hierarchical Maps, Isometric-2½ Hierarchical Maps, 3D Virtual Maps

Past articles have extensively delved into the features of 2D flat sitemaps and how to enhance its effectiveness. The following researches are just a sample selection of these studies:

- A rather old publication (Utting & Yankelovich, 1989), gives a broad view of how researchers and web designers ended up creating sitemaps in the ways that we are using nowadays. The article discusses different contexts that were used by designers such as: Spatial Context, Temporal Context, Cue-Mediated Context and Alternative approaches.

- An article by UC Berkley researchers (Newman & Landay, 2000) includes ample information about the integration of information design, graphic design, and navigation design within the context of web design.

- Another article (Klemmer, Everitt, & Landay, 2008) expands on the previous article and discusses the use of postits to develop sitemaps on an augmented reality electronic whiteboard. This integration may be of importance of the user interactions with sitemaps on touchscreen enabled computers.

- A web article (Russell, 2002) includes the current trends in sitemap design. The article identifies five major types: Categorical; Extended Categorical; Hierarchical; Graphical; and Alphabetical Index.

- Finally, but not lastly, a direct relationship between spatial abilities of users and the preference of sitemaps has been shows (Pilgrim, 2007; Bernard & Chaparro, Searching within Websites: A Comparison of Three Types of Sitemap Menu Structures, 2000). The author concludes that "…website users with high spatial ability have a stronger tendency to choose sitemaps when performing open tasks than those users with low spatial ability" (Pilgrim, 2007, p. 80).

Some of the past studies have proposed computational methods for automatically generating the sitemaps (2D flat and isometric):

- In his dissertation (Fry, 2004), Fry explains different computational methodologies that can be used to visualize information with a more comprehendible design. These approaches can be adapted in the automatic generation of sitemaps and isometric sitemaps.

- An approach (Durand & Kahn, 1998) to develop and create the isometric sitemaps is by using a computational method which will automatically generate them. MAPA, an automated tool, has been used to do this. A past technical report by Brunk (Brunk, 1999) has also detailed information about MAPA, and how it is used to generate dynamic isometric sitemaps automatically (Brunk, 1999, p. 18).

Studies and articles that have discussed the necessity to enhance the traditional sitemaps:

- Chapter 7 of the 'Information Architecture for the World Wide Web' discusses the navigational systems for the web (Rosenfeld & Morville, 2002). The chapter includes various topics that are useful in conceiving the necessity for sitemaps and perhaps advanced concept maps. The author argues that "While a well-designed taxonomy may reduce the chances that users will become lost, complementary navigation tools are often needed to provide context and to allow for greater flexibility." (Rosenfeld & Morville, 2002, p. 106).

As discussed before, there are only a few publications that include a comparison between isometric sitemaps and 2D flat sitemaps. The following are a snapshot of their findings:

- Kahn et al. describe the application of diagrams that use the form of isometric projections to visualize the contents of a web site (Kahn, Lenk, & Kaczmarek, 2001). The authors describe and explain the detailed steps involved in the development of the isometric sitemaps. The article names a series of advantages of isometric sitemaps over 2D flat sitemaps for web designers but does not explain how they have reached to such a conclusion. There are no indications of advantages or disadvantages of isometric sitemaps compared to 2D flat sitemaps for web users.

- Past studies have shown that isometric format do not require extra learning process. "The Isometric format works well because it is a way of organizing space that people already know from the real world" (Kahn & Lenk, Mapping Web Sites, 2001, p. 137) Isometric projection can be visualized in way that resemble real world to people. Therefore, the presentation of this format does not require extra learning and study process for users as might flat diagram requires.

- Studies have shown that different mapping formats have different application. For instance, flat presentation technique is more suitable for linear sequences of web pages. "Different map presentation formats have different strengths and weaknesses. The flat presentation technique is more suited for showing the process when the user experiences the web site as a linear sequence of screens" (Kahn & Lenk, Mapping Web Sites, 2001, p. 130). However, isometric formats are suitable for hierarchical structures. The flow of structure in isometric format shows the sequence of the hierarchy in a certain way that provides kind of information for users that are already familiar with. "The isometric format works better with hierarchy structures, by emphasizing spatial relationships with depth cues. Some designers have used both presentation formats in the same diagram." (Gladden, 2002, p. 17)

Deficiencies in Past Studies

Unfortunately past studies about isometric sitemaps are limited. After an extensive search on various scholar databases, no publications were found comparing the effectiveness of isometric sitemaps for web users in locating web pages compared to traditional 2D flat sitemaps. Consequently, there are also no studies showing the user satisfaction of the isometric sitemaps.

Research Question

The main question of this research is: Will isometric sitemaps reduce the time and effort required for web users to find specific pages/information on a website compared to traditional navigational systems (such as flat 2D sitemaps)?

I have to make a note here that 'web users' means casual users that are not computer savvy persons who are familiar with the design of websites. Please see 'Participants and Recruitment Process' for further information.

Alternative Hypotheses

- $HA_{(1)}$: Users who will interact with the isometric sitemap will navigate the website more efficiently (less time/fewer clicks) than users who will interact with the flat-2D sitemap of the same website

- $HA_{(2)}$: Users who will interact with the isometric sitemap will navigate the website more effectively (higher hit rate) than users who will interact with the flat-2D sitemap of the same website

- $HA_{(3)}$: Users who will interact with the isometric sitemap will be more satisfied navigating the website than users who will interact with the flat-2D sitemap of the same website

Methods

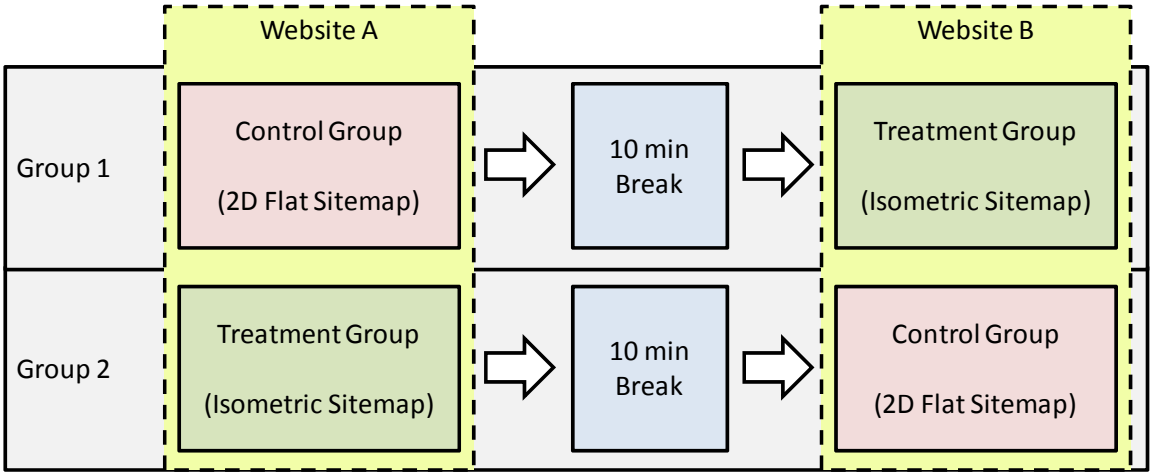
Research Design

The study will implement a between group methodology. Two websites with a similar hierarchical complexity will be implemented in the study: A and B. In order to reduce extraneous variation owing to the heterogeneity of participants in a between-group design, both groups will interact with both websites; however, only one visualization solution (i.e., either 2D sitemap or an isometric sitemap) will be offered in each group. Based on this research design, participant in group 1 will experience and evaluate the effectiveness of using 2D sitemaps in interaction with site A and then after a short break they will use and evaluate the effectiveness of the isometric sitemap of site B. Participants in group 2, will use the opposite visualization solutions for each website. This means that participants in group 2 will be exposed to the isometric sitemap of site A and then will experience the 2D sitemap solution for site B. Therefore, the study will include two between-group comparisons for each website, A and B.

Despite the experience of each participant with two different methods, within-subject design will not be studied due to the learning effect. In addition, participants are experiencing two different websites that employs two different sitemaps and therefore it is not possible to narrow down the effect of the website content versus the sitemap type. For example, a higher effectiveness rate of isometric sitemap for website A can be either because of the isometric map, the content of website A (which despite its similar complexity to website B has a different content, and look and feel), or the interaction between them. However, if we assume that the web content does not have an effect on the effectiveness of a sitemap and only the complexity plays a role then we can mix the within-subject design with the between-

group design and analyze the results in a crossover mixed methodology. I will not make this assumption and thus avoid entering a complicated methodology.

The following diagram depicts the proposed research design:



10 minute break is provided to the users to minimize possible learning effects; although, I expect minimal learning effects due to the change in both the website content and sitemap type.

Each group will contain 30 participants. Please refer to 'Participation and Recruitment Process' for further information.

The research process will include the following stages:

- Preliminary: IRB acquirement, Recruitment of participants, Collecting consent forms, Demonstration of the sample websites and how to complete the tasks
- The same websites will be provided to both control and treatment groups – website will be in the form of offline content to minimize online-downloading latency
- 20 tasks will be provided to each participant to complete – tasks will apply variable conceptual categories such as relevance depth of the destination page. Participants will be only able to navigate the websites through the sitemaps to avoid them browsing the website by content hyperlinks.
- Half of the participants (randomly) will interact with the 2D sitemap while the other half with the Isometric one (between-group design) for each site
- Each task will be recorded (timing, clicks, hit/miss)
- A questionnaire will be provided at the end of the study

Participants and Recruitment Process

Sixty participants will be randomly selected from a population that meets the following criteria:

- Age: 18 to 40 years old;
- Sex: male and female;
- Location/Education: undergrad and graduate students at IUPUI – all fields except from HCI and Communication Studies;
- Prior knowledge: at least one year experience in browsing the web; have minimum-to-no knowledge about the website's content (e.g. no advanced art knowledge in the case of the Louvre website);
- Impairment: no visual impairment; no major cognitive or psychological disability;

Variables

Dependent Variable(s)

- Efficiency
  - Time spent finding a specific page (continues – max 30 seconds)
  - Number of clicks required to find the page (ordered – max 10 clicks)
- Effectiveness
  - Hit/Miss ratio in finding the appropriate page (ratio)
- Satisfaction (Questionnaire)
  - Qualitative open ended questions
  - Quantitative Likert-scale questions (ordered)

Independent Variable(s)

- Flat 2D Sitemap versus Isometric Sitemap

Advantages and Disadvantages

- Advantages:
  - Between-Group design eliminates learning effect
  - Between-Group design uses a simple data analysis approach (e.g. simple t-tests and no trend analysis)

- Limitations/Disadvantages:
  - Despite the randomization, subjects' demographics may bias the study in between-group design – this can be eliminated by adding a within-subject design (cross-over design)
  - Participant attrition may decrease the power of the study and complicate the generalizability of the results
  - Subjective bias in the qualitative open-ended questions of the questionnaire plus prior knowledge about the subject matter

- Grouping/matching the participants based on age or gender may improve the power of the study but it limit its external validity
- The study only incorporates two websites however the complexity and structure of the websites will limit its validity for other websites that needs to be further tests.

Data Analysis

The study implements two separate between-groups experiments. Both of these experiments will be analyzed using one-way ANOVA and t-test analyses (Field, 2005). Data analysis will be accomplished by SPSS (Field, 2005). The study tries to find a statistically-significant lower mean for time, lower mean of clicks, higher hit/miss ratio, and satisfaction rate for participants who used the isometric sitemap compared to participants who used the 2D flat sitemap.

Ethical Concerns

The study is considered a minimally-invasive (no assumed harm to the user) however the following items should be considered:

- Users in the treatment group may find interacting with the isometric sitemaps intimidating (i.e., complexity of the map)
- Users may feel uncomfortable knowing that they are working under a time-constraint (i.e., finishing tasks by a specific time limit)

Timeline

The proposed timeline to develop the sitemaps, acquire the IRB, conduct the experiments, and analyze the results is listed below:

- Development of Isometric and Flat sitemaps – 1 month
- IRB application and approval – 2 months
- User recruitment – 1 month
- User tests – 2 months
- Data analysis – 1 month
- Writing the thesis – 3 months

A total timeframe of 10 months is proposed for this research.

Budget

The anticipated required budget for participant reimbursement will be $1200 in total ($20 each participant will constitute a total of $1200 considering 60 participants)

There will be no cost to develop the sitemaps, conduct the study, and analyze the results.

Future Directions

If isometric maps were shown effective compared to 2D flat sitemaps, future studies will focus on elements of the isometric sitemap that would generate the highest effectiveness, efficiency, and satisfaction rates among the web users.

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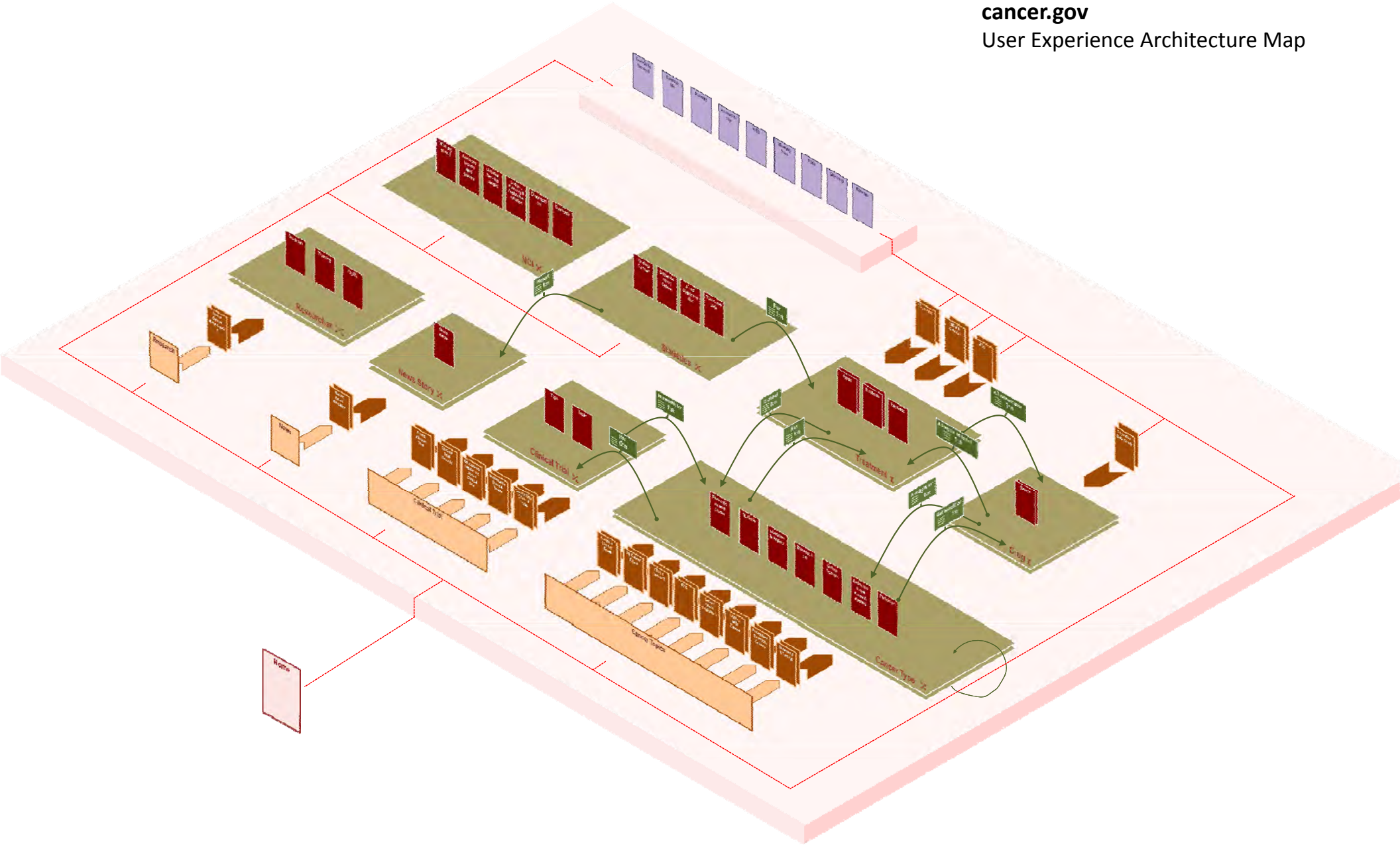
User Experience Architecture Map



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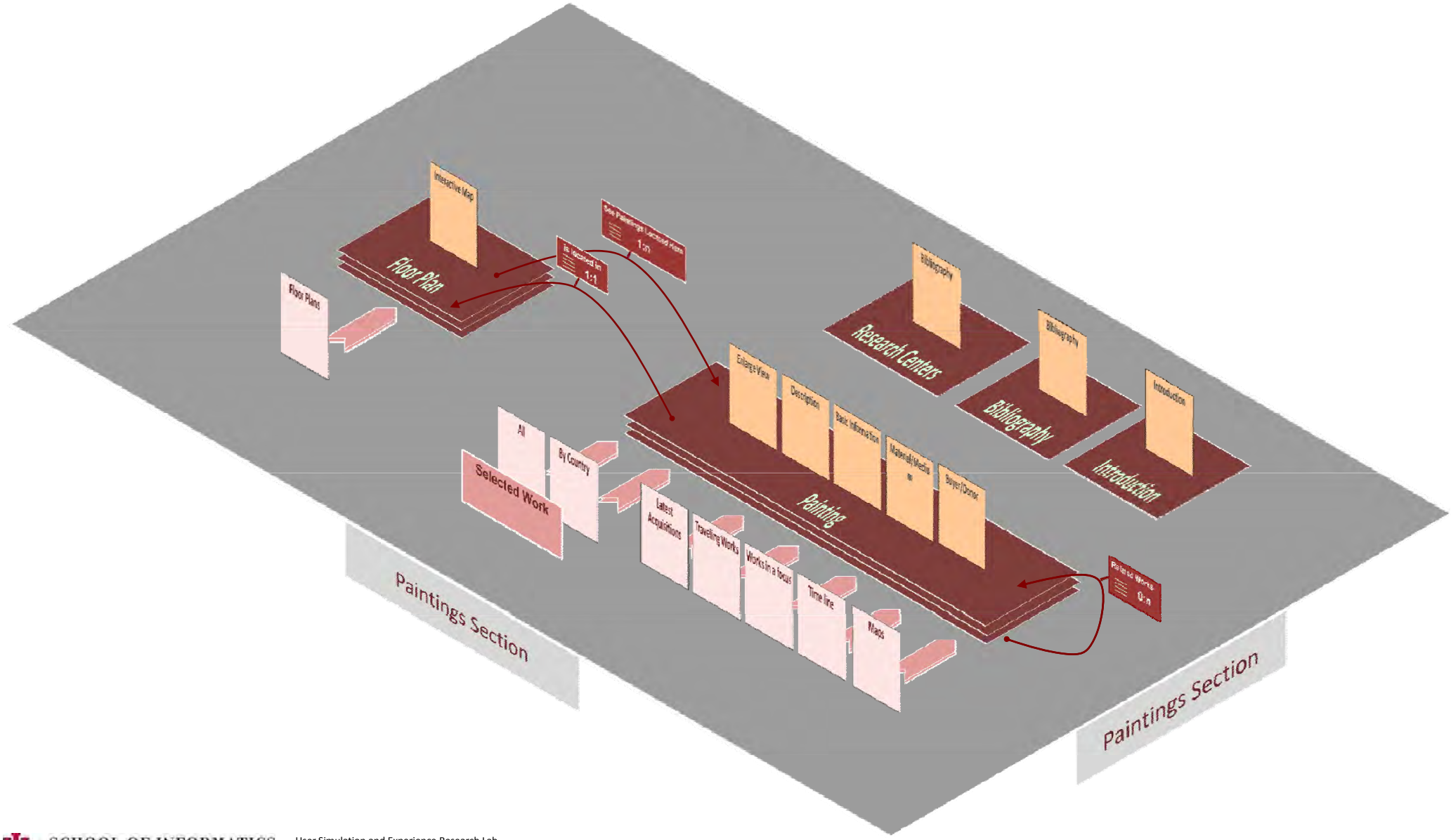

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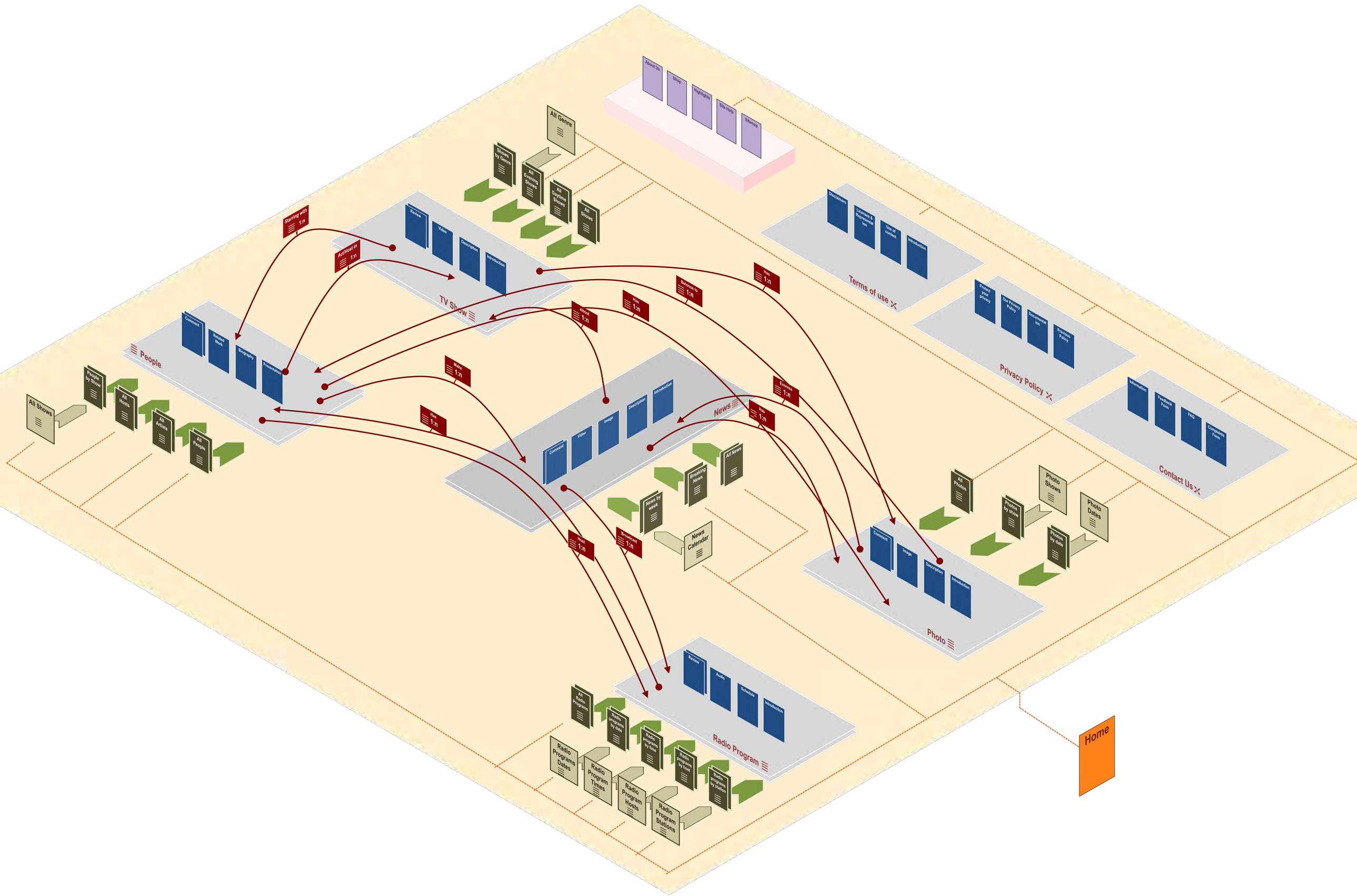
User Simulation and Experience Research Lab
Contributors: Dr. Davide Bolchini, Sepideh Ansari, Adam Neddo
Contact: Dr. Davide Bolchini – dbolchin@iupui.edu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