Design considerations for creating eLearning animations

Subject Communication (Computer Science)

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Subject Communication

Growing need for eContent

- More number of students and inadequate number of teachers [Banerjee, 2007]
- Digital access is growing in the country
- Archive the teaching methods of good teachers
- Potential of digital resources that can be used to facilitate learning and training, and which are available online, is rapidly increasing [Friesen, 2001]
- Learning Objects (LOs) constitute an appropriate medium

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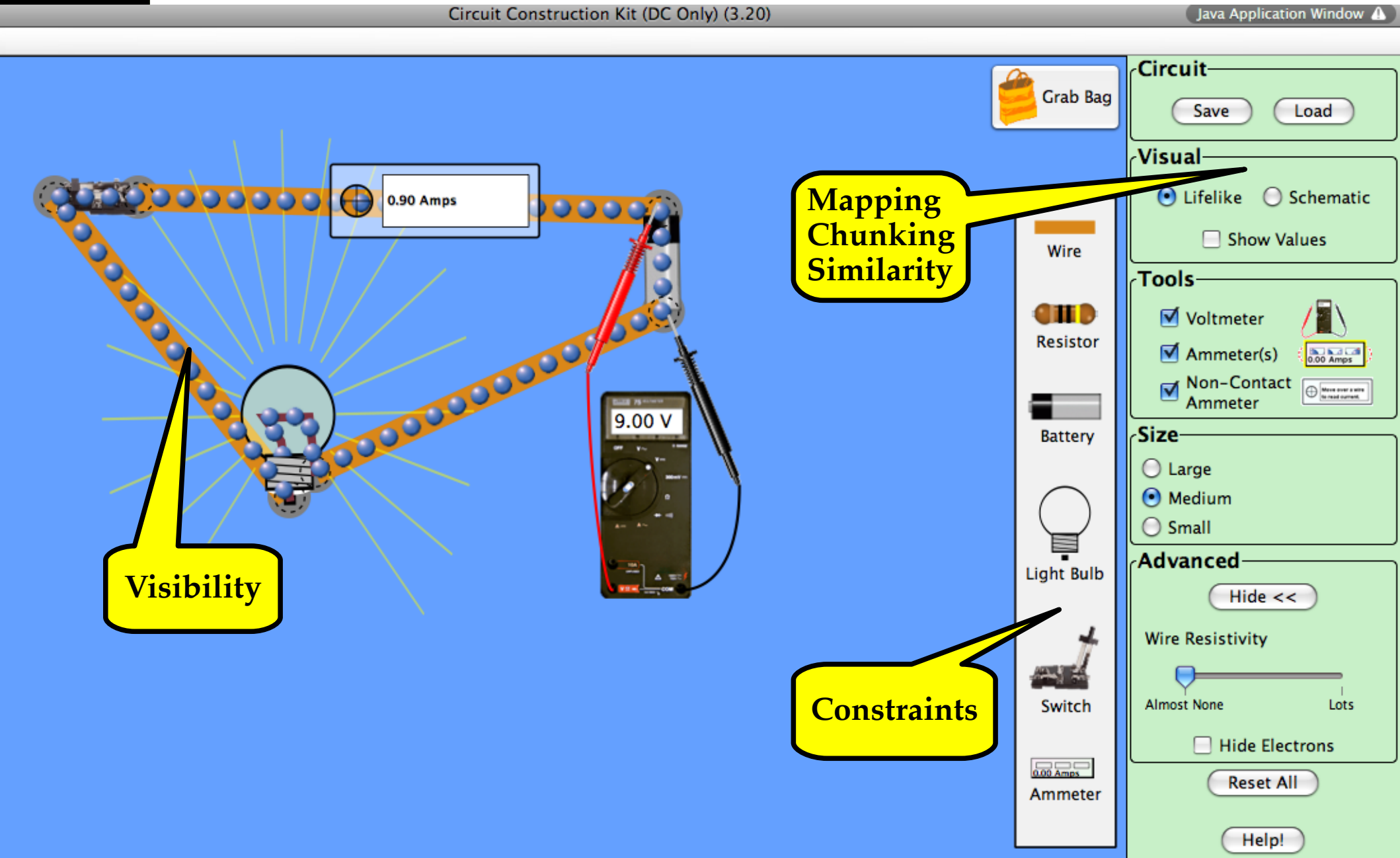
eLearning

Learning Object

Standalone unit
with
defined Learning objective
and
Assessment [1]

1. L'Allier, 1997

Example of an LO



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Example 2

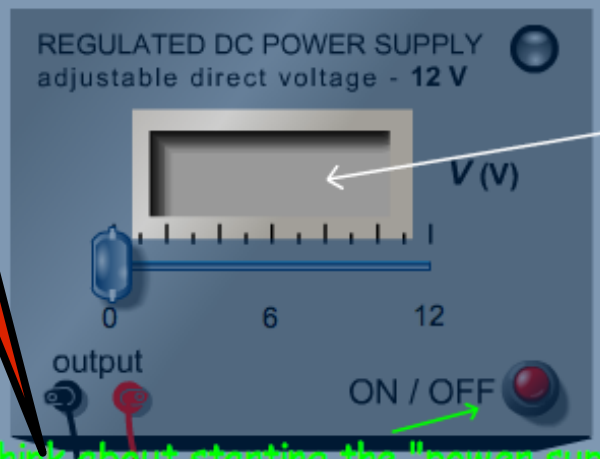
Continuity

Appeal

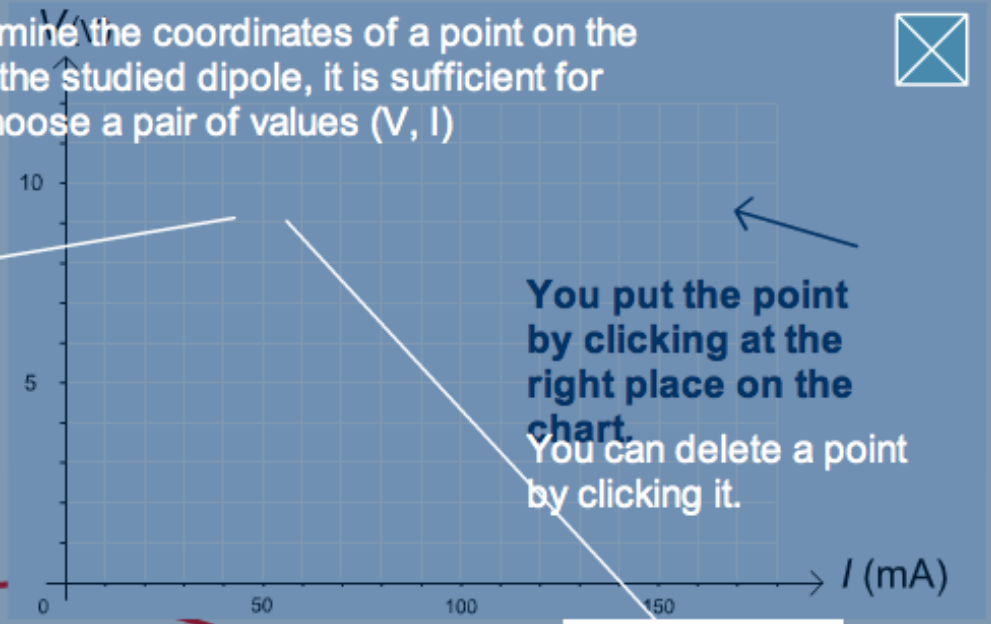
Visibility

instructions

To determine the coordinates of a point on the curve of the studied dipole, it is sufficient for you to choose a pair of values (V, I)



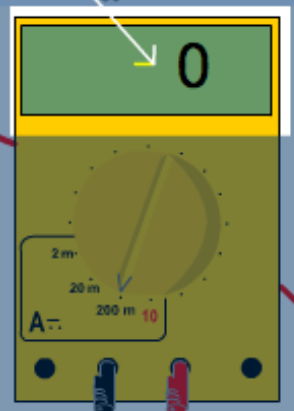
Think about starting the "power supply".



You put the point by clicking at the right place on the chart.

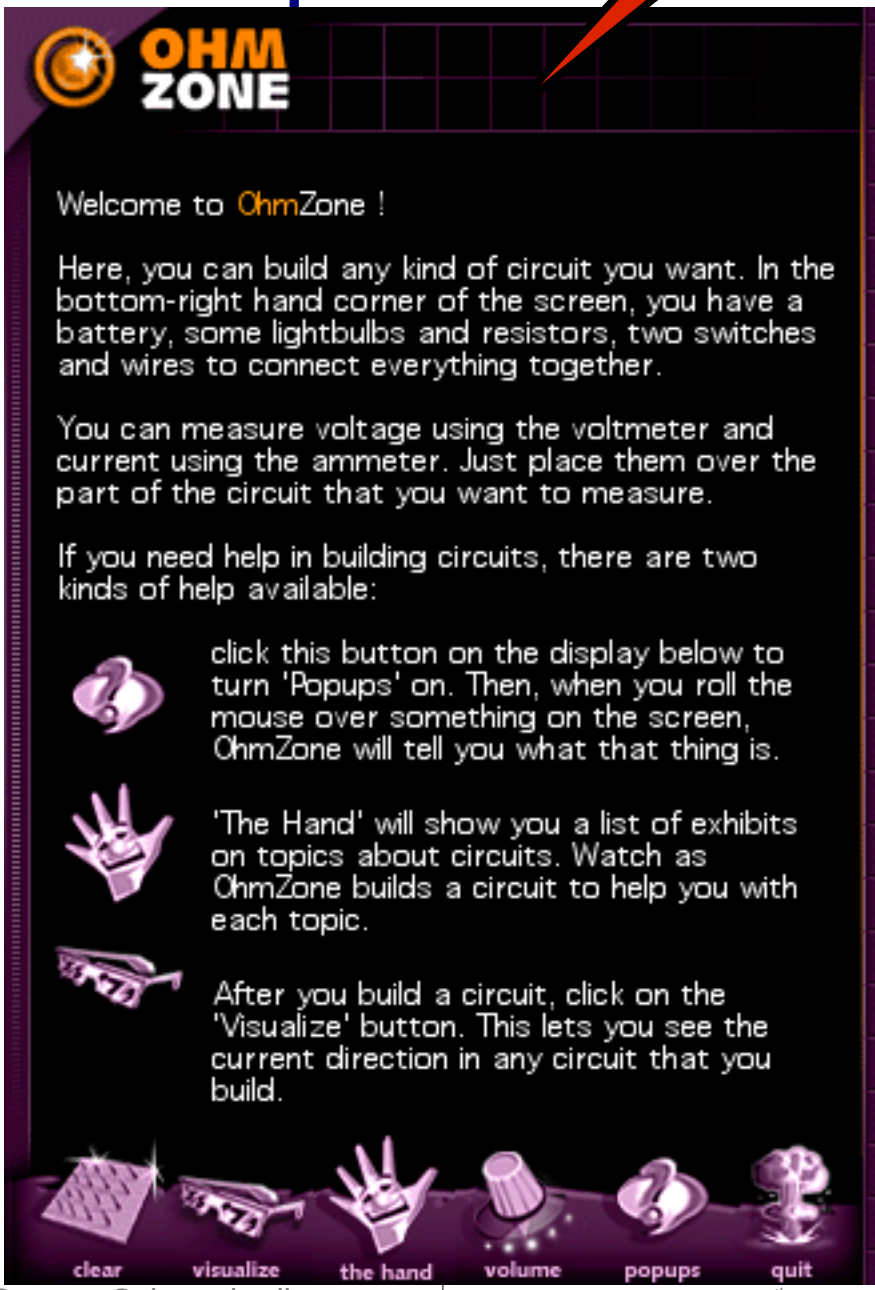
You can delete a point by clicking it.

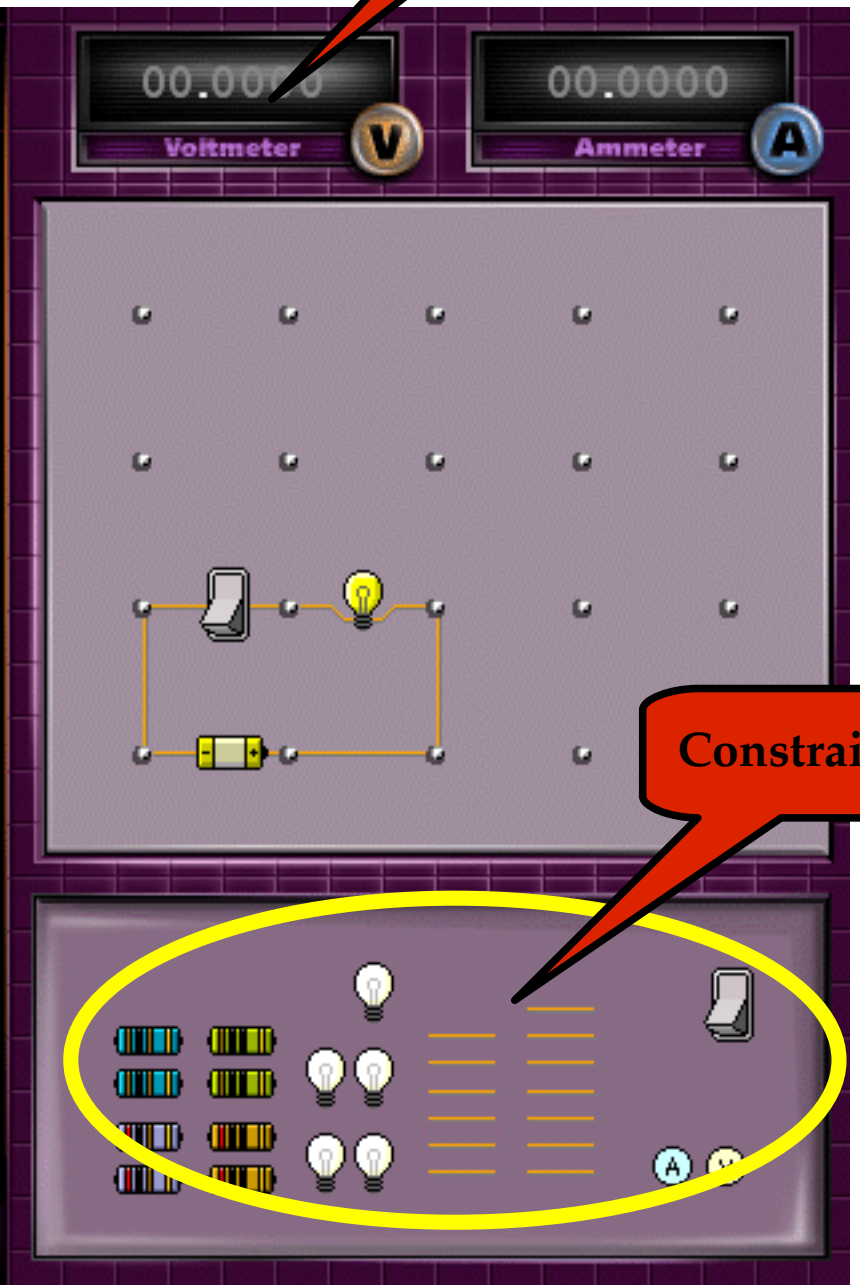
"Game" is over when you place the fourth point.



Trick : selected integer values for V : the point will be easier to place.

Example 3





Balance

Visibility

Constraints

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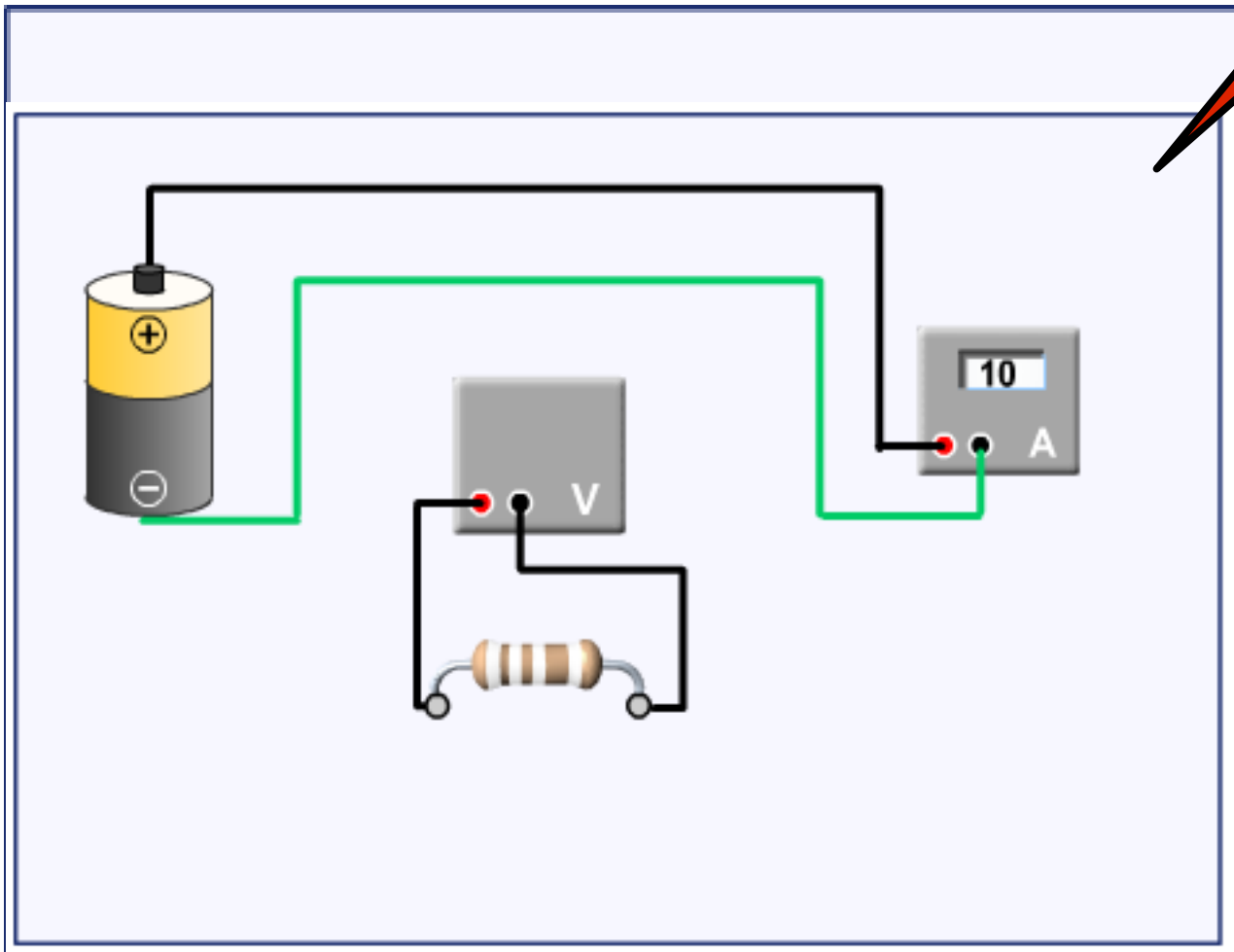
Example 4



When a short circuit occurs, there is zero resistance (R=0). The current will travel unhampered from the

$$I_{sc} = \frac{E}{r}$$

Balance

What is the problem?

- Both functionality and form are important.
- Inadequate attention to either leads to a "bad" LO.
- How do we ensure that:
  - The LO depicts what was intended (correct functionality)
  - The LO depicts it in the way it was intended (correct form)

LO creation

Not *merely* a programming task!

Involves stakeholders from multiple domains

Iterations based on the reviews by the stakeholders

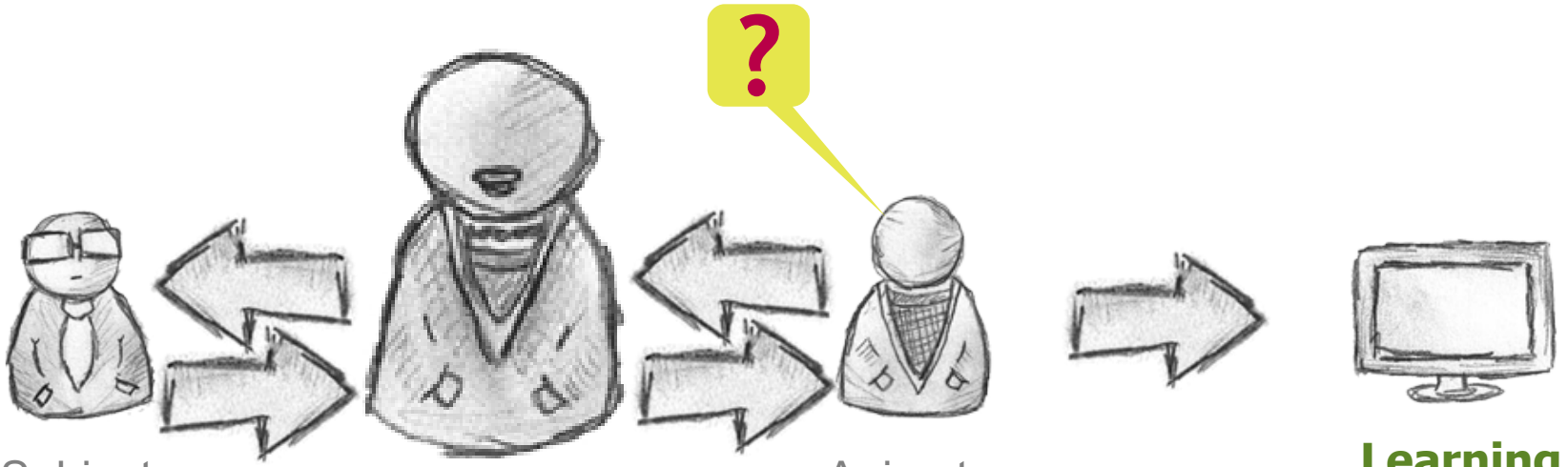
Major challenges:

Exact transfer of the information across domains

Using common language

Ensuring usability of the enduser

Knowledge expertise of the stakeholders



Subject Matter Expert (SME)

Strong Subject matter

Good pedagogy

Less design

Instruction Designer (ID)

Strong pedagogy

Moderate subject matter

Moderate design

Overall coordination

Animator

Moderate design

Less pedagogy

Less/No Subject matter

Learning Object (LO)

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Possible solution approaches

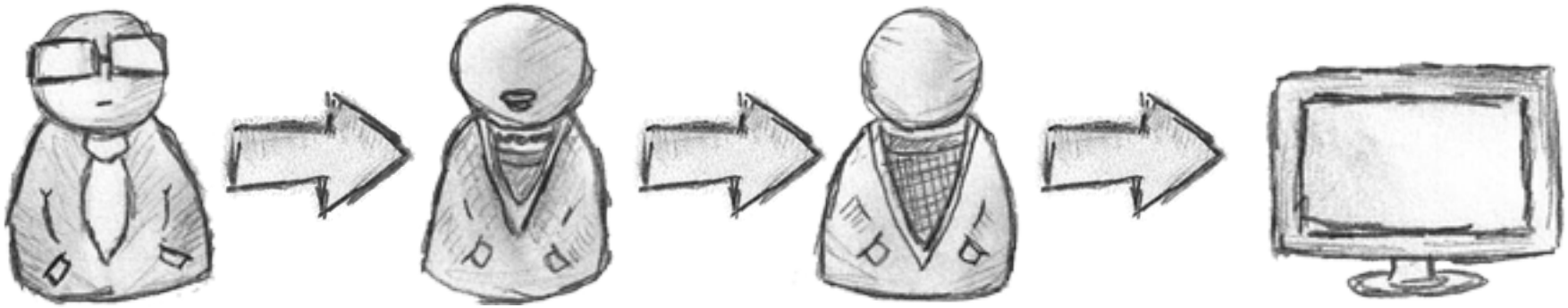
For rapid creation of usable and effective LOs:

- More skilled personnel
  - Not a practical solution
- More face-to-face interaction
  - Non availability of the time of experts

Our approach:

- Operationalize VC principles for elearning.
- Capture VC expertise into a template.

Typical life cycle for LO creation



Observations:

- SME, ID or end users find usability problems in the LO
- SME and ID cannot often give the necessary visual inputs
- Animator can go wrong if inadequate information about subject matter is provided [2]

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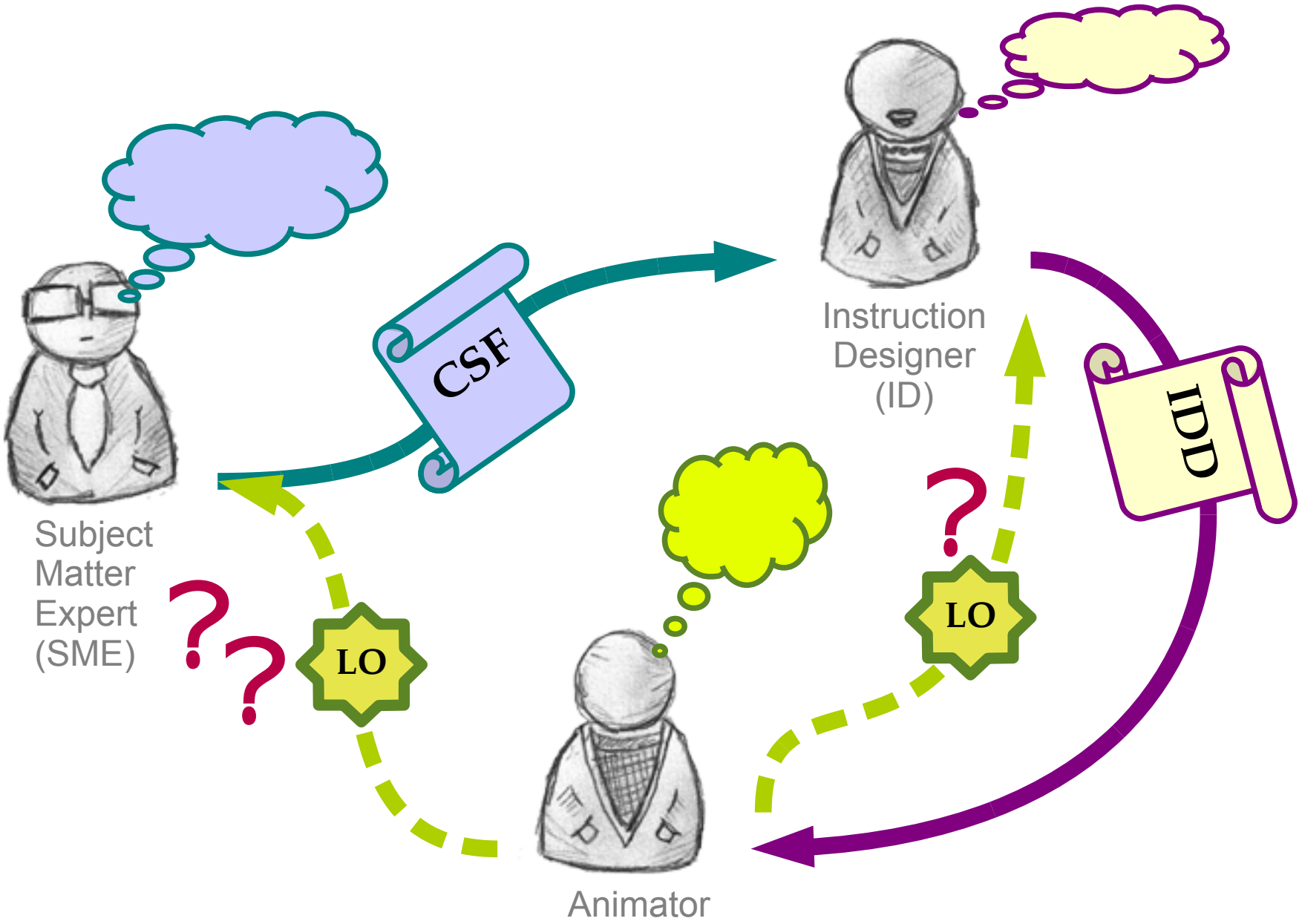
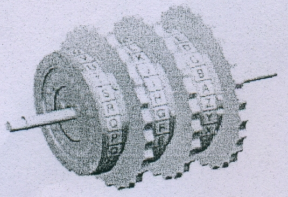
Communication: Is it adequate?

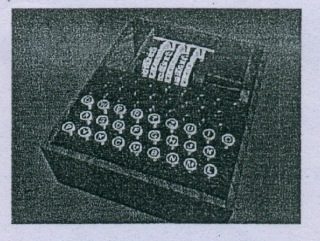


Subject Communication

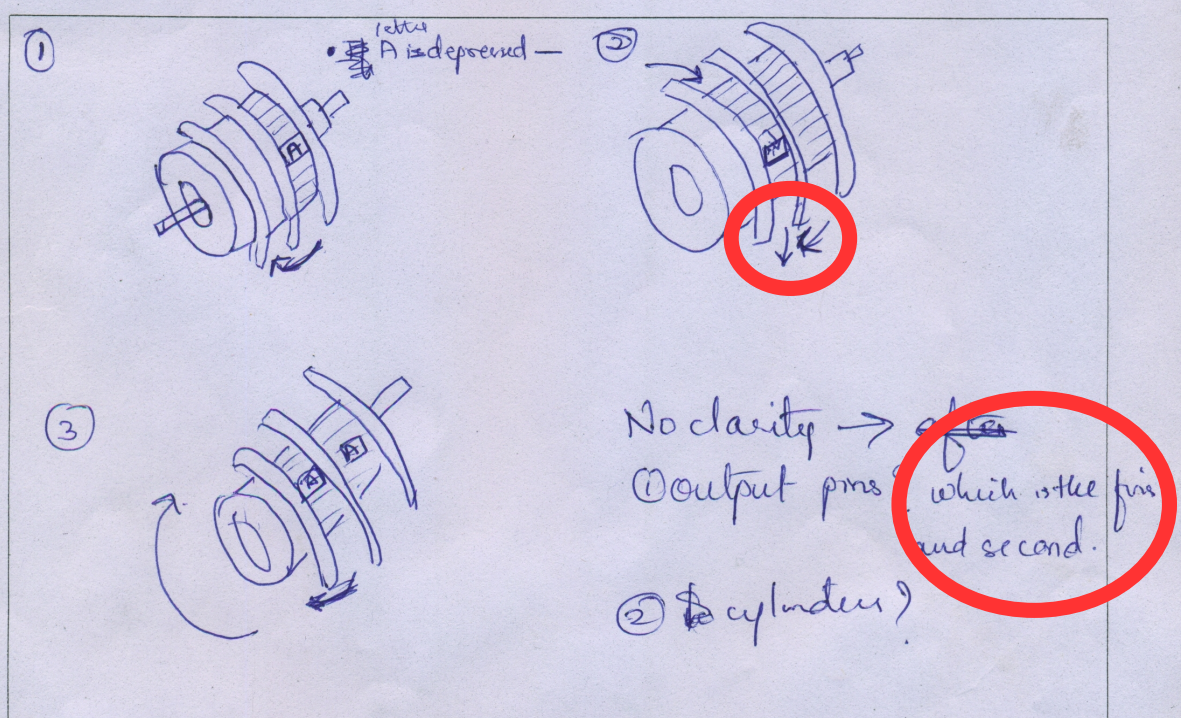
Example: problem due to lack of prompts in template

Given: The machine consists of a set of independently rotating cylinders through which electrical pulses can flow. Each cylinder has 'n' input pins and 'n' output pins, with internal wiring that connects each input pin to a unique output pin, where each input and output pin can be associated with a letter of the alphabet.





ID Instructions: If the key for letter A is depressed, an electric signal is applied to the first pin in the first cylinder and flows through the internal connection to the (n-1)th output pin. After each input key is depressed, the cylinder rotates one position, so that the internal connections are shifted accordingly. After 'n' letters of plaintext, the cylinder would be back to the initial position.



Example: problem due to lack of prompts in template

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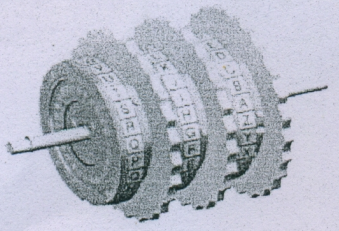
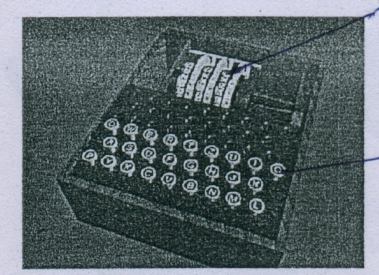




ID Instructions: If the key for letter A is depressed, an electric signal is applied to the ~~first~~ first pin in the first cylinder and flows through the internal connection to the ~~(n-1)th~~ output pin. After each input key is depressed, the cylinder rotates one position, so that the internal connections are shifted accordingly. After 'n' letters of plaintext, the cylinder would be back to the initial position.

which is the first pin

which is (n-1) pin

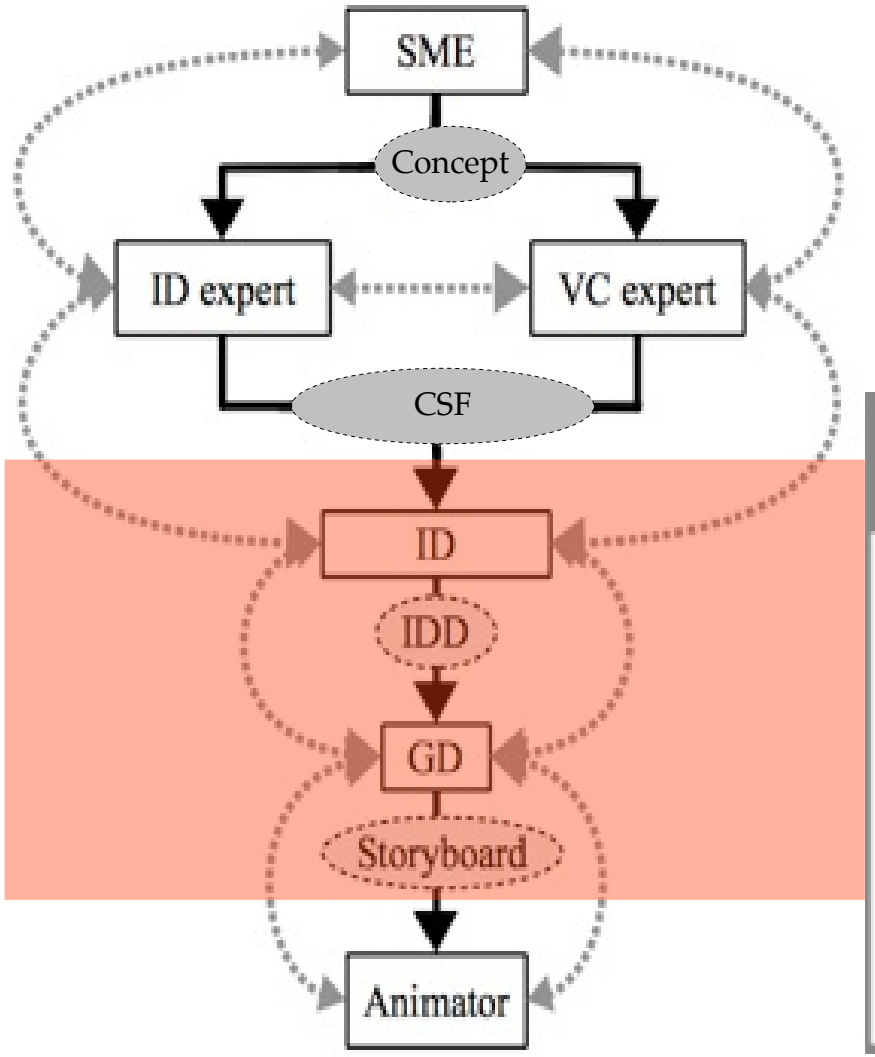
which connections?

Electric sig nal is applied

Clockwise or anticlockwise

Burned.

Focus of our research



Legend	
SME	Subject matter expert
ID expert	Instructional design expert
VC expert	Visual communication expert
ID	Instructional designer
IDD	Instructional design document
GD	Graphic designer
→	Text+Visual communication
⇢	Face to face communication

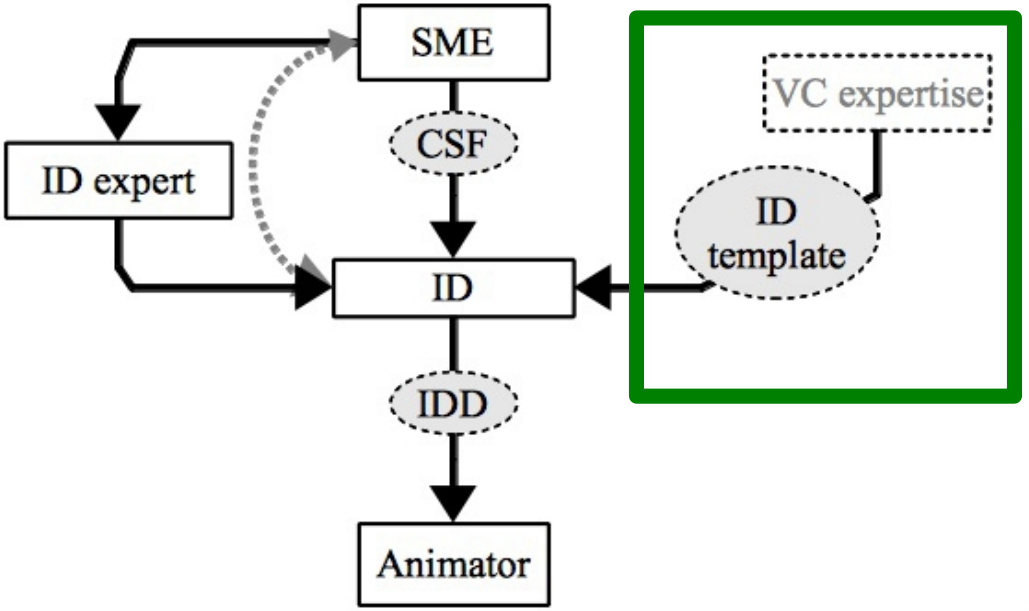
[Sahasrabudhe]

Subject Communication

Interactions between stakeholders regarding VC

Team members	Topics of decisions
SME with Lead ID and Lead VC	1. To decide the pedagogy approach 2. To decide the visual presentation and user interaction pattern
Lead VC with Lead ID	1. Finalizing the visual presentation pattern which is suitable for the pedagogical approach selected
Lead VC with GD	1. Explaining the way in which the visual presentation pattern has to be realized in the final LO 2. Details of the placement and colour scheme to be finalized
GD with ID	1. Exact mapping of the interactive elements
GD with ID and Animator	1. Finalizing the placement and interactivity decisions based on format specified by VC expert. 2. Finalizing animation style and motion

Our solution:



Legend	
SME	Subject matter expert
ID expert	Instructional design expert
VC expertise	Visual communication expertise
CSF	Concept selection form
ID	Instructional designer
IDD	Instructional design document
GD	Graphic designer
→	Text+Visual communication
⇢	Face to face communication

- **Our approach:**
  - Operationalize VC principles for elearning.
  - Capture VC expertise into a template.

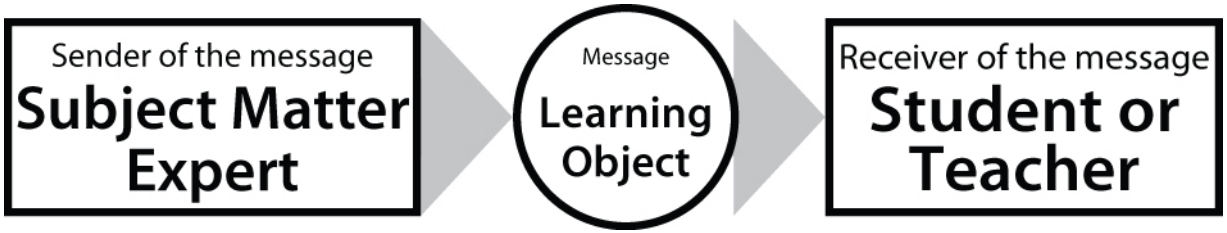
Subject Communication

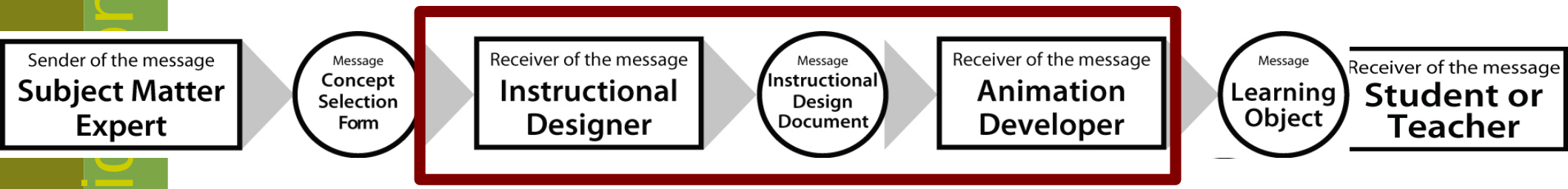
Details (of the rest of the presentation)

- Research questions
- Choice and adaptation of research method
  - 3 research cycles
    - Operationalization of VC principles
- Final experiment/s
- Results and analysis

Communication angle

- Primary communication





Research Questions

Would students find the LOs created using a template having VC principles embedded, to be more usable than the LOs created using a template without VC principles?

- **Do ID writers find our ID templates having VC principles usable?**
- **Do animators find IDDs created by the above ID writers usable?**
- **Do students find the LOs created by the above animators usable?**

Subject Communication

Variables

Independent: Principles applied in the intervention

Proven principles from visual communication domains like graphic design, multimedia, animation and interaction design.

Dependent: Usability of the intervention

Proven constructs to test the usability of interactive eLearning content like: perceived usefulness, ease of use, format, accuracy and content

Subject Communication

Hypotheses

H_0 No difference would be seen in the usability scores of the LOs created using ID templates having VC principles embedded in it and LOs created using ID template without VC principles embedded in it.

H_1 There would be increase in the usability scores of the LOs created using ID templates having VC principles embedded in it and LOs created using ID template without VC principles embedded in it.

Subject Communication

Choice of research method

Complex nature of the context:

- Multiple stakeholders
- Communication/information flow
- Multiple interactions between the stakeholders

To benefit from those interactions a combination of methods is required.

Choice of research method

Iterations involved in creation of the interventions and its validation

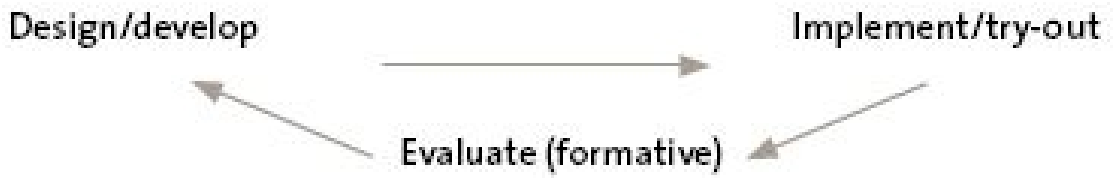
- Not based on 'create once and use' format.
- Answers about why a certain intervention (created using 'X' theory) was found effective/not effective.

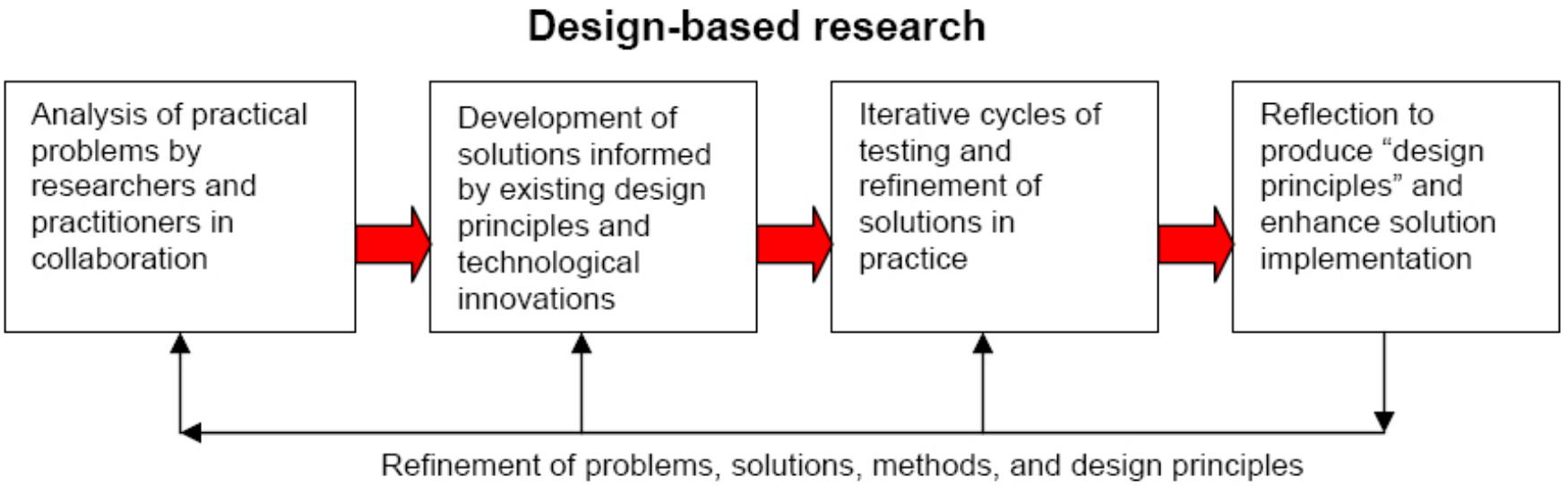
Requires a method which can combine empirical data and (underlining) theories used in creating the intervention.

This process would then be replicated to validate and justify other principle/s.

Subject Communication

Design-based research overview





Choice of research method

Multiple interacting variables and levels

Educational background of the ID writers	Graduate level education. Additionally, a postgraduate level education in ID is desirable.
Work experience of ID writers	Work experience of 6-10 months of ID for an educational institution or in an eLearning production setup.
Educational background of Animators	Graduate level education in design/animation. Additionally, a postgraduate level education for the animation software (~1 year) is desirable.
Work experience of animators	Work experience of 6-10 months of animation for an educational institution.
Face to face communication between the stakeholders	Less or no face-to-face interaction between the team members producing LOs.

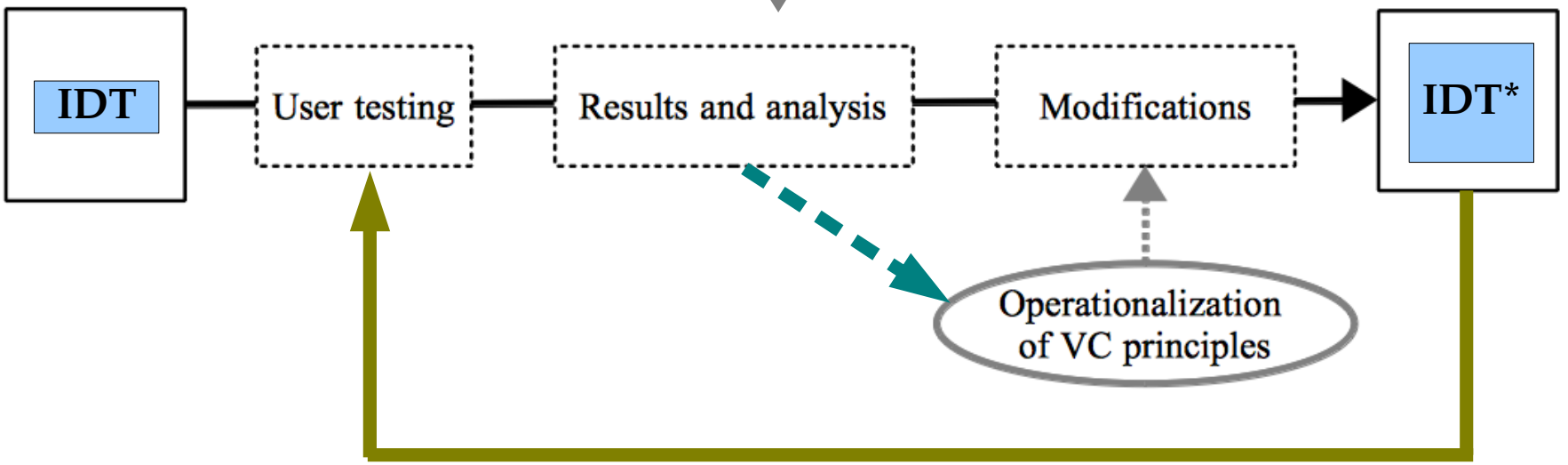
Subject Communication

Research methodology

- Complex nature of the context
- Iterative process
- Standardize the production

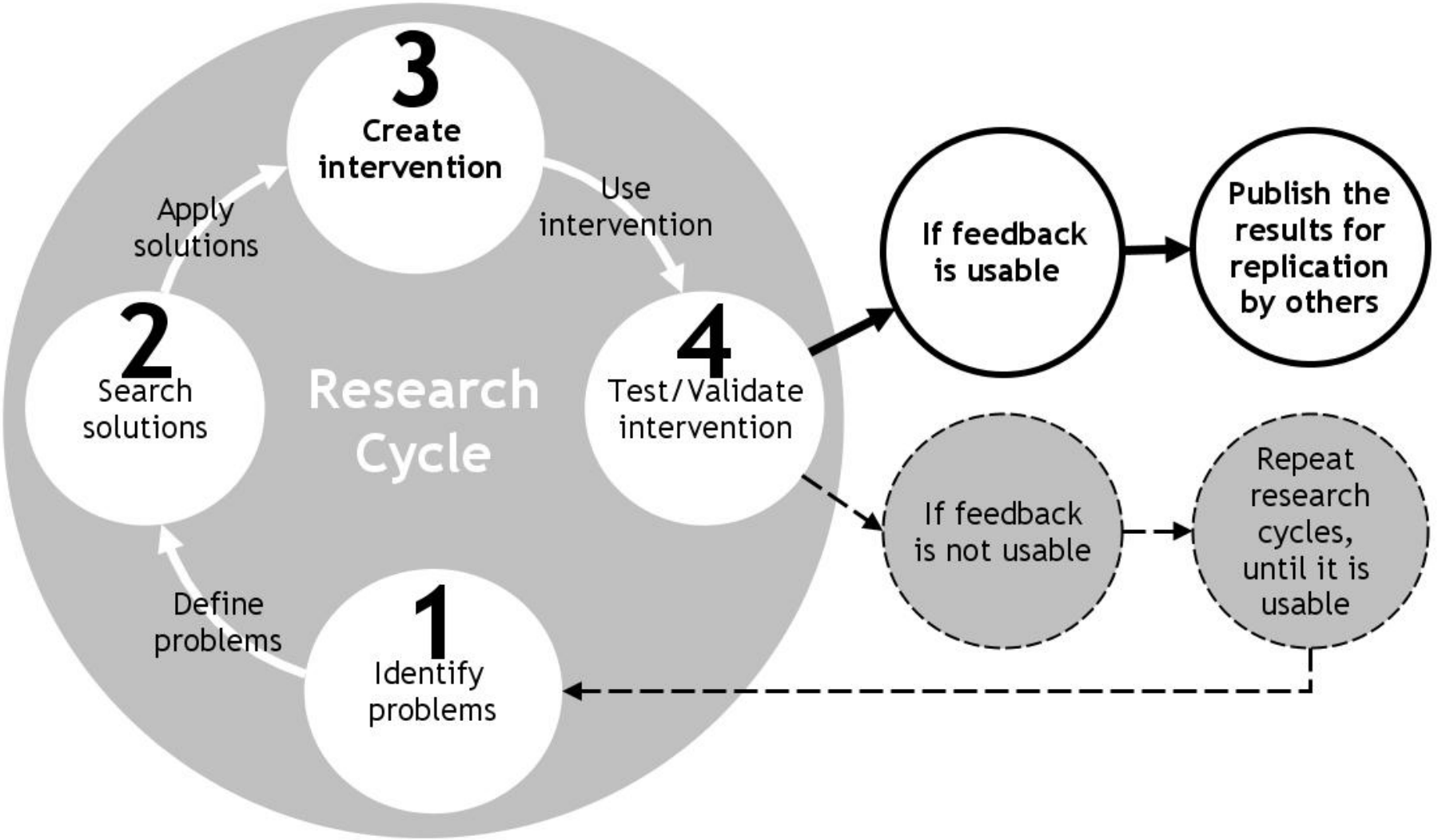
Design Based Research

Reeves | Plomp | Wademan

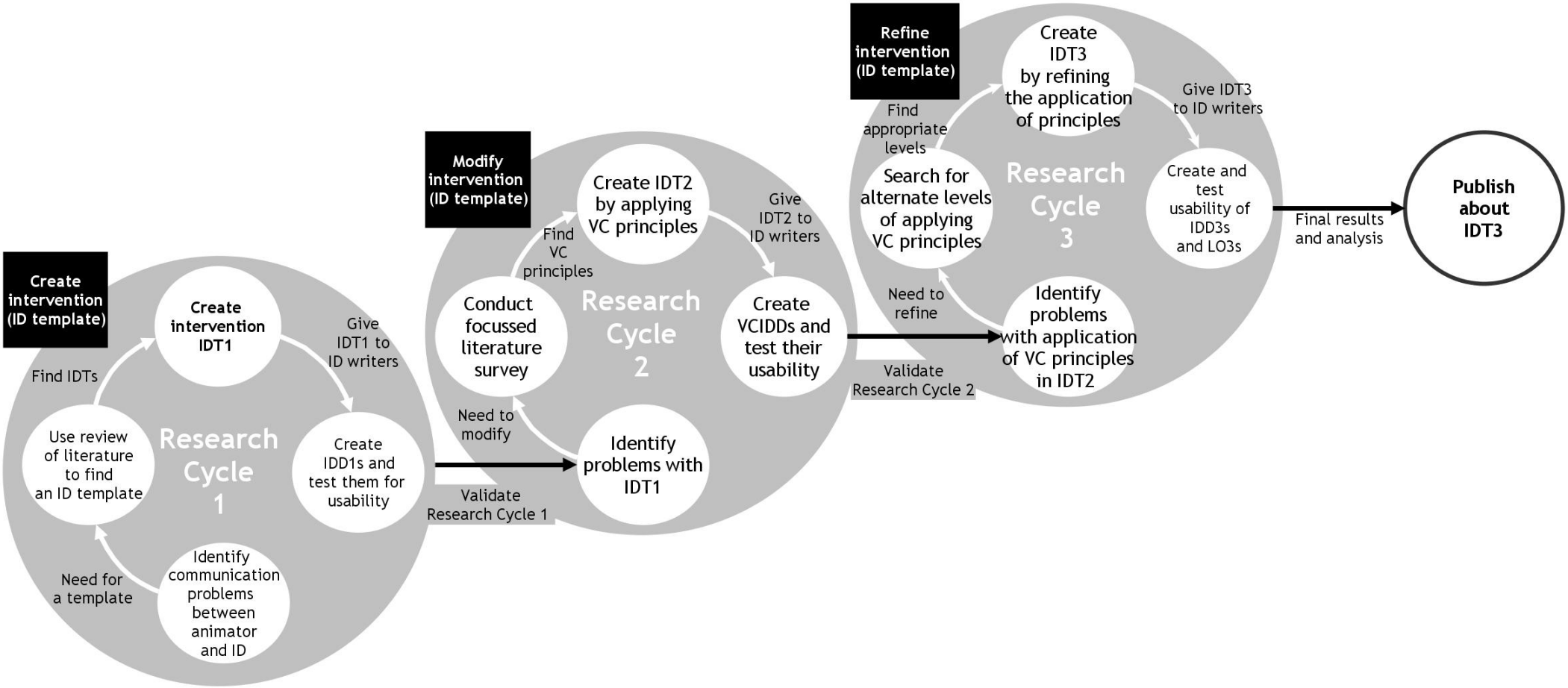


Subject Communication

Typical research cycle



Research method implementation



Tool: System Usability Scale (SUS)

- Technology independent: SUS can be used online as well as offline
- Easy to modify: Original SUS form contains 10 questions, in a specific format. It also allows modification of questions, based on the context in which it is being used.
- It is relatively quick and easy to use by both study participants and administrators: 10 questions with 5 point Likert scale
- SUS provides a single score on a scale: formula*
- It is nonproprietary: It is free to use

Back to Phase 1

Overview of three research cycles

	Template	Stakeholders	Artefacts	Results	Modifications
RC1	IDT1	Animators	10 IDD1s	IDD1s not usable	Modify IDT1 by adding VC principles
RC2	IDT2	Animators	12 IDD2s	IDD2s are usable	-
	IDT2	ID writers	12 IDD2s	IDT2 is not usable	Refine adding of VC principles in IDT2
RC3	IDT3	ID writers	14 IDD3s	IDT3 is usable	

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Focussed literature survey

Principles from domains which are useful for LO creation:

- Animation: Disney, Pixar
- Graphic design: Gestalts
- Multimedia: Mayer and Clark
- Interaction design: Sharp, Preece & Rogers

Literature review

	Animation	Graphic design	Interaction design	Multimedia design
Principles referred from	The Illusion of Life: by Thomas Frank and Ollie Johnston	Gestalts laws of design	Interaction design: by Sharp, Rogers, and Preece The essentials of interaction design: by Cooper, Reinman, and Cronin	Multimedia design: by Ruth Clark and Richard Mayer
Principles found suitable for applying In LO creation process	Staging, Timing Follow Through and Overlapping Action Secondary Action Slow In and Slow Out Pose to Pose action Appeal. These can be applied after modification: Anticipation Arcs	Figure-Ground Focal Point Proximity Continuation Unity/Harmony Similarity Balance/Symmetry Good Form	Visibility Feedback Constraints Mapping Affordance Consistency.	Multimedia Contiguity Modality Redundancy Coherence
Principles NOT found suitable for applying in LO creation process	Squash and stretch, Straight Ahead Action Exaggeration	Closure Isomorphic Correspondence Simplicity		

Back to Phase 2

Implememtation of research cycles

RC1	**RC2**	RC3
Usability score for IDT1	Usability score for IDT2	Usability score for IDT3
Animators	Animators	
34.75	**68.75**	
	ID writers	ID writers
	54.16	**69.42**

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Usability experiments

Artifacts:

- LOs created using two levels of templates
- Tested with students for the usability

	IDT2	IDT3
Image thresholding	$LO2_1$	$LO3_1$
Line coding	$LO2_2$	$LO3_2$

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Usability experiments

Short demo of the LOs:

- Image processing: $ITLO_2$ and $ITLO_3$
- Line coding: $LCLO_2$ and $LCLO_3$

Sample for the usability test

- Convenient sampling technique
- Under graduate students from engineering colleges affiliated to Mumbai University, who have undergone a course on Image Thresholding OR Line Coding (n=128)
- Three colleges were included in the sample, to test the generalizability of the intervention.

Testing instrument

Survey form

- Having seven statements
- Three point likert scale: Agree, Neutral or Disagree
- Constructs
  - Perceived usefulness
  - Ease of use in terms of navigation and interactivity options
  - Feedback of the interactive elements and response features
  - Accuracy and correctness of the content.

Testing instrument

Construct	Actual statement in the questionnaire
Perceived usefulness	Concept is presented in an interesting manner in the animation
Ease of use	Interaction design features like buttons, tabs and other options help navigation through the animation
	Interaction design features like sliders, buttons, drop downs and other options in the animation are easy to use
Format	Features like sliders, buttons, drop downs and others display the output as expected after using them
	Feedback of the response features like, pop-ups, explanation instructional text and others help in interacting with the animation
Content	Animation provides sufficient examples to understand the concept

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Testing instrument

- Validity
  - Interviewing experts (n=3), and modifying the statements based on their feedback
- Reliability
  - Test administered on students (not part of the final sample (n=10)
  - Cronbach alpha for the feedback given by students (for seven statements) was found greater than the accepted value of 0.6

Cronbach Alpha and Related Statistics				
Items	Cronbach Alpha	Std. Alpha	G6 (smc)	Average R
All items	0.6564	0.6648	0.8935	0.2208

Process

- Distribution of the total sample (n=128) was done as per the availability of the students.

Topic	**1. Image thresholding**	**2. Line coding**
College 1	23 students	-
College 2	45 students	22 students
College 3	-	42 students
Total	**68 students**	**64 students**

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Process

- Students were asked to open LO2 (having basic VC principles) on their respective computer terminal.
- Usability questionnaire A (paper based) was given to the students to give feedback about the LO2.
  20 minutes were given to interact with LO2.
- Additional 10 minutes were given to ll up the questionnaire.
- The feedback forms were collected.
- Students were instructed to open LO3 (having advanced VC principles) on their respective terminal.
- Usability questionnaire B was given to the students to give feedback about the LO3.
- 20 minutes were given to interact with LO3.
- The feedback was collected.
- The researcher thanked the students for their participation.

Process

The order of LOs (basic and advanced) was swapped for the next group of students to counter balance and avoid bias.

	Order of assigning	
	First LO	Second LO
Group 1	$LO2_x$ (Basic)	$LO3_x$ (Advanced)
Group 2	$LO3_x$ (Advanced)	$LO2_x$ (Basic)

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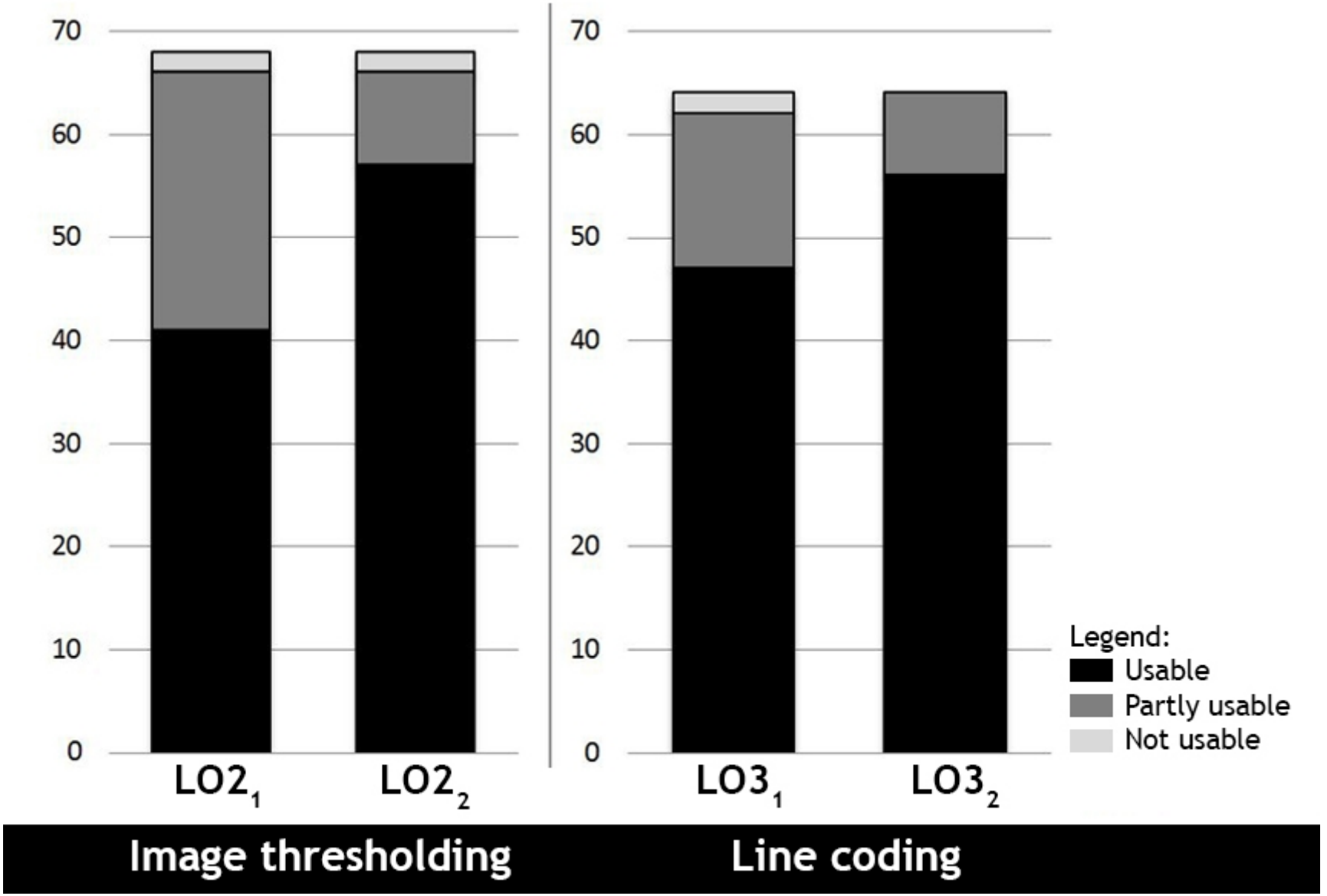
Data analysis

Wilcoxon matched pair signed rank test was found appropriate for the data analysis of the experiment (Bruin, 2011), since it is recommended under the following conditions:

- Data are paired and come from the same population (Same population in this research).
- Data are measured on an ordinal scale (3 point Likert), but need not be normal

Feedback comparison (usability scores)



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Frequency of responses

A common trend of increase was seen, in the `Agree' scores of LO3s as compared to LO2s, for each statement.

ITLO

	S1		S2		S3		S4		S5		S6		S7	
	$LO2_1$	$LO3_1$	$LO2_1$	$LO3_1$	$LO2_1$	$LO3_1$	$LO2_1$	$LO3_1$	$LO2_1$	$LO3_1$	$LO2_1$	$LO3_1$	$LO2_1$	$LO3_1$
A	38	53	34	52	41	51	44	56	39	49	43	52	41	57
N	23	13	24	12	18	13	17	11	22	16	22	13	25	09
D	07	02	10	04	09	04	07	01	07	03	03	03	02	02

A: Agree, N: Neutral and D: Disagree

LCLO

	S1		S2		S3		S4		S5		S6		S7	
	$LO2_2$	$LO3_2$	$LO2_2$	$LO3_2$	$LO2_2$	$LO3_2$	$LO2_2$	$LO3_2$	$LO2_2$	$LO3_2$	$LO2_2$	$LO3_2$	$LO2_2$	$LO3_2$
A	38	48	46	49	42	53	41	50	40	48	35	46	47	56
N	19	15	16	15	15	10	22	14	19	15	26	18	15	08
D	07	01	02	00	07	01	01	00	05	01	03	00	02	00

A: Agree, N: Neutral and D: Disagree

Effect size of the results

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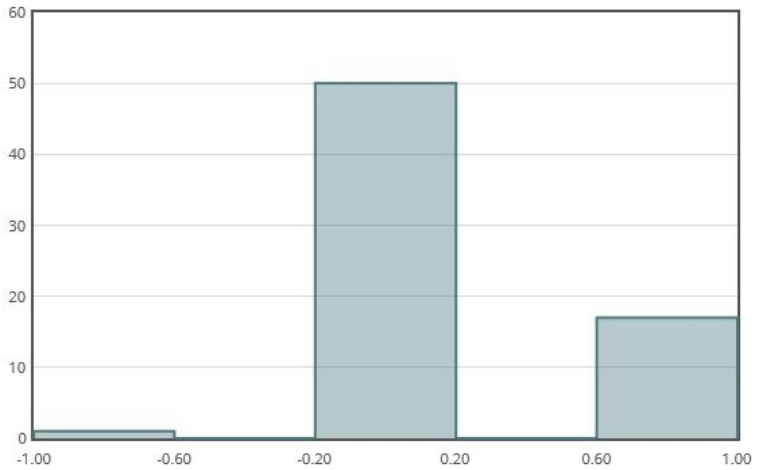
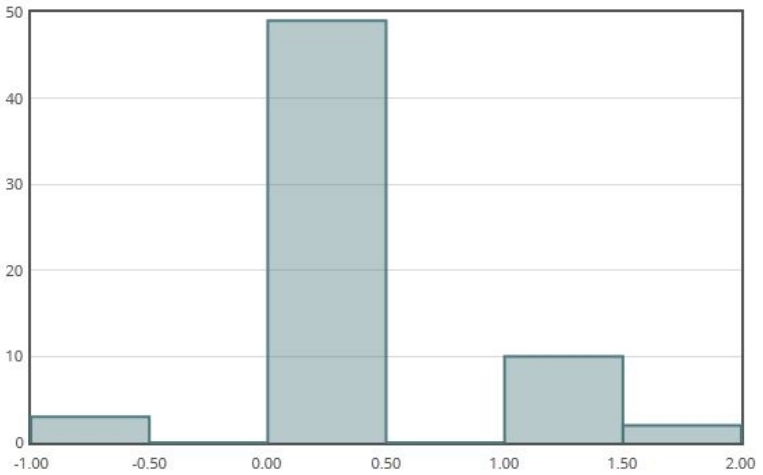
ITLOs

Effect size is moderate
(z-score = 3.771, p< 0.001)



LCLOs

Effect size is modest
(z-score =-2.399, p <0.016)



Results of the engagement survey

SMEs

- Interactivity
  - Interesting and innovative forms of interactivity provided in LO3s.
- Interface design
  - `Look and feel' of LO3s was very good, user friendly.
- Learning and reinforcement
  - Combination of interaction design and pedagogy useful in making the LO3s more suitable for learning and reinforcement.

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Results of the engagement survey

Students

- Mentioned a specic preference for LO3s in terms of the interactivity and engagement.

Responses for the LOs created for Topic 1: Image thresholding						
	$LO2_1$			$LO3_1$		
Statement	**A**	**N**	**D**	**A**	**N**	**D**
S1: I liked the look and feel of the LO	3	1	1	4	1	0
S2: Look and feel of the LO helped me in learning	3	2	0	3	2	0
S3: I find LO to be engaging	2	3	0	4	1	0
S4: Working with LO helped me learn	2	2	1	3	1	1

A: Agree, N: Neutral and D: Disagree

Responses for the LOs created for Topic 2: Line Coding						
	$LO2_2$			$LO3_2$		
Statement	**A**	**N**	**D**	**A**	**N**	**D**
S1: I liked the look and feel of the LO	2	2	1	3	1	1
S2: Look and feel of the LO helped me in learning	2	3	0	3	1	1
S3: I find LO to be engaging	2	1	2	3	2	0
S4: Working with LO helped me learn	1	3	1	2	2	1

A: Agree, N: Neutral and D: Disagree

Subject Communication

Conclusions

- **null hypothesis was rejected**
  - since the data showed LO3s were signicantly usable than LO2s ($p=0.000$; $z=-3.771$ for topic 1 and $p=0.016$; $z=-2.399$ for topic 2).
- **alternate hypothesis was not rejected**
  - since increase in the usability scores of LO3s, as compared to LO2s

Subject Communication

Conclusions

- engagement experiment conducted for the students
  - LO3s more engaging than LO2s.
- unstructured interviews with the SMEs
  - usefulness in terms of learning: interactivity and the interface design of LO3s was more appealing than LO2s.

Intervention created in this research was found usable for the respective users.

Contributions

Theoritical

- Identifying the VC principles applicable for LO creation
- Operationalizing the VC principles in an IDT
- Refining the operationalization of VC principles so that the ID writers find it usable
- Creation of feedback instrument having usability and engagement constructs and validating it.

Artifacts

- ID templates: validated, and found usable by the stakeholders.
- Usability tools: modified tools with specific constructs addressed were created
- Learning objects: to be used in the future offerings of the courses.

Subject Communication

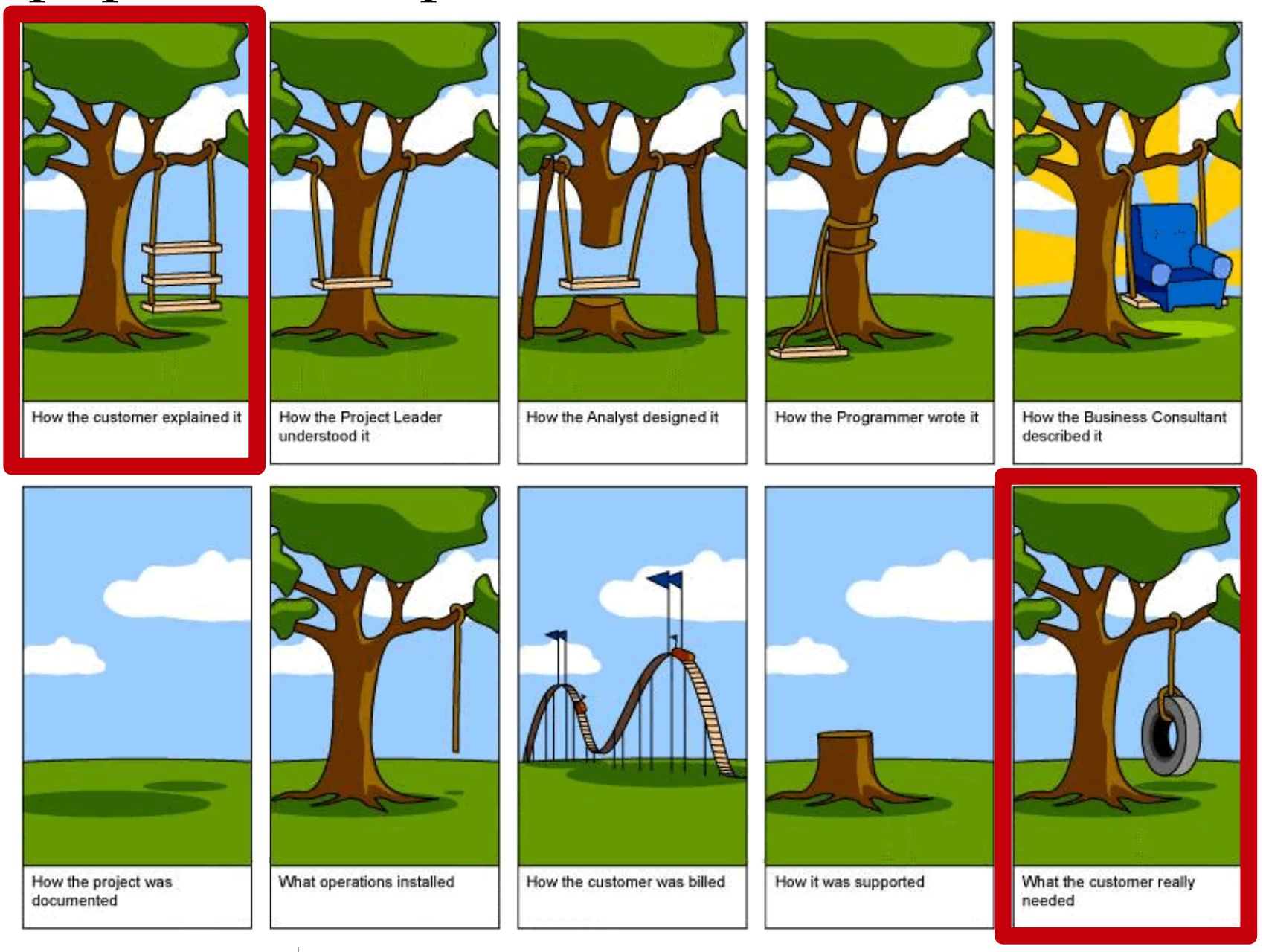
Future work

- Generalization of templates for different domains
  - ID templates are required for eLearning content creation across domains. It would be beneficial to see whether the template having VC principles is able to create usable LOs.
- Software version of IDT
  - Prompts written as text may be ignored, therefore a software tool would be beneficial.
- Design Guidelines Document for animators
  - Not all the animators have sound design background. This document will help in achieving similar level of visual design.

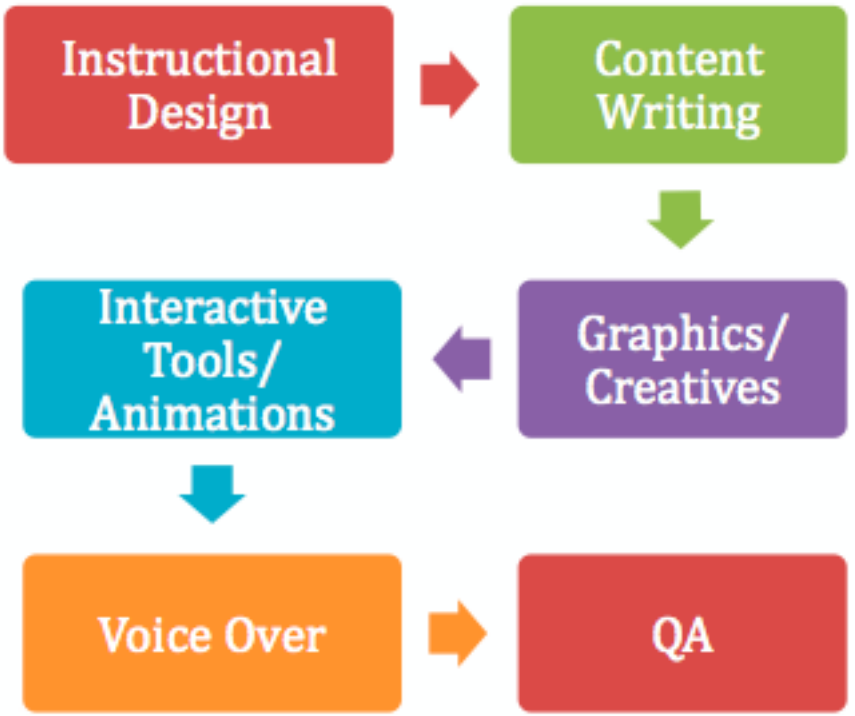
Thank you

Additional Slides

A popular example of miscommunication



Processes followed at other organizations (Career Mantra)



Processes followed at other organizations (Career Mantra)

I. The requirement of the client is understood by our domain experts.

II. The experts enmesh their own knowledge with research and build raw content that is canny, current and complete. The raw content is then vetted with the client to ensure that nothing is missing or extraneous.

III. Storyboarding is then done by our experts in instructional design, graphic design and animation.

IV. The flow of the storyboard is then checked by our in house instructors and trainers to ensure that the flow of the storyboard is amenable to imparting instructions.

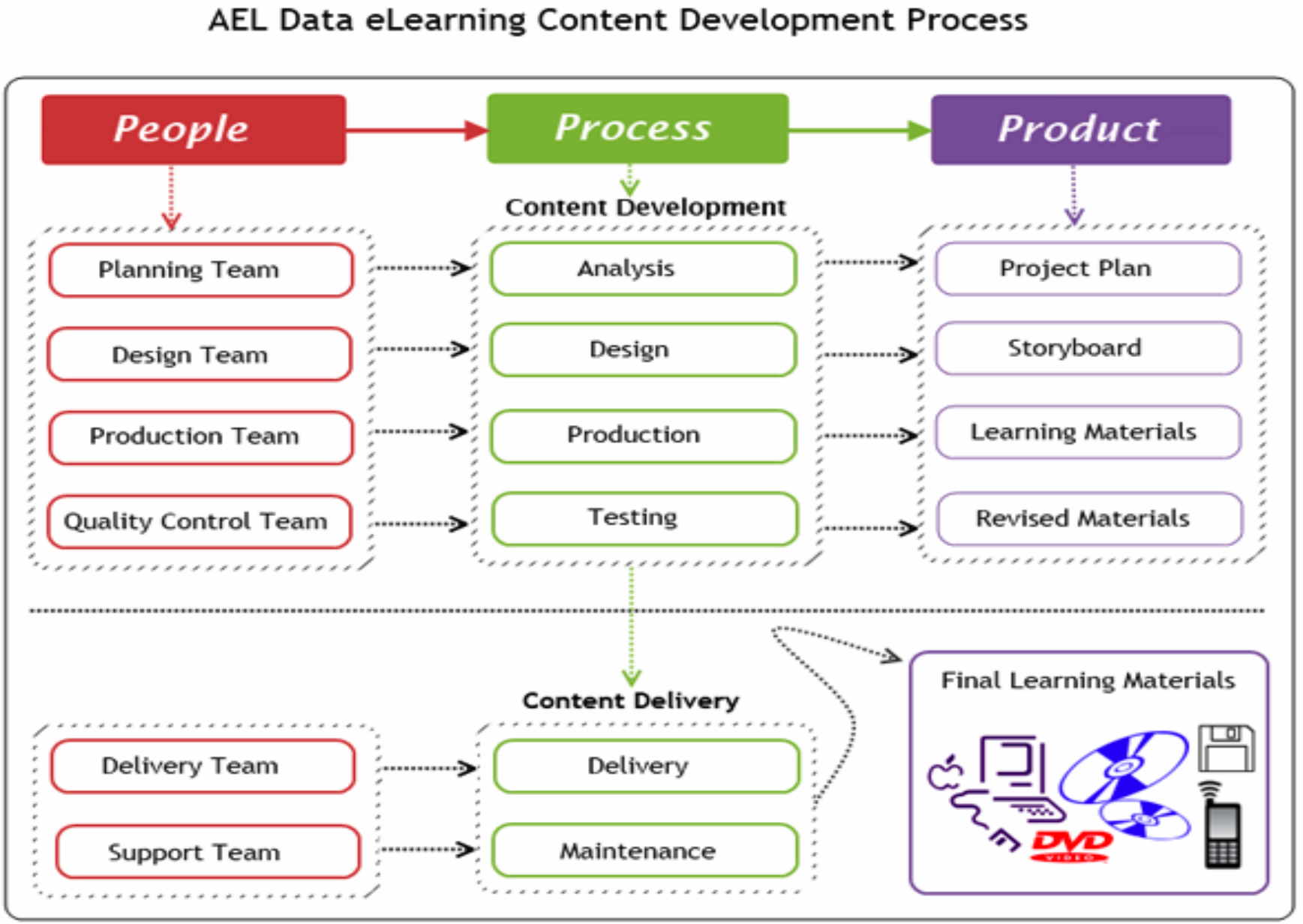
V. The content is then transformed into rich media by our GUI designers and animation experts.

VI. Where required, voice over is given to the presentation.

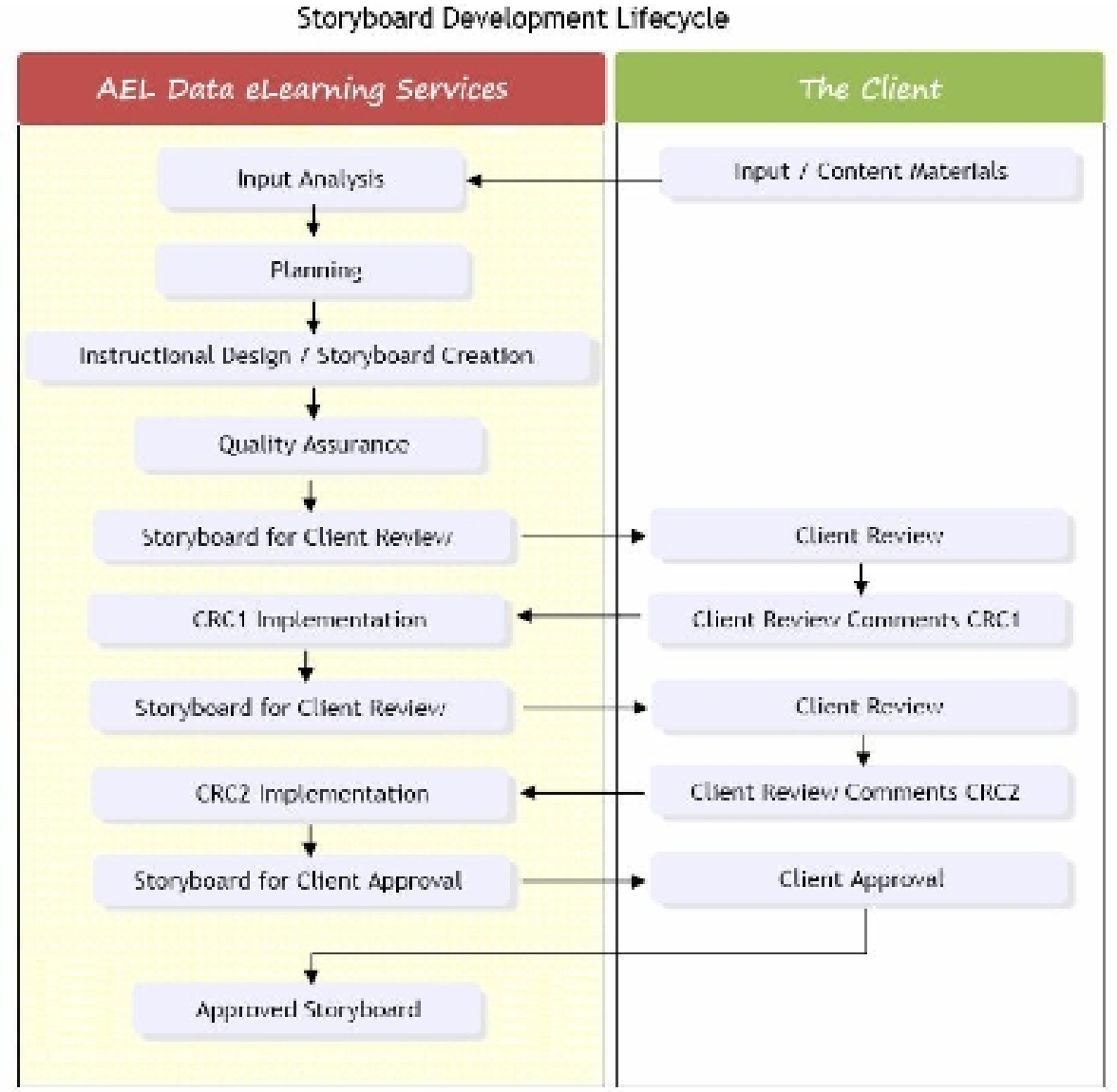
VII. A final quality check is done by the SMEs to filter inaccuracies, if any.

VIII. The module is packaged in CBT, SCORM, IMS etc as per client's requirement.

Processes followed at other organizations (AEL Data Services)

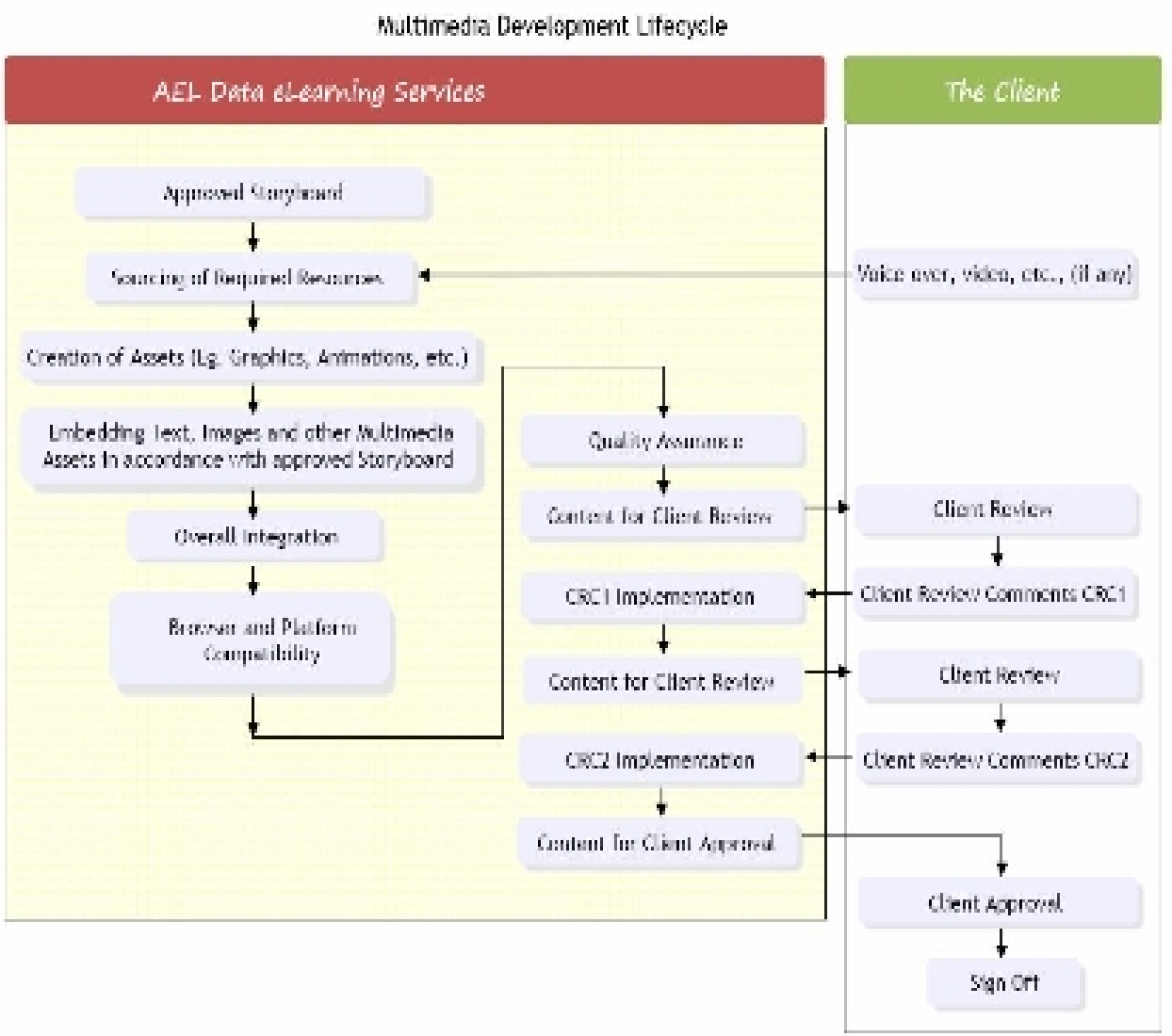


Processes followed at other organizations (AEL Data Services)



Subject Communication

Processes followed at other organizations (AEL Data Services)

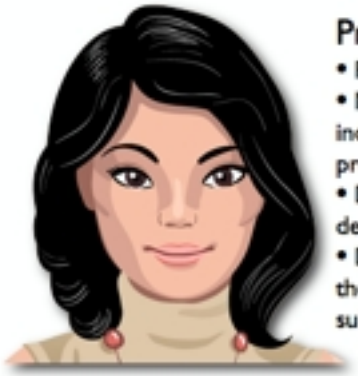


Processes followed at other organizations

Report by: Sumeet Moghe, Thoughtworks

In recent months I've met over 50 elearning practitioners and evaluated at least 6 elearning firms. My inspiration for this series of posts has been what I've learnt about their style of learning design and how approaches we've tried internally at ThoughtWorks compare as a stark contrast. In today's post I want to outline the current state of elearning content development in the industry.

The Graphic Artist plays a very transactional role in the project. He works with descriptions provided by the Instructional Designer, without any considerations of whether the final output fits the image of the client or the learning material in the module.



Project Manager

- Follows Prince 2
- Manages/ Admin's multiple individuals on multiple projects.
- Doesn't do any development work.
- Doesn't know much about the client's problem or subject.

Instructional Designer

- Conducts a heavy upfront analysis of the material.
- Documents and plans every detail of the module, so that the builder has no issues when she's away on another project.

Builder

- Skilled on a Rapid Elearning Platform.
- Executes the written instructions from the Designer.
- Knows nothing about the client or subject.

Tester

- Does Manual Testing of the module.
- Has fairly good technical knowledge of various e-learning technologies.
- Knows nothing about the client or subject.

Graphic Artist

- Works freelance.
- Is skilled on various graphic design tools.
- Works on written descriptions from Designer around the creation of graphics.
- Knows little or nothing about the client or subject.

Processes followed at other organizations

Report by: Sumeet Moghe, Thoughtworks

Background and Literature survey

- Animation in eLearning
  - Only carefully designed and appropriate graphics prove to be beneficial for conveying complex systems [Tversky, Morrison]
  - A systematic approach would be studied to design algorithms which can be applied by the content developers for effective animated content creation. [Thomas Huk]
  - Animations are useful in showing processes which have
    - Change over time
    - Complex viewing angles

Background and Literature survey continued

- Use of animations vis-a-vis camera videos
  - More control on the visual quality
  - Ability to show objects which cannot be captured or do not exist
  - Ability to show critical angles/situations which cannot be captured in videos

Background and Literature survey continued

- Design principles for animations in eLearning
  - The categorization of the principles is an independent decision, and is influenced by the domain of the content to be created
  - In certain cases it extends to the medium used.

Definitions of important terms

LO: Learning object

SME: Subject matter expert

ID expert: Instructional design expert

ID: Instructional designer

VC expert: Visual communication expert

GD: Graphic designer

IDD: Instructional design document

IDT: Instructional design template

CSF: Concept selection form

Sample of an instruction slide from IDT 1

INSTRUCTIONS SLIDE

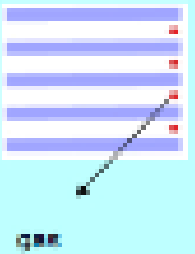
Project OSCAR

Interactivity and Boundary limits expected in the animation

- In this section provide, interactivity options for all the parameters/components of the concept.

For example:

- Numerical values to change the state of the component: By providing input boxes
- Drag and drop of components: To test the comprehension of the users
- Movement of objects: To explain the action of the components

Interactivity option number	Details of Interactivity	Image / Diagram	Text to be displayed	Boundary limit
1	The user can move the 'balloon' of gas in the resonator		When the balloon is placed in high pressure region, it would shrink and its temperature will rise (it will become red). When moved to low pressure region, it expands becoming cold (blue)	...

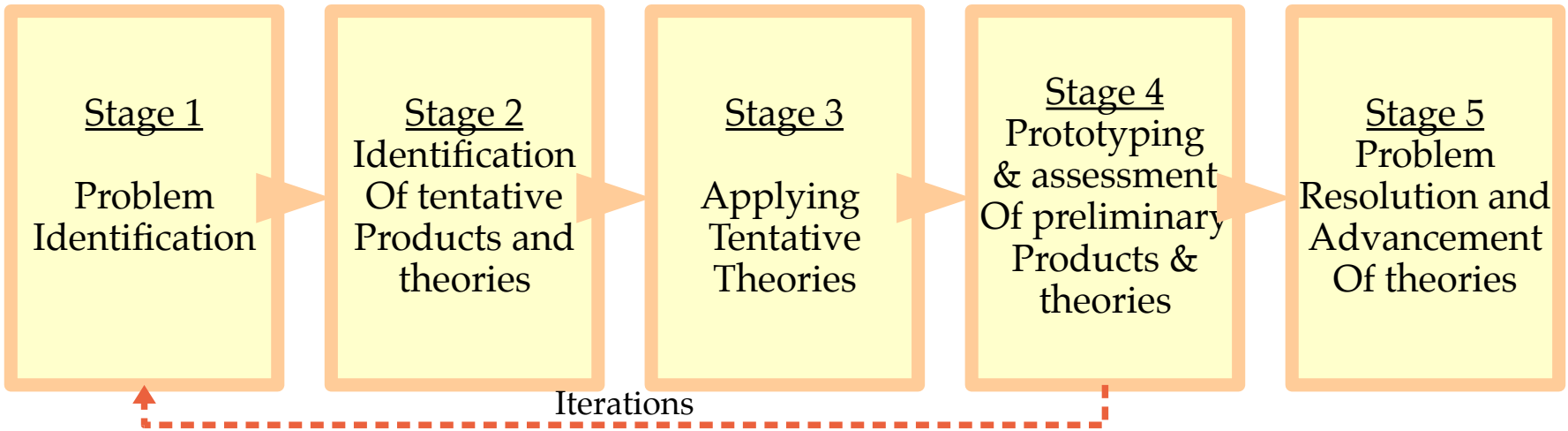
Subject Communication

Example: Face-to-face interaction between the stakeholders

Stakeholders	**Topics of decisions** (regarding the LO)
SME with ID expert and VC expert	Pedagogy approach, Pattern of interactivity, Visual design strategy
ID expert and VC expert	Visual presentation pattern, suitable for the pedagogical approach selected
VC expert with GD	1. Visual presentation pattern for the LO 2. Details of the placement and colour scheme 3. Typography
GD with ID	1. Mapping of the interactive elements 2. Types and size of the buttons, their placement and relationship (what to show if the button is clicked)
GD with ID and Animator	1. Placement and interactivity decisions based on format specified by VC expert. 2. Animation style and motion

Implementation of our research methodology

Every phase has the following stages:



Communication angle

- Primary communication

Research questions

- What is the information that is necessary for the ID which forces requirement of face-to-face interaction with the animator?
- Since the ID is not an VC expert, how to enable ID to provide VC information to the animator?
-

Scope:

- Subject domain of IDDs and LOs: Physics
- Academic level: concepts from B.Sc curriculum in Mumbai university

Limitations:

Findings of this research may not be applicable to

- Other eLearning mediums like eBooks,