SMART SCIENCE COMMUNICATION:

A GUIDE TO CRAFTING VISUALLY EFFECTIVE SCIENTIFIC POSTERS AND IMAGERY

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TABLE OF CONTENTS:

02

ABOUT VISUAL COMMUNICATION

Images are an important tool for communicating science. Visual imagery, unlike traditional written media alone, can convey complex concepts, elicit emotional reactions, and relay information about author's credibility almost instantaneously. As scientists, we are not trained in the field of visual design. We do not take courses on visual rhetoric, and we may never consider concepts like visual literacy or the factor in the elements of design when trying to communicate science. In a 2015 study, researchers noted that scientists idealize concepts like usability, process, aesthetics, and audience in theory, but in practice we use data, argument, and genre as our main logical templates. We tend to prioritize the scientific data when creating imagery and fall away from thinking about how our audience will interpret and be able to use the data we are presenting. Therefore, it is important to learn how to effectively communicate science visually, as this is not always an intuitive or a straightforward process. By being mindful of visual literacy, utilizing effective science communication tactics, and incorporating the elements and principles of design, we can create useful and informative scientific graphics that appeal to larger audiences.

Science can be communicated using any of the 5 senses – sight, touch, smell, hearing, or taste – but here we will focus on the visual aspects. Visual science communication uses imagery to communicate scientific concepts to a target audience. These images can take the form of:

- Abstract illustrations
- Diagrams
- Literal images (photographs)
- Symbolic notions
- Infographics

Regardless of the media and avenue we choose for our imagery, we are in control of the framing of the information – what colours, sizes, fonts, and perspective we choose determines what our audience sees and therefore ultimately what conclusions they make from our imagery. If we are aware of the impact these elements have on how our images are perceived, we can make mindful design decisions and have our audience take away what we deem to be the most important concepts from our research.

SCIENTIFIC VISUAL LITERACY

Visual literacy, like literacy in general, encompasses the ability to read write, analyze, and evaluate information. We want our audience to be able to recognize or "read" the visual language we are speaking and accurately attribute meaning to it. To be effective science communicators, we need to be fluent in visual language and be able to interpret the meaning in visual elements. Through the lens of scientific communication, visual literacy helps us to understand which symbols to use when communicating scientific concepts. It helps us to explore the deeper meaning of the elements in our images to avoid speaking in a language that only scientists understand. This idea helps us consider important questions for refining our images:

- Will a nonspecialist interpret my pictorial cues the way I intend?
- Which visual style would my audience find most engaging and informative?
- What scientific background or understanding does my audience have? How will this affect the way the audience perceives my image?

04

SCIENTIFIC VISUAL LANGUAGE

Whether you choose to display your imagery in scientific papers, magazines, on Twitter, or other various media, you need to embrace visual language to achieve effective communication of ideas. Elements of visual language include:

Colour

- Do my colour choices complement my information?
- Are the colours distracting?
- Do certain colours have any meanings associated with them that I did not consider?

Typefaces

- What are the effects of my font choice?
- Does the font type infer scientific credibility?
- What is emphasized by my font?

Photographs

- Is this photograph necessary for communicating my concept?
- Will my audience know what they are looking at?

Page Structure

- Does my information flow in a logical order?
- Where does my eye go to when it first looks at my document?

Graphs/Charts

- Do the graphs and charts I have chosen to incorporate help or hinder my communication of the science?
- Could I choose to incorporate the data in a different way that is more effective for my audience?

05

VISUAL THINKING AND LEARNING

Now that we understand some of the elements of visual language, we can consider how our brains process and think about this language. Visual thinking is the way to classify images to attribute meaning. You can think of it as how we “read” images. Each of the elements are like different words, and our brain works to structure these “words” into complex sentences with meaning. Therefore, we need to be mindful of the visual elements of our imagery because they are the basis for our interpretation and understanding.

Most of us have some knowledge of the meaning behind visual elements. However, we need more insight on how to incorporate our knowledge into creating our imagery. If we use visual learning tools properly, we have the power to invoke strong emotional connections even before concepts are fully understood.

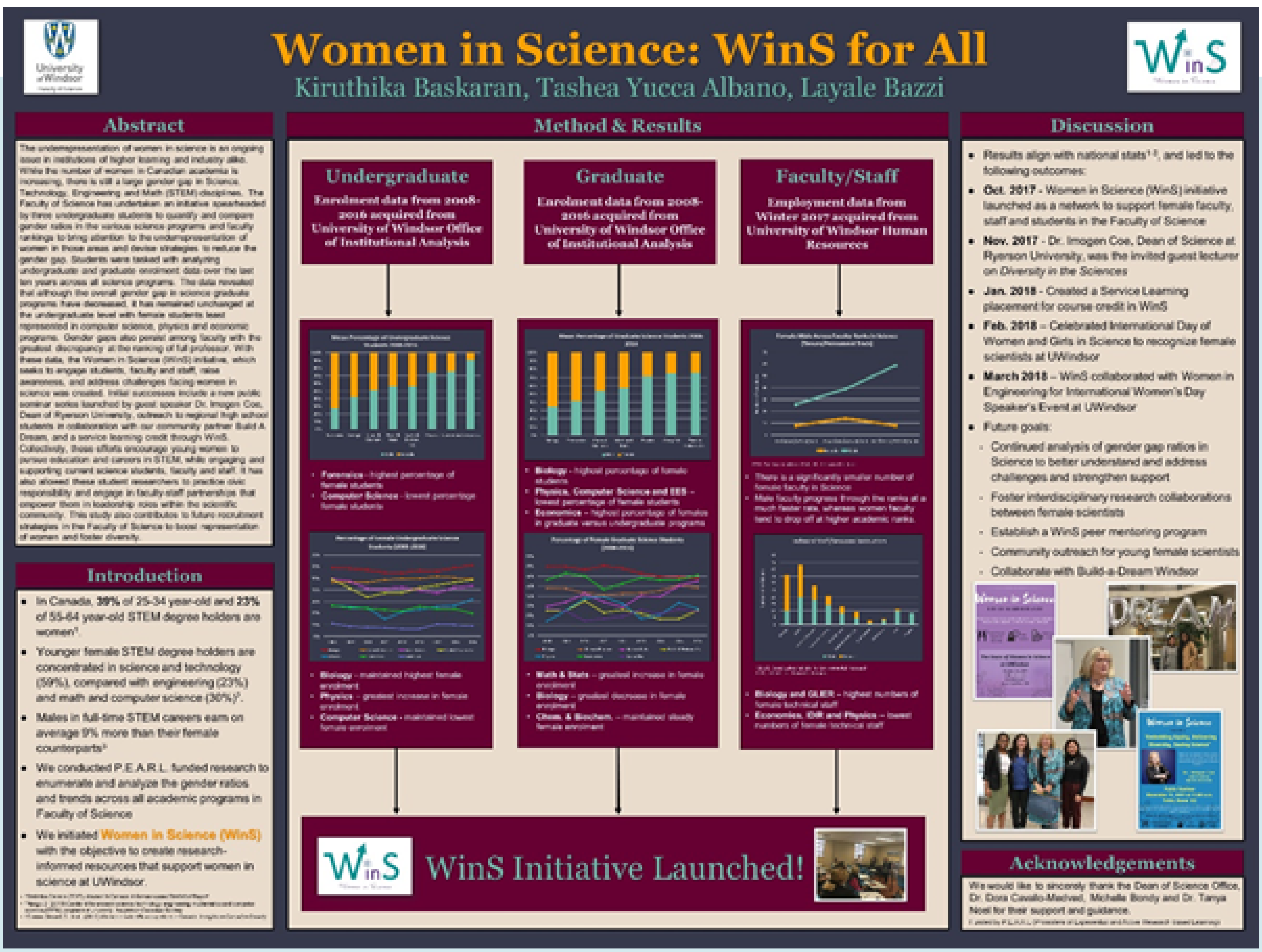
VISUAL RHETORIC

An important component of visual literacy is visual rhetoric – how we use visual images to communicate meaning. It considers the visual input, in the context of the audience, through different persuasive channels to determine meaning. Visual rhetoric states that each image is an argument that is intended to either promote the audience to action, a belief, or a specific feeling. This concept emphasizes the impact audience and context has on how we interpret imagery.

In summary, if we, as science communicators, are visually literate, we can “read” and understand the meaning behind visual language and “write” comprehensive images.

EFFECTIVE SCIENCE COMMUNCIATION

For this section, we will use a poster created by members of the Women in Science (WinS) program, to showcase the concepts surrounding effective visual science communication.

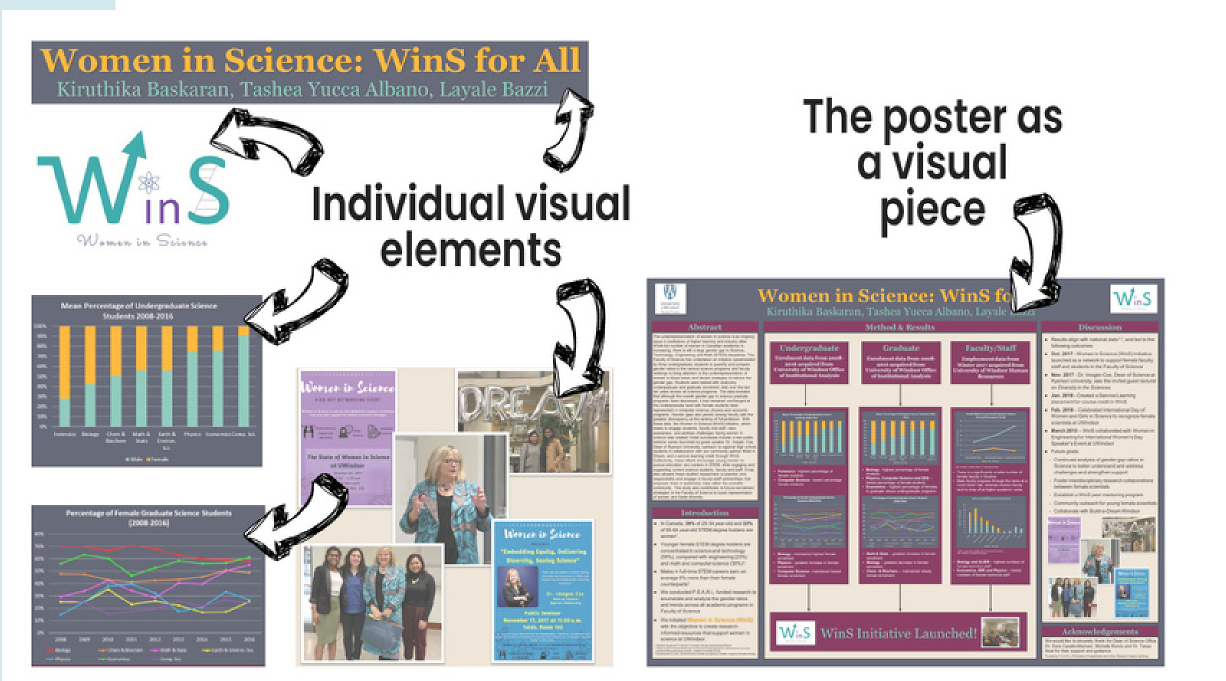


07

MAKING VISUALS INTEGRAL

Often scientific visuals are an add-on that are used to emphasize the written content. The old saying goes that “a picture is worth a thousand words” but that is not always the case, especially when that picture is an afterthought. This is why as effective science communicators we need to advance past merely using images to illustrate the written information and consider the visual aspect equally important to the written component.

From the beginning, we need to think of our posters as the visual piece that it is. We must think about not only the independent visual components like illustrations and photographs, but how the piece will come together as a whole.



KNOWING YOUR AUDIENCE

The better we know our audience, the more we can refine our work to that specific audience. Tailored messaging helps us to communicate our main points. The first step is to know who we are addressing and target them well. It is not enough to say we wish to reach nonspecialist audiences. Which non specialist audience are we reaching out to? What age are they? Where do they live? What is their education? What preconceived notions about our work might they have based on life experiences? The general public is too general. In this respect, it pays to be specific.

It is important to look at the ideas through the eyes of our audience. Think about social, political, cultural, or economic contexts that could influence how we should tailor our message to them. Each social group has their own persuasive devises that are based on culture, values, and life experience.

In the case of the *Women in Science: WinS for All* poster, the audience is science students and faculty at the University of Windsor. This audience has a strong background in science, is familiar with the dynamics of the science programs at the University of Windsor, and has a general understanding of the issue of gender diversity in science fields. Had the audience been different, the researchers may have opted for less graphical representations of data, more photographs, or perhaps more background information.

A MIND SHIFT: FROM SIMPLIFICATION TO RECONTEXTUALIZATION

When we think about what our goal is in creating scientific imagery, many of us will come up with statements that involve “simplifying the science” to meet our audiences' level of understanding. By adopting this way of thinking, we are setting ourselves up to fall short of creating meaning for our audience. By aiming for simplifying concepts, we fail to consider what motivates our audience and what framing would be most useful to them. If we shift our mindset from simplification-based communication to a goal recontextualization of the science, we will present our audience with scientific concepts in a way that is relevant to them and that they can easily interpret and take away meaning from.

We can recontextualize science by:

- Using analogies and metaphors
- Using symbols
- Focusing on main concepts/ideas opposed to facts

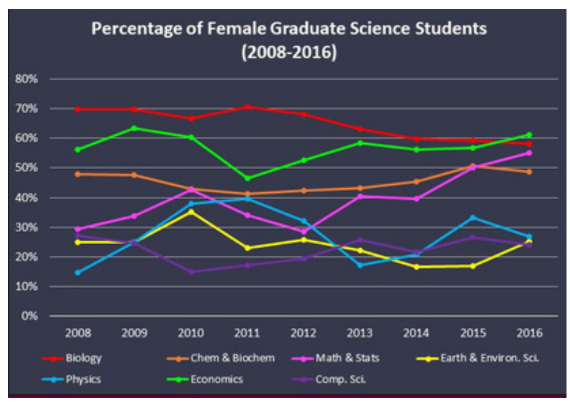
10

EXAMINING OUR LOGICAL TEMPLATES

Logical templates are the way we frame our arguments. By thinking about the logical framework we are using for our piece, it allows us to imagine the arguments that are resorted to by our audience when they view our work. Examining our logical templates also exposes the limitations of our templates and what aspects we are emphasizing. We also choose logical templates when creating our visual arguments. These include the following

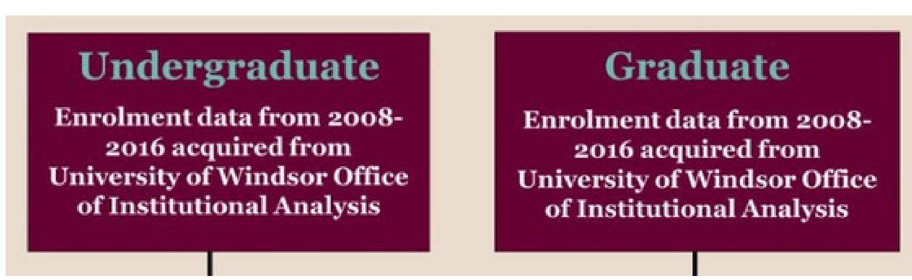
Change Over Time

The change over time framework is relatively intuitive, it shows how a variable changes over a given time period. This framework can be observed when the researchers used a graph to show how women's enrolment in STEM fields fluctuated based on the year.



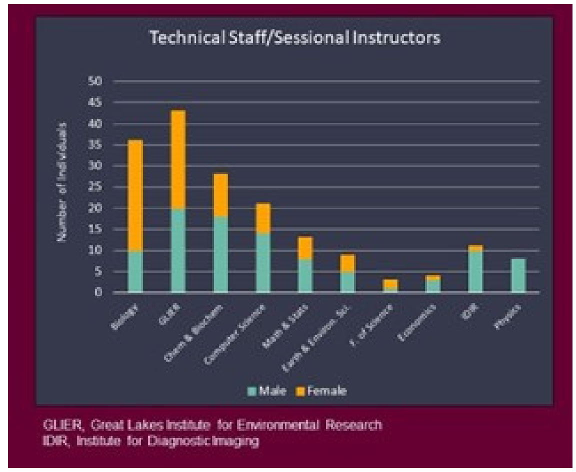
Compare/Contrast

The compare/contrast framework includes imagery where two or more elements are presented, allowing the audience to observe the similarities and differences between them. We can also see compare and contrast in the WinS poster when we are shown graphical representations of both undergraduate and graduate enrollment data.



Degree

The degree visual framework highlights the level, amount, or extent to which an element is present.



There is an example of this in the WinS poster in the graph depicting the staff and seasonal instructors. We can see to what extent female staff are present at the university of Windsor.

Spatial Disposition

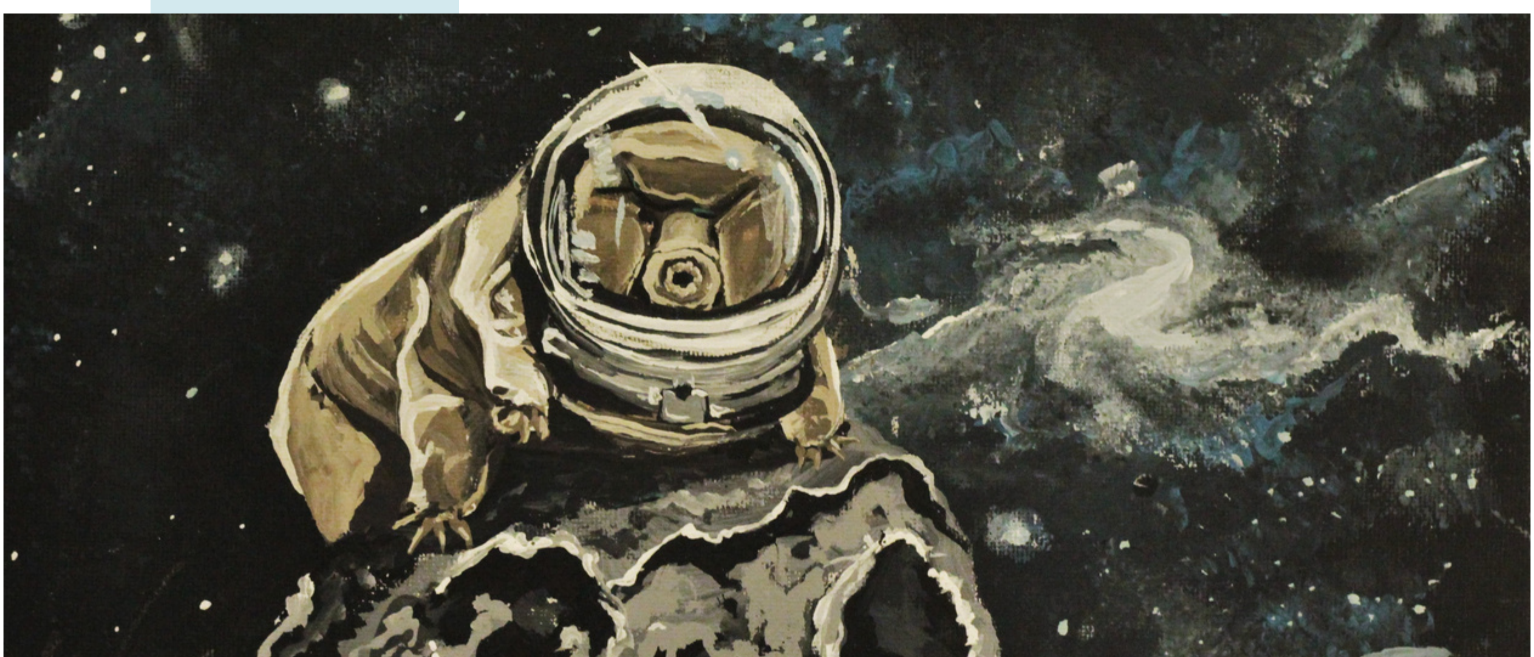
The spatial disposition framework entails images where meaning is inferred based on the spatial arrangement of elements in relation to one another.

While there is no direct example of this in the WinS poster, we can clearly see this framework exhibited in a piece titled “The Tree of Life” created by SMArt artist Phil Habashy. We can infer relationships between DNA, neurons, and a tree depicted in this painting due to their arrangement on the page. In this case, we can see that the artist is highlighting the similarities and relationships between elements opposed to emphasizing the differences or contrasting elements.

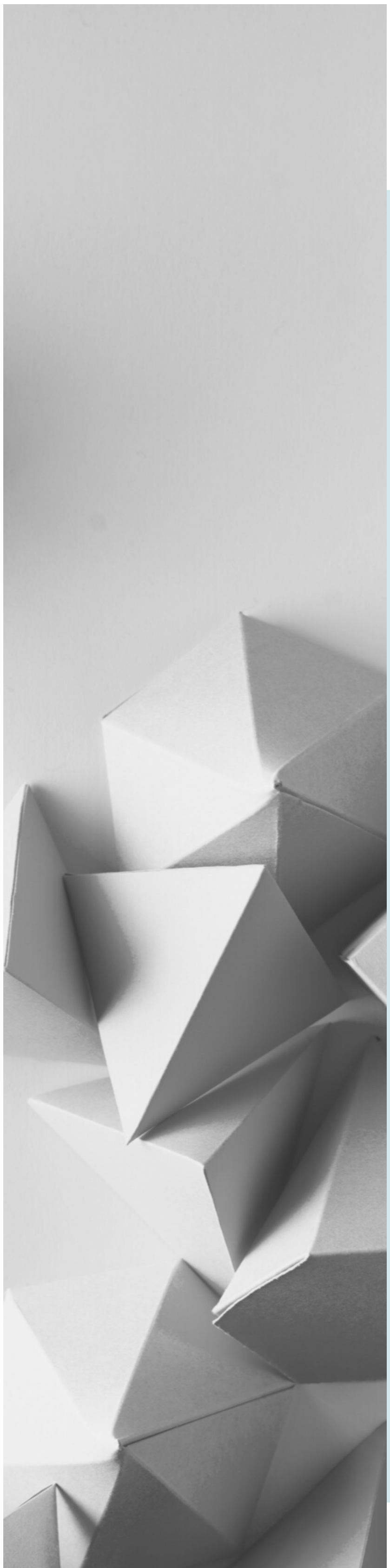
The template we choose contributes to “codes” that manifest in our imagery. They can act as a barrier for nonspecialist audiences to access and interpret STEM imagery. Since the information we are presenting is second nature to us, we may not consider the implications of the visual template we are using. Are we assuming our audience understands the subject as well as we do? According to a 2015 study by Walsh and Ross, if we lean towards a god’s-eye view style – presenting an uninterpreted form of data -- as being the preferred visual communication style of science communicators, we tend to increase the political authority of STEM fields, but we fail to increase our audiences’ public literacy. In other words, we will be seen as authoritative, but will not be successful in providing useful information if we stick to this approach.

WHERE SCIENCE MEETS ART

As we have seen, some of the concepts that make for effective science communication are not intuitive to scientists and require training in visual literacy. Most scientists do not have formal training in visual fields like design, so they neglect to incorporate the elements and principles of design when creating science communication pieces. Understanding these elements and principles will give you the power to make intentional choices with your communication pieces.



UNDERSTANDING YOUR VISUAL TOOLBOX: THE ELEMENTS OF DESIGN



There are 7 elements of design, and they act as the building blocks for any visual piece. They are the components that we must use effectively to create a cohesive, informative image. They are as follows:

Shape/Form

Shape is a contained two-dimensional area, like a circle or a square, while form refers to the three-dimensional counterpart. Shapes/forms can be organic (ex. a cloud) or geometric (ex. a square).

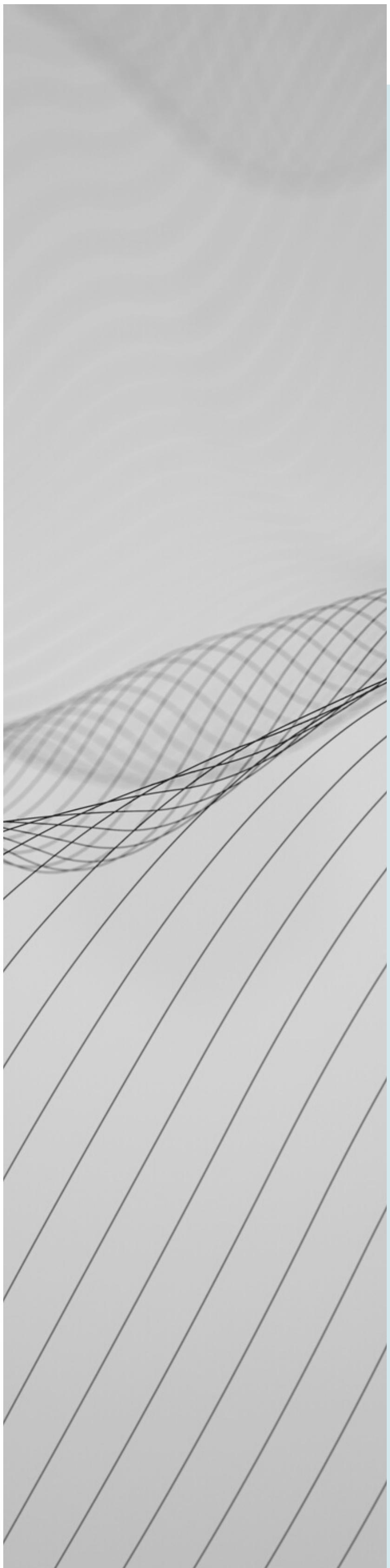
Rectangular shapes were consistently used by the authors of the Women in Science (WinS) poster.

Space

Space is the distance that we have between elements in our work, often referred to as white space or negative space. By manipulating the spacing of our objects, we can create the illusion of depth. Variations in spacing we can use include:

- Overlapping elements to imply a connection
- Sizing of elements -- closer objects appear larger and further objects appear smaller
- Level of detail -- closer objects have more detail whereas further objects have less detail
- Colour -- the further an object is the duller the colour appears

THE ELEMENTS OF DESIGN CONTINUED...



Line
Line is a mark in the surface that is continuous, or the result of the meeting of two shapes. Lines can be two-dimensional (ex. a paint stroke), or three-dimensional (ex. a rod). Lines are either explicit (ex. lines on a ruled piece of paper) or implied by the edge of shapes and forms. If there are two dots on a page, our brain immediately connects them and the distance between them becomes an implied line.

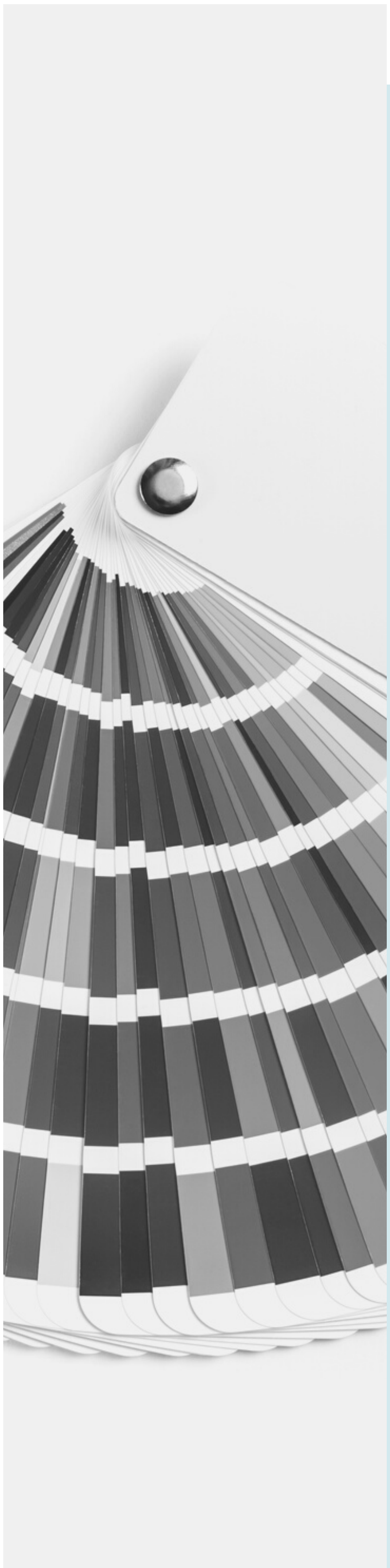
Notice the use of arrows, an explicit line, in the WinS poster.

We can also see implied lines through the different rectangular boxes in the central portion of the poster. Elements of lines we can manipulate include thickness, direction, and movement.

- Lines that remain consistent in their thickness come across as objective and analytical
- Variability in thickness can be used to emphasize parts of a line, or appear more organic
- Lines can be used to divide a space or volume
- Lines can also be used to unite elements

Size
Size refers to the relative area of our image occupied by different elements. Size is correlated with importance – the largest elements should be the most important.

THE ELEMENTS OF DESIGN CONTINUED...



Colour
Sometimes referred to as hue, colour is the specific wavelength of visible light reflected by an element. Colour has the potential to have strong emotional connotations in different contexts. For example, red can be linked to anger, danger or “stop”.

When designing our pieces, we can utilize colour in two main ways:

1. Picking a Colour Scheme
Choosing a colour scheme allows the colours in our poster to remain consistent throughout and ensure the colours we choose go together well. You can look up colour schemes on the internet to get inspiration for your graphics

2. Using Complementary Colours to Emphasize
When choosing a colour scheme, we can include complementary colours -- those opposite on the colour wheel – as those will stand out the most and provide emphasis. Notice how the Wins poster uses yellow, the complementary colour to purple, throughout their design.

THE ELEMENTS OF DESIGN CONTINUED...

Value
Value is independent of colour and refers to how light or dark something is. Again, we can use different values to contrast our objects and emphasize certain aspects of our images. A full range of light to dark values tends to be more visually pleasing than all light or all dark.

Notice how the WinS poster uses a variety of colours with darker values, like the purple, dark blue and black, as well as colours with lighter values like whites, yellows, teal, and tan.

Texture
Texture is how a shape/form appears to feel. It can be rough, smooth, fuzzy, hard, etc. We can imply texture based on the material we use to create our visuals. Take for example digitally created graphs which tend to feel “hard” whereas pencil sketches feel “softer”.

17

UNDERSTANDING YOUR VISUAL TOOLBOX: THE PRINCIPLES OF DESIGN

Now that we know the elements of design, next to understand are the principles of design. The elements can be thought of as the tools we have to use, and the principles can be thought of as how we use those tools. It is one thing to know you have a power drill at your disposal, but it is another to know when and how you should use it.

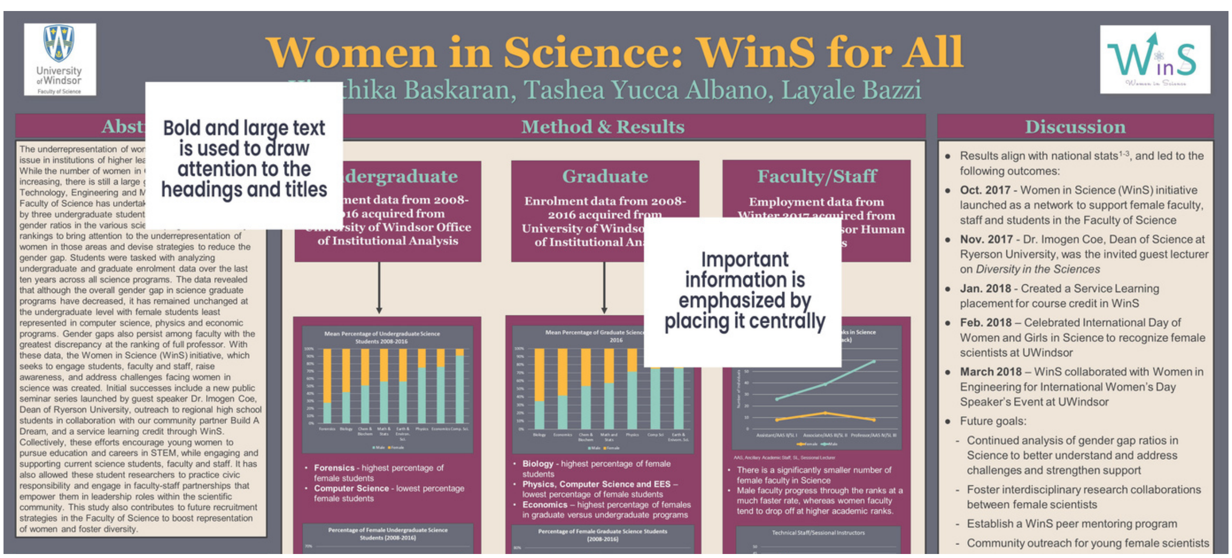
Six principles of design are as follows.

- **Emphasis**
- **Balance**
- **Contrast**
- **Repetition or Pattern**
- **Movement**
- **Harmony**

EMPHASIS

Emphasis is when we draw attention to a particular aspect of our work by visually reinforcing it. Maybe we want to emphasize a certain data point, or maybe we want to draw attention to a specific result. The area our eyes first look towards is called the focal point. By knowing how to create a focal point, we can draw the attention of our audience exactly where we want them to look. We can use elements like:

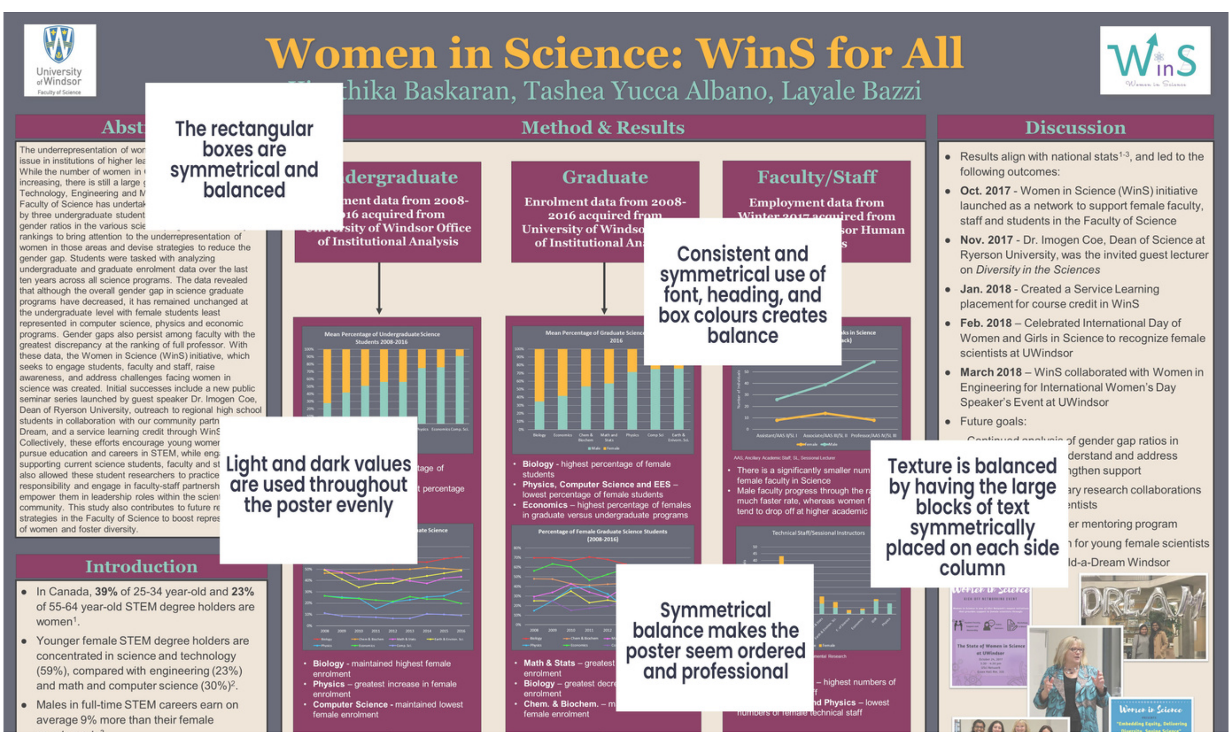
- **Variation** -- If we manipulate elements of an object like colour, texture, or value, to be different than the other objects, our audience will be drawn to the outlier.
- **Colour** -- Our eye will be drawn to the colour that most contrasts the majority of colours
- **Placement** -- Where can we place an object on our page so that it stands out?
- **Size** -- We can vary the size of an element to emphasize importance. The larger something is, the more important it is.



BALANCE

Balance is how we distribute the “visual weight” within our works. We can think of it as our piece having equilibrium within its composition. Balance can be asymmetrical, symmetrical, or radial, and each of these ways of balancing bring different meaning to your work. The main question to ask ourselves when determining if our work is balanced is “which parts of my piece stick out the most to me, and are those parts the elements I intend to emphasize?” Elements to consider when determining if your work is balanced include:

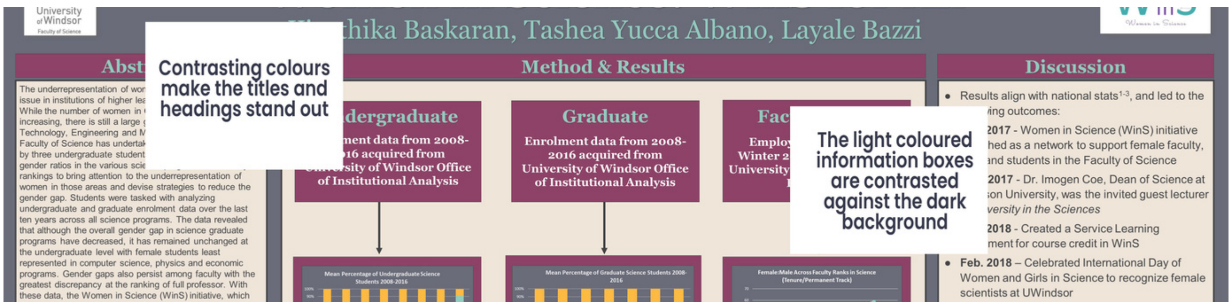
- **Object placement** – Am I distributing my objects evenly throughout my visual space?
- **Colours** – have I balanced the colours in my work to emphasize the parts I intend to?
- **Textures** -- Does one part of my image stand out more than others based on texture?
- **Values** -- Do I have a mix of light and dark throughout my piece, and have I used contrasting values to bring attention to the parts I want to?
- **Shapes** -- Do any particular shapes stand out?



CONTRAST

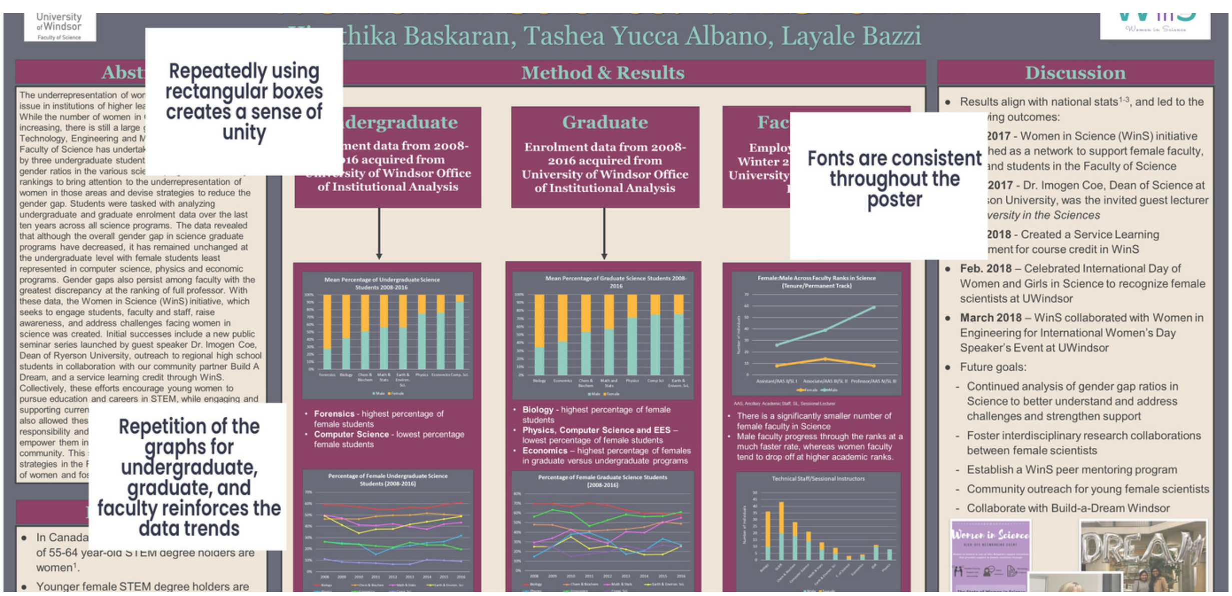
Contrast is the difference in quality between instances of art elements. We can contrast shapes, colours, value, size etc. The more two things contrast each other, the more they will stand out.

- High contrast makes pieces livelier and more vibrant.
- Lower contrast makes pieces seem calmer and more subtle.



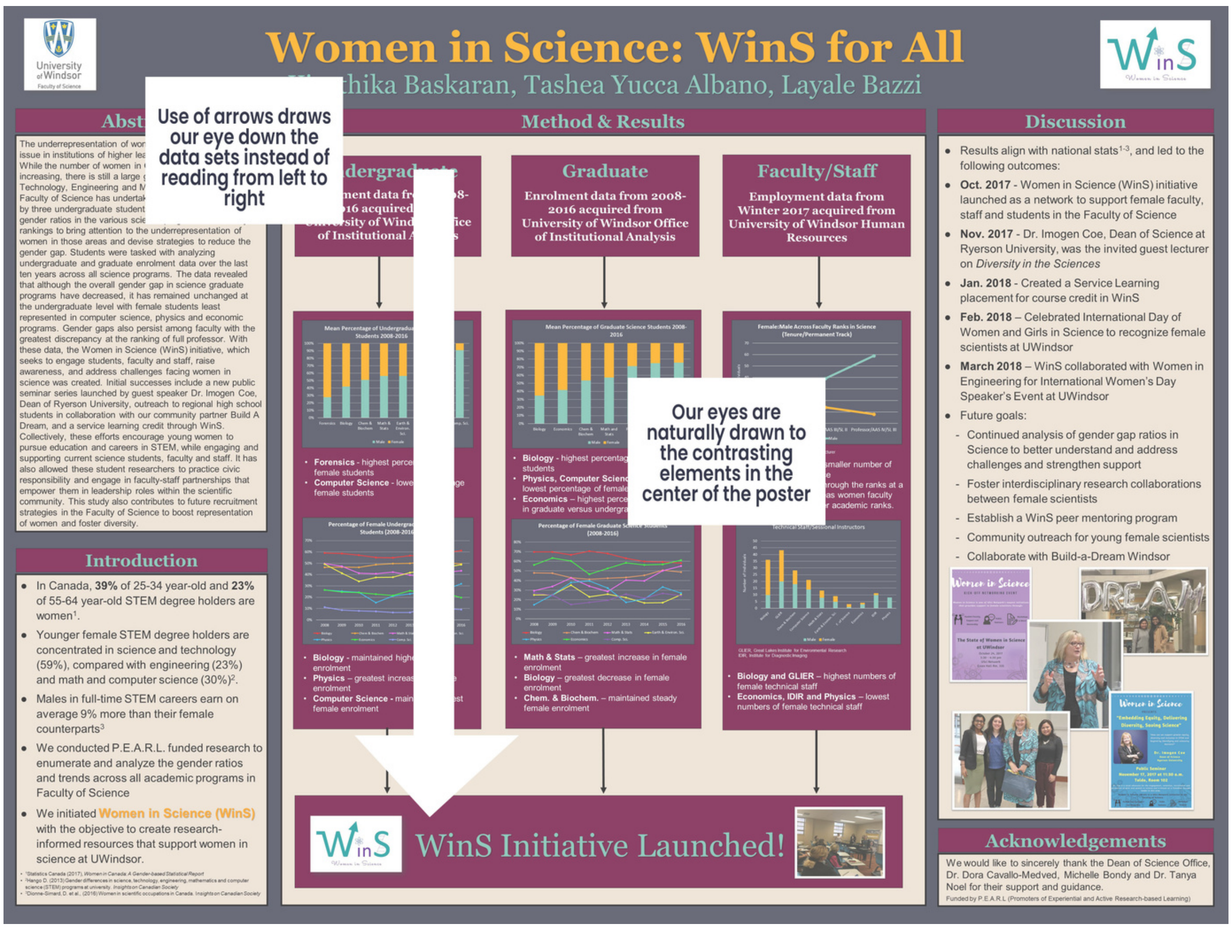
REPETITION OR PATTERN

We can use repetition to create harmony in our works. Using the same fonts, repeating the same shapes, and using consistent colours makes our poster cohesive and unites our elements.



MOVEMENT

Although our pieces are likely not moving, our audiences' eye must move throughout the piece to digest all the information. We can guide our audience through our pieces by incorporating certain design elements like lines – our eyes naturally want to follow a line, whether implied or explicit.



CONCLUDING REMARKS

No matter how you choose to display your science, the method you employ will be interpreted visually. It is important to not only consider how each of your elements look separately, but also how they function as a cohesive whole. Each aspect of your image, whether it be the fonts you choose, the types of images you include, or how you balance your image, will affect how your audience interprets your message. It is important to be fluent in scientific visual language to make intentional design choices using the elements and principles of design. Making appropriate, mindful decisions relevant to your specific audience will allow for more effective science communciation.

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Visit www.smartuwindsor.com for more information about effective visual science communication

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