

COURSE CODE:	<i>AGE 302</i>
COURSE TITLE:	<i>Design of Agricultural Machine Elements</i>
NUMBER OF UNITS:	<i>3 Units</i>
COURSE DURATION:	<i>Three hours per week</i>

COURSE DETAILS:

Course Coordinator:	Dr. Olayanju T.M. Adeniyi , B.Sc., M.Sc. Ph.D
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Other Lecturers:	None

COURSE CONTENT:

Philosophy of design. Components of design. Agricultural machines; types, design and functional requirements. Engineering materials. Stress and deflection analysis. Theories of failure. Design against failure. Detachable fasteners. Power screws.

COURSE REQUIREMENTS:

This is a compulsory course for all students in the University. In view of this, students are expected to participate in all the course activities and have minimum of 75% attendance to be able to write the final examination.

READING LIST:

1. A Textbook of Machine Design by R.S. Khurmi and J.K. Gupta. S Chand India. 2000
2. www.designnetwork.com

LECTURE NOTES

AGE 302: Design of Agricultural Machine Elements (3 Units)

1.0 Design

Design is the planning that lays the basis for the making of every object or system.

The [American Heritage Dictionary](#) defines design as: "To conceive or fashion in the mind; invent," and "To formulate a plan";

It can be used both as a [noun](#) and as a [verb](#) and, in a broader way, it means [applied arts](#) and [engineering](#)

As a verb, "to design" refers to the process of originating and [developing a plan](#) for a product, structure, system, or component with intention

As a noun, "a design" is used for either the final (solution) [plan](#) (e.g. proposal, drawing, model, description) or the result of implementing that plan in the form of the final product of a design process

This classification aside, in its broadest sense no other limitations exist and the final product can be anything from [clothing](#) to [graphical user interfaces](#) to [skyscrapers](#).

The person designing is called a [designer](#), which is also a term used for people who work professionally in one of the various design areas, usually also specifying which area is being dealt with (such as a *fashion designer*, *concept designer* or *web designer*).

Designing often requires a designer to consider the [aesthetic](#), [functional](#), and many other aspects of an object or a process, which usually requires considerable [research](#), [thought](#), [modeling](#), interactive [adjustment](#), and re-design. With such a broad definition, there is no [universal language](#) or [unifying institution](#) for designers of all disciplines.

Design as a process

Design, as a process, can take many forms depending on the object being designed and the individual or individuals participating.

Defining a design process

According to [video game developer Dino Dini](#)^{[6][7]}, design underpins every form of creation from objects such as chairs to the way we plan and execute our lives. For this reason it is useful to seek out some common structure that can be applied to any kind of design, whether this be for video games, consumer products or one's own personal life.

For such an important concept, the question "What is Design?" appears to yield answers with limited usefulness. Dino Dini states that the design process can be defined as "The management of constraints". He identifies two kinds of constraint, negotiable and non-negotiable. The first step in the design process is the identification, classification and selection of constraints. The process of design then proceeds from here by manipulating design variables so as to satisfy the non-negotiable constraints and optimizing those which are negotiable. It is possible for a set of non-negotiable constraints to be in conflict resulting in a design with no solution; in this case the non-negotiable constraints must be revised. For example, take the design of a chair. A chair must support a certain weight to be useful, and this is a non-negotiable constraint. The cost of producing the chair might be another. The choice of materials and the aesthetic qualities of the chair might be negotiable.

Dino Dini theorizes that poor designs occur as a result of mismanaged constraints, something he claims can be seen in the way the video game industry makes "Must be Fun" a negotiable constraint where he believes it should be non-negotiable.

It should be noted that "the management of constraints" may not include the whole of what is involved in "constraint management" as defined in the context of a broader [Theory of Constraints](#), depending on the scope of a design or a designer's position.



An [architect](#) at his [drawing board](#), 1893. The [Peter Arno](#) phrase "Well, back to the old drawing board" makes light of the fact that designs sometimes fail and redesign is necessary. The phrase has meaning beyond [structural designs](#) and is an idiom when a drawing board is not used in a design.

Redesign

Something that is redesigned requires a different process than something that is designed for the first time. A redesign often includes an evaluation of the existent design and the findings of the redesign needs are often the ones that drive the redesign process. Some authors nevertheless suggest that from the evolutionary point of view the functionality, and even the aesthetic sophistication of artifacts is best understood as a result of redesign rather than design, as all successful artifacts are outcomes of cumulative improvements.

Typical steps

A design process may include a series of steps followed by designers. Depending on the product or service, some of these stages may be irrelevant, ignored in real-world situations in order to save time, reduce cost, or because they may be redundant in the situation.

Typical stages of the design process include:

- Pre-production design
 - [Design brief](#) or [Parti](#) – an early often the beginning statement of design goals
 - [Analysis](#) – analysis of current design goals
 - [Research](#) – investigating similar design solutions in the field or related topics
 - [Specification](#) – specifying requirements of a design solution for a product ([product design specification](#)^[8]) or service.
 - [Problem solving](#) – [conceptualizing](#) and [documenting](#) design solutions
 - [Presentation](#) – presenting design solutions
- Design during production
 - [Development](#) – continuation and improvement of a designed solution
 - Testing – [in situ](#) testing a designed solution
- Post-production design feedback for future designs
 - [Implementation](#) – introducing the designed solution into the environment
 - [Evaluation](#) and [conclusion](#) – summary of process and results, including [constructive criticism](#) and suggestions for future improvements
- Redesign – any or all stages in the design process repeated (with corrections made) at any time before, during, or after production.

These stages are not universally accepted but do relate typical design process activities. For each activity there are many [best practices](#) for completing them. ^[9]

Philosophies and studies of design

Philosophy of design is the study of assumptions, foundations, and implications of [design](#). The field is defined by an interest in a set of problems, or an interest in central or foundational concerns in design. In addition to these central problems for design as a whole, many philosophers of design consider these problems as they apply to particular disciplines (e.g. [philosophy of art](#)). Although most practitioners are [philosophers](#), several prominent designers and artists have contributed to the field.

There are countless philosophies for guiding design as the design values and its accompanying aspects within modern design vary, both between different schools of thought and among practicing designers. ^[10] Design philosophies are usually for determining design goals. A design goal may range from solving the least significant individual problem of the smallest element, to the most [holistic](#) influential [utopian](#) goals. Design goals are usually for guiding design. However, conflicts over immediate and minor goals may lead to questioning the purpose of design, perhaps to set better long term or ultimate goals.

Philosophies for guiding design

A design philosophy is a guide to help make choices when designing such as [ergonomics](#), costs, economics, functionality and methods of re-design. An example of a design philosophy is “dynamic change” to achieve the elegant or stylish look you need.

Approaches to design

A design approach is a general philosophy that may or may not include a guide for specific methods. Some are to guide the overall goal of the design. Other approaches are to guide the tendencies of the designer. A combination of approaches may be used if they don't conflict.

Some popular approaches include:

- [KISS principle](#), (Keep it Simple Stupid, etc.), which strives to eliminate unnecessary complications.
- [There is more than one way to do it](#) (TIMTOWTDI), a philosophy to allow multiple methods of doing the same thing.
- [Use-centered design](#), which focuses on the goals and tasks associated with the use of the artifact, rather than focusing on the end user.
- [User-centered design](#), which focuses on the needs, wants, and limitations of the end user of the designed artifact.

[Design methods](#)

Design Methods is a broad area that focuses on:

- [Exploring](#) possibilities and constraints by focusing critical thinking skills to research and define problem spaces for existing [products](#) or [services](#)—or the creation of new categories; (*see also [Brainstorming](#)*)
- [Redefining](#) the specifications of design solutions which can lead to better guidelines for traditional design activities (graphic, industrial, architectural, etc.);
- [Managing](#) the process of exploring, defining, creating artifacts continually over time
- [Prototyping](#) possible scenarios, or solutions that incrementally or significantly improve the inherited situation
- Trendspotting; understanding the trend process.

Philosophies for the purpose of designs

In [philosophy](#), the abstract noun "design" refers to a pattern with a [purpose](#). Design is thus contrasted with purposelessness, [randomness](#), or lack of [complexity](#).

To study the purpose of designs, beyond individual goals (e.g. [marketing](#), [technology](#), [education](#), [entertainment](#), [hobbies](#)), is to question the controversial politics, [morals](#), [ethics](#) and [needs](#) such as [Maslow's hierarchy of needs](#). "Purpose" may also lead to [existential](#) questions such as [religious](#)

[morals](#) and [teleology](#). These philosophies for the "purpose of" designs are in contrast to philosophies for guiding design or methodology.

Often a designer (especially in commercial situations) is not in a position to define purpose. Whether a designer is, is not, or should be concerned with purpose or intended use beyond what they are expressly hired to influence, is debatable, depending on the situation. In society, not understanding or disinterest in the wider role of design might also be attributed to the commissioning agent or client, rather than the designer.

In [structuration theory](#), achieving consensus and fulfillment of purpose is as continuous as [society](#). Raised levels of achievement often lead to raised expectations. Design is both medium and outcome, generating a [Janus](#)-like face, with every ending marking a new beginning.

Terminology

The word "design" is often considered ambiguous depending on the application.

Design and engineering

[Engineering](#) is often viewed as a more rigorous form of design. Contrary views suggest that design is a component of engineering aside from production and other operations which utilize engineering. A neutral view may suggest that design and engineering simply overlap, depending on the discipline of design. The [American Heritage Dictionary](#) defines design as: "*To conceive or fashion in the mind; invent,*" and "*To formulate a plan*", and defines engineering as: "*The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.*".^{[12][13]} Both are forms of problem-solving with a defined distinction being the application of "scientific and mathematical principles". How much science is applied in a design is a question of what is considered "[science](#)". Along with the question of what is considered science, there is [social science](#) versus [natural science](#).

Process design

"Process design" (in contrast to "design process" mentioned [above](#)) refers to the planning of routine steps of a process aside from the expected result. Processes (in general) are treated as a product of design, not the method of design. The term originated with the industrial [designing of chemical processes](#). With the increasing complexities of the [information age](#), consultants and executives have found the term useful to describe the [design of business processes](#) as well as [manufacturing processes](#).

The 7 Components Of Design

[Unity In Design: Creating Harmony Between Design Elements](#) »

Before solving complex design problems you need to understand the basic components of design at your disposal. Much as a musician seeks to understand pitch and rhythm, melody and tempo, a designer should seek a greater understanding and control over:

- [Unity](#)
- [Gestalt](#)
- [Space](#)
- [Dominance](#)
- [Hierarchy](#)
- [Balance](#)
- [Color Part I: Color Theory](#)
- [Color Part II: How to Use Color](#)

Through learning these 7 components of design, the whole of your designs will become more than the sum of their elements and you'll be better able to [communicate your ideas](#).

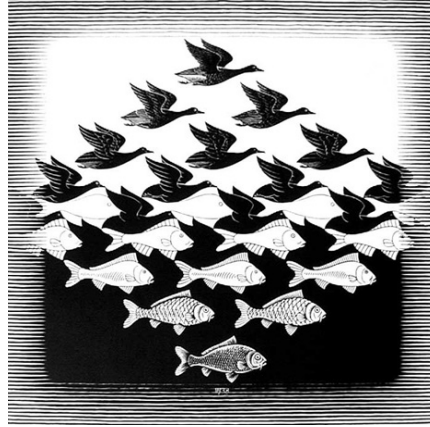
1.2.1 Unity

[Unity exists when your design elements are in agreement](#); when they belong together and aren't arbitrarily placed or added to the design. Agreement can be either visual, conceptual or both.

The 4 basic design principles of [contrast](#), [repetition](#), [alignment](#), and [proximity](#) can be used to gain visual unity over your design. Elements that are aligned, repeat some basic characteristic like size, or are located in proximity to each other will appear to belong together. The last principle, contrast, is used to add variety.

Unity imparts order, but too much order can be dull and static. Variety adds interest, but too much can lead to a chaotic design. The key is to find a balance between unity and variety so as to have a well ordered design that is also visually interesting.

Elements can be conceptually unified by being about the same subject. An image of a steering wheel, a fuel pump, and a glove compartment are all unified around the concept of a car.



1.2.2 Gestalt

Gestalt is a German word for form and shape and here refers to the human mind's ability to visually organize forms and shapes into a unified whole. When first looking at a design we see the whole instead of the parts. When someone says "this design works" it's because gestalt is at play.

By controlling design elements and how each element affects those around it you affect the cumulative perception of the viewer. A small change in one element affects how the other elements in your design are perceived. This cumulative perception is gestalt.

We can manipulate gestalt through the same 4 basic principles mentioned above as well as through:

- **figure/ground** – the relationship of a subject to its surrounding space
- **closure** – the viewer's tendency to complete unfinished forms
- **continuation** – the arrangement of elements to lead the eye across the page and create flow in your design

Gestalt helps communicate your message through the cumulative perception of all your design elements.

Andy Rutledge has written a great series of posts on Gestalt principles which I encourage you to read

- [Figure Ground Relationships](#)
- [Similarity](#)
- [Proximity, Uniform Connectedness, and Good Continuation](#)
- [Common Fate](#)
- [Closure](#)

1.2.3Space

[Whitespace](#) or negative space is the space between design elements. It's just as, if not more, important than the space you fill and is one of the most neglected components of visual design.

Day only exists in comparison to night and in much the same way your positive space (where design elements are located) only exist in comparison to the empty space around them. Without whitespace, designs become crowded and chaotic. There's no flow of movement from one element to the next.

Space is the context in which your message is perceived. Without ample space communication is difficult. Imagine a piece of music where every note in the piece was played by every instrument at the same time. The result would be noise and not music. Music needs space (time) between notes in order to build rhythm and melody. Visual design needs space between elements in order to effectively communicate.

1.2.4 Dominance

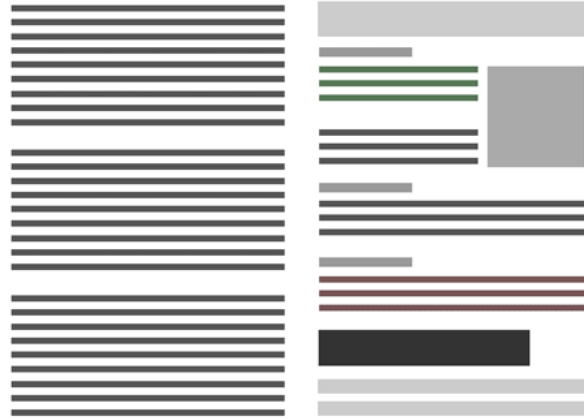
Dominance is contrast taken to the extreme. By creating one element to dominate other elements on the page, you create an area of interest and a focal point to your design. Dominance gives viewers a way into your design. It lets them know right away where to look and from there you can [guide them through the rest of your design](#).

Without dominance your visitors have to think about where to look first. Don't make me think. Make it clear where I'm to look first. Give me an easy way to enter your design and begin to look about.

You can create dominance through manipulation of:

- size
- position
- color
- style
- shape

You can have more than one area of interest in your design, though one should be dominant. One should be the primary area of interest and be dominant over everything else.



1.2.5 Hierarchy

While one element should be dominant you can create a hierarchy of dominance in order to guide people through your design. By creating a [visual hierarchy in your design](#), you enable your page to be scanned and communicate the relative importance of different parts of the whole.

Which of the two layouts above is easier to read? The one without a clear hierarchy on the left or the one with a hierarchy on the right?

Once again the [basic design principles](#) help us create a hierarchy and help us move the eye from most important to least important elements. Contrast to make clear what's most important and repetition, alignment, and proximity to lead the viewer across a single level of hierarchy and into the next.

Try not to create too many levels of hierarchy. It's easy to discern most and least, but what's in between tends not to be so easy to distinctly separate. Aim for 3 levels of hierarchy if you can, most important, least important, and everything else.

1.2.6 Balance

Balance is a state of equalized tension. It's important for achieving gestalt. A [balanced design](#) is a more unified design.

Designer's use visual weight to control design balance. Through the use of things like size, color, space, and density your design elements can visually balance each other to create a pleasing whole.

There are 4 types of balance, 2 of which are more important.

- Symmetrical – formal or static balance
- Asymmetrical – dynamic balance

- Radial – elements radiating from a central point
- Mosaic – balanced chaos lacking hierarchy and focal point

Symmetrical and asymmetrical balance are the two more important types of balance, with asymmetrical balance being the more interesting of the two. Kandinsky's Composition #8 below is a good example of asymmetrical balance and dominance.



The dark circle in the upper right is the dominant element that pulls you into the piece. Notice how there is no equally dominant object on the right side to balance it, but rather a combination of elements is used to balance the painting.

In a balanced design the whole is more than the sum of its parts. When a design is unbalanced some of the parts become more visible which leads to competing messages instead of a single unified message.

1.2.7 Color

Color aids organization through contrast and repetition. A good use of color in your design will help visitor comprehension of your overall message. Color provides direction as it relates elements to each other.

Random color choices negatively affect your message. A color scheme affects your message positively by helping achieve unity. You should plan for color early when creating a new design or your colors will end up being cosmetic and somewhat random.

[Color theory](#) defines [classic color schemes](#) as:

- Monochromatic – different shades and tints of a single color
- Analogous – colors adjacent on the color wheel
- Complementary – colors at opposite ends of the color wheel
- Split complementary – a main color and 2 additional colors next to the complementary of the main color

- Triadic – 3 colors equally spaced around the color wheel
- Tetradic – 2 complimentary color pairs

Color evokes emotions. Psychology and cultural differences influence the way people react to and interpret color.

Darker colors are seen before lighter colors. Warmer colors move elements forward while cooler colors make elements recede into the background.

[Seven Design Components](#)

View more [documents](#) from [Lori Shyba](#).

Summary

Whether you're consciously aware of them or not, each of the above components will be present in your design.

You can choose how much or how little of any to include, but they will all be there to some degree no matter. Not being aware of them during design will lead to them being included haphazardly which might have negative consequences on your overall design.

As I mentioned at the start I've written more in depth about some of these 7 components in the past and over the next few weeks I'll add more detailed posts about those I've yet to cover. This post is meant to serve as an introduction to each of those detailed posts, both written and yet to be written.