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### **Kirolos George**

Application of usability testing to GUIs in the Electronic Design Automation Industry



### Agenda

- Biography
- EDA Industry
- Usability definitions
- Usability evaluation methods
- Usability testing challenges in the EDA industry
- New UX adopted process
- Mapping UX heuristics with automated test scenarios
- Usability testing results





## Biography



- Kirolos George has been a senior quality assurance software testing engineer in Siemens EDA for almost 11 years
- ISTQB & ASTQB certified tester (Foundation Level Agile Tester Mobile Tester Usability Tester – Test Analyst)
- Published a paper as main author about freelancing digital platforms at ICT in Our Lives 2020
- Published a paper as a co-author at SPIE Advanced Lithography 2014
- Received Bachelor's degree in electrical engineering, electronics and communications from Ain-Shams University, Egypt
- Received MBA from ESLSCA European University
- Interested in: software testing, quality, electronic design automation, semiconductors, digital platforms & marketplaces.





## Biography





- Marwa Adel is a Senior Quality Assurance Software Testing engineer in Siemens EDA
- Received Bachelor's degree in computer and systems engineering from Ain-Shams University, Egypt
- 18+ years of experience in software test automation in the electronic design automation (EDA) industry. As a senior quality assurance engineer for multiple products, I built my experience in graphical user interfaces qualifications and test design, analysis, and automation.
- Interested in Quality Evaluations, Analysis, Management and Automation and Electronic Design Automation technologies.



## Biography



- Reem ElAdawi holds a B.Sc., M.Sc. and Ph.D. from Ain Shams University, electronics and communication department, Egypt. Both her M.Sc. and Ph.D. are related to machine learning applications, speech recognition, and rare event detection for high replication circuits, respectively.
- She has multiple publications related to machine learning applications.
- She has been with Siemens EDA (formerly Mentor Graphics) for more than 25 years.
- She started as a behavioral model engineer and moved to software development positions in both analog and digital products. She has been managing software teams for over 15 years.
- She is interested in leveraging machine learning to be more effective and productive.









## Electronic design automation (EDA) Industry



## **EDA Industry**

- As digital transformation becomes the main theme and driver of many industries, software and hardware in the form of integrated circuits (ICs) now sit at the heart of product functionality.
- Advancements in the semiconductor industry allow IC designers to add more electrical circuits to support the new and expanded functionalities that are the main drivers of this digital transformation.
- In 1960, researchers for leading industrial and academic labs developed the first computer-aided design (CAD) tools to help and support engineers creating the layouts of electrical circuits.
- Many EDA tools exist to help electronic design houses and manufacturing foundries design, simulate, and verify both the physical construction and the designed performance of IC chip designs, and predict the outcome of IC fabrication processes, all before delivering a design for fabrication.
- A billion-transistor chip can now be designed, debugged, and tested far more easily and quickly using sophisticated EDA tools that reduce time to market while ensuring product quality.



#### Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.





**Usability Testing in EDA GUIs** 

**Kirolos George** 







### **Semiconductor Ecosystem**









## **Usability Insights**



### People form first impression about other people in 100 milliseconds That's 0.1 or 1/10<sup>th</sup> of a second



Author Jennifer K. South Palomares. The study, published in <u>Social</u> <u>Psychological and Personality Science</u>, was based on results from 126 university students.





### According to Google research, people form first impressions about web pages in 17 -50 milliseconds That's 1/59<sup>th</sup> - 1/20<sup>th</sup> of a second







### Bad usability equals no customers. Jakob Nielsen, "Designing Web Usability Author"

### If users can't find or see it... Nothing else matters.





## **Usability Definitions**

## **Usability definitions**

#### • User Experience:

- "Person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service" (ISO 9241-210).
- "User experience includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviors and accomplishments that occur before, during and after use" (ISO 9241-210).





## **Usability definitions**



#### • Usability

- Usability is the extent to which a software product can be used by specified users to achieve specified goals with <u>effectiveness</u>, <u>efficiency and satisfaction</u> in a specified context of use [ISO 9241-210].
- Specific users—not just any user, but the specific ones for whom the product is designed.



## **Usability components**



#### Effectiveness Can users achieve their desired goals on your application ? Efficiency How quickly can users achieve their goals on your application ? Learnability Is application easy to learn the first time users encounter it ? Memorability Can users easily remember how to use your application ? Error handling X How does the application help users recover from errors ? User satisfaction

Do users like your application & recommend it to others ?





## **Usability definitions**

#### User Interface

- Consists of all components of a software product that provide information and controls for the user to accomplish specific tasks with the system.
- Usability evaluation includes the following principal activities:
  - Usability reviews Usability testing User surveys





## **Usability definitions**

### • Usability Testing

• Is the activity that focuses on observing users working with a product, performing tasks that are real and meaningful to them.









## **Usability Testing in Siemens User2User**

- Siemens product usability labs are part of a formal usability testing event held during the annual Siemens User-to-User (U2U) conference.
- During the U2U usability labs, product teams can directly engage customers to collect feedback on new product enhancements or usage flows.









## Usability Evaluation Methods

## **Usability Evaluation**



A process through which **information about the usability of a system is gathered** to improve the system or to assess the merit or worth of a system.

#### **Usability Problem**

- Is a software defect that results in difficulty in performing tasks via the user interface. This affects users' ability to achieve their goals effectively, or efficiently, or with satisfaction.
- Can lead to confusion, error, delay, or outright failure to complete some task on the part of the user.



## **Usability Evaluation Techniques**



Technique	Users involved?	Key characteristic	Specific techniques	Туре
Usability review	Optionally	Experts and users evaluate the user interface of a software	Informal usability review	Qual
		product for usability problems; the evaluation	Expert usability review	
		is based on their experience.	Heuristic evaluation	
Usability testing	Yes	Users are observed while they perform typical tasks with the software product.	Think aloud testing	Qual, Quant
User surveys	Yes	Users fill out questionnaires regarding their satisfaction with the software product.	-	Qual, Quant

Qual = Qualitative usability evaluation

Quant = Quantitative usability evaluation



## **Usability Evaluation**

- The objectives of usability evaluation are:
  - To assess whether usability requirements have been met
  - To uncover usability problems so they can be corrected
  - To measure the usability of a software product



## **Heuristic Evaluation**

- Is a review or "inspection" of a product by experts. Typically this means usability experts, but it can also mean double expertise: in both usability and the product domain. Heuristics are a set of principles, or "rules of thumb," used by the experts to inspect an interface in search of violations of the heuristics.
- Must always be tested with people



## Heuristic Evaluation (created by Jacob Nilson and Don Norman)



### **Ten Design Heuristics**







## Usability testing challenges in the EDA industry

### Usability testing challenges in the EDA industry

- ry
- 1. Customers use the EDA tools when simulating their designs, which are confidential and cannot be exposed outside their companies or disclosed or shared with anyone

a. Cannot easily access real users in their normal environmentb. Sometimes we can't know the exact way users use our tools

- 2. Some users are used to traditional methods of using EDA tools and are reluctant to adopt new practices
- 3. Product development team members usually focus on functionality and performance rather than usability



## Usability testing challenges in the EDA industry



- 4. Can be difficult to justify investments in usability and UX efforts to management
- 5. Cannot build code within the software to track most-used features
- 6. Pressures of time and budget considerations
- 7. Difficult to recruit and bring in real users to participate in usability testing
- 8. Multiple personas (e.g., foundry engineers vs. design engineers) may use the same EDA tool in different environments and conditions
- 9. Users prefer to use batch EDA tools rather than GUIs





## New UX Process for the Calibre Pattern Matching GUI: Adopting usability testing

### **Adopting New UX Process**







### **Adopting New UX Process**



- For each new feature, we receive a functional specifications document describing the functionality of the new GUI. We use this to write a Test Plan that address testing the functional aspect only.
- However, a software product can work exactly as described in specification and still have serious usability problems, such as:
  - Complicated/unclear error messages
  - Unclear use model/steps of operations
  - No enabled/disabled buttons to help guide the user
  - Bad/poor look and feel
  - No undo/redo to correct users' mistakes
  - Extra un-needed steps to add confusion



### **Adopting New UX Process**



- Most product design team address usability at the end of the development cycle;
  we evaluate usability throughout the whole development life cycle
  - 1. We adopted a new check-list for each new GUI to be evaluated against the 10 Nielsen Usability heuristics. A new GUI feature must address all checklist points to pass the initial evaluation.
  - 2. We added new Usability evaluations sections to the functional test plans that contain all the UX testing scenarios and expected behavior for the GUI.
  - 3. We implemented automated testcases for each of the mentioned scenarios in the test plan.
  - 4. We regularly run automated usability testcases against the GUI to guarantee consistency across versions and updates.
  - 5. We review wireframes and low-fidelity prototypes provided by the development team for evaluation and assessment.





## Usability test automation: mapping UX heuristics with automated test scenarios

#### Mapping of UX heuristics with automated test scenarios



Usability heuristic	Automation		
Visibility of system	Dump AUT messages and warnings.		
status	Dump AUT status bar.		
Match between	Verify all labels, error and warning messages, tool tips use simple, real-world language.		
system and real world	Verify all error and warning messages provide clear guidance for accurately performing task.		
	Dump label names.		
	Dump error and warning messages.		
User control and	Verify tool dialogs include specified or required user controls (ex: Cancel, Apply, Undo, Redo buttons).		
freedom	Dump user control state status (e.g., enabled/disabled).		
	Verify user controls are enabled and clickable when needed.		
Consistency and	Verify labels, tooltips, messages, and warnings, generated by the GUI are comprehensive, correct, and compliant with		
standards	Calibre product standards.		
	Verify similar functionalities in various Calibre products use the same shortcuts and are placed in similar drop-down		
	menus.		
Error prevention	Verify unneeded widgets are disabled.		
	Verify tool prevents bad data (e.g., special characters in line edit fields).		
	Verify tool provides clear warning/opt-out message to users before performing any deletion action to prevent data		
	loss.		
	Verify dialog widgets include only specified/standard actions (e.g., Apply, Cancel, Close buttons).		
	Verify provided error messages provide corrective guidance and prevent actions likely to fail.		
	Verify warning and error messages ask for confirmation of risky/irreversible task before it is performed.		
	Dump all widgets' status and verify they are only enabled in correct order of testcase execution.		



### Mapping of UX heuristics with automated test scenarios



Usability neuristic	Automation
Recognition rather than recall	Verify user choices are recognized and saved for future checks. Dump tooltips and verify they provide accurate, clear guidance to users for performing specified scenarios. Dump tool transcripts and verify user choices are printed correctly to minimize the need for user memory recall. Verify indicators provide users with flag if anything is edited/changed Dump dialog fields before and after user actions and verify AUT remembers user's choices. Dump selected menus and verify the last-edited items appear first in the list.
Flexibility and efficiency of use	Dump selected menus and verify the last-edited items appear first in the list. Use AUT shortcuts and verify they function correctly and invoke the correct dialogs. Test the search and filter features to verify user can easily and quickly reach intended data. Dump dialog fields and verify default values are set correctly to speed up the process and enable user to perform intended goal efficiently.
Aesthetic and minimalist design	Dump widget frames and windows sizes to verify GUI provides the same view on different environment (OS, machine resolutions, platforms). Dump font styles and file window types (native or modified) to verify GUI provides the same view on different environment (OS, machine resolutions, platforms). Verify users can use menu button(s) to select which dialogs to view, keeping unselected dialogs hidden
Help users recognize, diagnose, and recover from errors	Dump messages and warning messages and verify they provide accurate error correction guidance. Verify selected actions can be performed using multiple alternative methods in the GUI.
Help and documentation	Dump GUI help messages and options and verify they are comprehensive, accurate, and easy to read. Dump tool tips and help buttons and verify the information accurately guides users to correct tool use.



#### **Automating Testing**

#### Examples of the new checks and dumps for a new GUI dialog:

- 1. Check that the new dialog invocation is accurately placed
- 2. Add automated testcases to dump the default values of the dialog
- 3. Dump the tool tips of all widgets to check text consistency from run to run or identify text changes
- 4. Dump and check the state of the widgets, (selected/unselected) and/or (enabled/disabled)
- 5. Check the number of steps required to perform or reach target functionality to look for unnecessary steps
- 6. Dump all warnings and error messages to check that text is comprehensive, clear, intuitive, and correct
- 7. Check and verify that generated messages include updated data for any values that are changed
- 8. Dump the font type and font colors of the dialog widgets and check against usability standards
- 9. Check the background color for the drawing area to ensure the text is easily readable
- 10. Take screenshots of the drawing area and save them for image comparisons
- 11. Use the undo/redo functions of the tool to ensure dialogs retrieve previous input(s) correctly
- 12. Ensure keyboard actions result (like pressing the tab buttons) result in the desired function (including forward and backward, where applicable), and that keyboard shortcuts work properly







## Usability testing Results

### **Contribution of each usability evaluation method**





### **Usability testing Results**



 Implementing these changes contributed to a 28% increase in UX satisfaction, as calculated by dividing the number of the filed usability items by the number of filed functionality items within a certain time span.









## Before & After Usability Testing

### **Application #1**



#### Before

### After



### **Application #2: Fitts's Law**



The time to acquire a target is a function of the distance to and size of the target



### **Before**



### **Application #3**







### **Application #4**





User will not find Constraints tab here, as it is not checked in the Windows Menu





### **Usability Process**

















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THANK YOU