STUDY MATERIAL

DESIGN (CODE-830)

CLASS -XII

SESSION: 2019-20

PART-B

UNIT – 1

SESSION: DESIGN THINKING

Slide 2 - Link 1

What is Design?

A common misconception is that design is merely making things pretty. It's true, there is an element of design that is purely aesthetics, but it's not inclusive of everything that design is. Here is a non-exhaustive list of some of the things that design is:

Design is all around us.
It impacts the way objects and environments function. It is something that is executed by everyone, including you, even if you've never considered yourself a designer. You make design decisions all the time, at school or work and in your personal life.

Every choice you make to solve problems is a design decision. The way you get ready, by brushing your hair, then having a coffee, and finally brushing your teeth, is a design decision—an intentional choice to design your morning in a particular way.

This might have developed out of the way toothpaste was making your coffee taste and the coffee staining your teeth. You solved these problems at some point by ordering your routine so that coffee came before teeth brushing.

Design is problem-solving.
Signage added to a door to indicate if it's opened via push or pull is fundamentally helpful, right? A better design would be to make the door's direction intuitive; having a handle on the pull side and a flat area to push against on the other, with or without labels. But design isn't just the visual indication of which way the door swings.

Deciding that the door opens when pushed from the inside, in case of an emergency, is a design decision and is probably the most critical consideration. It's not just the obviousness of which way the door swings, but the consideration as to the best direction for the door to open.

If you're a door designer, for example, the problem you are solving for would be: we need to make doors safer. The solution of allowing a door to be pushed open from the inside, especially during an emergency, does solve that problem; and doing it with an intuitive, beautiful push plate on the inside of the door makes it an elegant solution to the problem.

Design is an act of listening, empathizing, and acting on that information.
Hearing our customers and their needs is a way that we can best ensure that our designs are solving the right problems. The solutions we're creating are addressing the needs of real people—solving problems that they might otherwise be frustrated by.

The best way for anyone in the design discipline to create a product or service that actually addresses a person's needs is by listening and understanding their problems in the first place.

Many products are built without listening to or consulting consumers, which usually ends badly. Intercom, a company that offers customer support tools, said this best:

If you were a chef wondering if customers are enjoying your new soup recipe, how would you find out? It's not rocket science.

In an ideal world, it's best to ask people who either use your solution or would consider using it what they think both before and after presenting them with your idea. This way, you can get feedback for consideration while you're still working on it—before it's too late to implement.

Design is storytelling

A good story has a distinct beginning, middle, and end; a mapped out journey for a viewer to explore and spend time encountering on their own. When reading a book or watching a movie you progress through the story in an order that hopefully makes sense, and experience it as it unfolds.

As your customer progresses through your app, website, infographic, three-dimensional world, etc. they are experiencing your story. This is what User Experience, or UX, design is; and is a part of the tools you have available to help people understand what problem you're solving, as well as how to interact with your creation.

How someone moves through a physical space is similar to this: they are presented with visual information, and from that, they are choosing how to proceed next. You could encourage someone to move through a building with navigational signs, or more subtle elements, like architecture that draws them in on their own.

Your customer may have an adverse experience and leave if they get confused (closing your app) or a negative experience that has them running out the door if something scares them (deleting your app from their device).

People use digital products in unexpected ways, so it's important to best guide them in the ways that we've built them to be used. By actively guiding our customers, we're able to help them have a great experience and ultimately get the most out of our products.

Writing is core part of the design process that should be taken into consideration. Spelling mistakes are as much an error of the designer as they could be for a copywriter or other content creator. Since design is not just how your creation looks, but how accessible it is to your audience, the clearness of the words on the page matter as much as your font choices. More on creating access and being inclusive in the Inclusion lesson.

You may be asking: why am I being told that design is about writing and storytelling? Consider the impact of a sentence with spelling mistakes in an app about healthcare offerings or on your bank's website. It's vital that people trust both of those services and a poorly written sentence, or worse, a poor experience using the product has real-world, adverse effects on how you feel about both the brand and its products.

Another consideration to keep in mind is that new design technologies and trends are always appearing. Understanding and leveraging a fundamental like storytelling will better prepare you for new types of designing, such as the latest trends in chatbots and augmented reality.

Design is function, then form

It's not just making stuff pretty—that is often a consequence of functioning well and offering a great experience for your customers/audience.

Steve Jobs said,

Most people make the mistake of thinking design is what it looks like, people think it's this veneer—that the designers are handed this box and told, 'Make it look good!' That's not what we think design is. It's not just what it looks like and feels like. Design is how it works.

To go back to our push/pull door example, a clear indicator of how to use a door can be beautiful while being functional, be it an ornate handle or art deco typography.

The use of well-crafted beauty can help accomplish your goals of indicating the direction a door opens, and also becomes aesthetically pleasing, adding to the overall interior design or architectural narrative of a space.

Creating the best solution for your customers' problems often results in a product that is pleasant and enjoyable to use.

Design is aesthetics

I know, I just said it's all about function.

But, there are lots of positive consequences of solving a problem, telling a story, and making something that functions well: it often turns out being simple and easy to use. There is always still an opportunity here to visually polish it further. These are the extra steps it takes to win over your competition and to grow your product in the long run sustainably. If all bank accounts theoretically hold your money, then how are they different? Easier to use, and dare I say fun?

There is also a phenomenon known as the Aesthetic-Usability Effect, which is a perception that people believe a more aesthetically pleasing product is easier to use than a less-aesthetic design—even if it's not easier to use. This is similar to attractiveness bias, which is often referenced when discussing the United States presidential election of John F. Kennedy v. Richard Nixon.

Every design begins with the same essential elements—points, lines, and shapes. Similarly, even the most complex designs can be reduced to these vital pieces. We believe that great design is one where these pieces are used efficiently together.

For instance, in the early days of designing Figma, we often talked about what tools you need to create modern designs for screens. We realized that the toolset does not have to be large if the tools are carefully selected and work together well. With a small set of functions (like the Vector Network tool or a Frame), designers can create a lot of different things to form sophisticated means of expression.

The same is true for communications design. You can create much of our designed world by using a small set of elemental shapes to build things of high complexity. Although the use of primary shapes and colors was famously promoted at the Bauhaus school as fundamental to design, these forms have been part of the language of design for hundreds of years.

The famous New York Subway Map and signage is an excellent example of this in action. Before its total design overhaul in the 1960s, the New York Subway system was an exercise in confusion with hundreds of signs inconsistently designed even within a single station.

It wasn’t until 1965 when graphic designers Massimo Vignelli and Bob Noorda took on the job of building the subway a visual identity with usability at its core, that it became much easier to navigate the system—thanks to well-considered signage and iconography. The pair focused on building a system that solved a problem, consistently, and was aesthetically pleasing at the same time.

The result is the same design system you may know today. The designers created a 182-page manual for the New York City Transit Authority that outlines all the ways the design should and should not be used—and it remains one of the most iconic bodies of work in the world.

Designs often have a visual element or existence, and the visual embodiment of a design is, ideally, pleasant to look at and experience. Often, if you set out to design your product in a way that is holistically focused on ease of use, aesthetics will follow.

Design is asking questions

As a designer, you must ask “Why?” Maybe not as much as an inquisitive four-year-old, but close.

Who are we designing for? What are the problems that they face? How can we go about solving those problems? Why might our solution not work? What can we do about that? Why was a decision made by our team or company?

There are lots of questions to be asked before, during, and after a product is created or redesigned. Question your coworkers and your customers.

Stay curious.

Design is practicing

Being a designer entails spending time building your experience level. You are not going to be great on day one. That's okay! It's important to keep doing it, you will get better. Ira Glass, talks about the creative gap between knowing something looks good, but not being able to create it. This is a valuable step in your journey to become a great designer. Understanding what works, what looks good to you, and building toward it. Ira Glass's advice for beginner creatives:

...we get into it because we have good taste. But it's like there is a gap. That for the first couple years that you're making stuff, what you're making isn't so good. Okay? It's not that great. It's trying to be good, it has potential, but it's not quite that good. But your taste, the thing that got you into the game, your taste is still killer. And your taste is good enough that you can tell that what you're making is kind of a disappoint to you. You know what I mean?

A lot of people never get past that phase, a lot of people at that point, they quit. And the thing I would just like say to you with all my heart is that most everybody I know who does interesting creative work, they went through a phase of years where they had really good taste, they could tell what they were making wasn't as good as they wanted it to be. They knew it fell short. It didn't have this special thing that we wanted it to have.

And the thing I would say to you is, everybody goes through that. If you go through it, if you're going through it right now, if you're just getting out of that phase; you gotta know it's totally normal and the most important possible thing you could do is do a lot of work.

Perseverance and discipline will make you an expert. Keep building your skills — and your portfolio — by solving problems for people through design.

Summary

As you might have realized by now, design is not easy to define. It is the culmination of a number of disciplines that come together to create something for people to use, and often overlaps into other areas like writing, or even development, along the way.

Much like art, many things could be considered design to the point where it is somewhat subjective. While something could be considered art when it is challenging for a viewer to comprehend, a design would be regarded as unsuccessful.

Everyone is a designer, and you can make high-impact design decisions without realizing you're a designer. When you understand the impact of decisions not traditionally considered to be 'design' it's easy to see why:

When an engineer takes a shortcut and scrimps on performance, they need to understand how that damages the user experience. Likewise, when a designer pushes an engineer to make a change that affects performance, that engineer should help the designer make the best overall design decision—not just roll over and do what the designer asked. It's this type of respectful collaboration that makes great design happen.

Daniel Burka

Source: **https://www.figma.com/resources/learn-design/what-is-design/**

Unit – 1 – Slide 2 - Link 2

What is Design?

Design is all around you

What is your objective when starting a new product, business, or project?

What is your objective when starting a new product, business, or project? In fact, a design refers to the plan for achieving that objective. Color, shape, technology, and function each are means of realizing this objective. It is because people always play a central role in design that it has the power to bring progress to society. We consider good designs to be things that truly enrich people's lives or have the potential to do so.

Changing definitions of design

The meanings of words change gradually with the times. The word "design" is no exception. It's said that the word first came into widespread use at the start of the 20th century. Over roughly 100 years since then, the meaning of the word has changed gradually. Another characteristic of the word "design" is the fact that it has different meanings to different people.

For these reasons, the Japan Institute of Design Promotion (JDP), an organization intended to promote design in general and the organizer of the Good Design Award, felt the need to issue guidelines concerning our thinking about design. Accordingly, a brief description of our thinking about design is provided below.

Our thinking about design

It's said that the word "design" comes from the Latin word designare. Designare is said to have meant to draw a plan. For this reason, it is thought that the word design initially was used in this sense of a plan on paper. In fact, the characters used to write the word for design in Chinese have this meaning.

In light of this historical background, one might think that anything planned on paper could be called design, but this would seem to leave out the most important subject of what is the essence, or the central feature, of contemporary design.

Just what is central to design? After years of working with design, it appeared to us that the answer was "people." While we may refer to them as "users" or by the lofty term "society," people always are a central concern when a designer plans something new. The designer asks him or herself the questions "What do people need? What should I design for them?" We consider this to be the core that is of utmost importance to the contemporary definition of design.

We consider design to consist of the series of processes of thinking constantly about people most of all, identifying objectives, and planning ways to achieve them. We believe that what is realized as a result of this process is one design solution.

Design of products and services

One topic that is brought up often these days about design concerns the design of products and services. Since we think of design as we defined it above, the Good Design Award accepts entries for both products and services. But sometimes we are asked if mixing the two does not lead to confusion. We'd like to take this opportunity to spell out our guidelines on this subject.

Products and services often are discussed in binary opposition to each other. This is true not only in design but in other areas as well. This reflects the binary opposition between tangibles and intangibles. But we believe that when talking about design it might be better to think of products and services in a slightly different way. In the case of design, we think that the difference between products and services is a difference of focus. A product is a means of achieving a service, and a service is an objective. We believe that this is the difference between products and services. For example, the Sony Walkman was a big hit around the world at one time. Viewed as a product, the Walkman was a portable music player, but beyond that one could discern the objective of being able to listen to music while walking around. That was the service. Providing the portable music player made it possible to achieve this service. This is how products and services are related.

So what do you think the designers designed in this case? We believe that they designed both a product and a service. Or more accurately, we could interpret this as a case of using a product as a means of designing a service. When considering this example in screening of the Good Design Award, we would look first at the appropriateness of the service and then at the appropriateness of the product in light of that service. In other words, we believe that instead of separating products and services in design we should continue to look constantly at both, without regard for their tangible or intangible status, because the product itself is a means to an end.

The difference between design and engineering

When discussing design, one topic that comes up often is the difference between design and engineering. Although this is a difficult question, we would like to state some simple guidelines here. The question often comes up of whether NANOPASS 33, a hypodermic needle for insulin injection that won the Good Design Grand Award in 2005, is an example of design or engineering. Often it is said that since this product can be described briefly as a pain-free hypodermic needle it should not be considered a case of design. However, the ultimate goal beyond the pain-free concept is the user. That is, the criteria for evaluation of a design are based on the user’s point of view. Even development of an extremely thin hypodermic needle would not have achieved this goal if it still felt painful to the user, so that the topic that must be kept in mind at all times in developing such a product is what kind of form to use to eliminate pain. In other words, it can be described as a design in light of our definition of the term because the ultimate objective is the user. An example of the opposite case in which a work could not be said to be a design would be a computer CPU intended to deliver 1.25 times the processing speed of a previous model. Since its goal is merely to increase speed by 1.25 times, it does not qualify as design. While of course many users would benefit from the increased speed, as long as the sole objective is to increase speed it can be interpreted as not qualifying as a design.

But this does not mean that any work for which the user is the ultimate objective is not a work of engineering. Such cases may be interpreted as being cases of both design and engineering. One point becomes clear when thinking about the topic from this point of view. It is that since the demarcation between what is and is not design is found in the purpose, or process, it is not possible to determine whether or not something is a design by looking at the finished product alone. Put another way, what the creators had in mind can be considered essential in judging whether an object qualifies as design. In the process of screening for the Good Design Award, applicants are asked to prepare numerous documents on subjects such as their intents and objectives. They also take part in screening interviews in which judges speak with them directly. This is because in screening a design it is essential to understand its goals and the process of how these goals were thought about and realized.

Source: https://www.jidp.or.jp/en/about/firsttime/whatsdesign

Slide 2 - Link 3

What is Design?

Design involves finding solutions that fit the user, task, and context of use. Properly designed objects -- including software, tools, and web sites -- fit their context so well that they are easy to use and beneficial to the user.

Design is:

A discipline that explores the dialogue between products, people, and contexts.

A process that defines a solution to help people achieve their goals.

An artifact produced as the result of solution definition.

Design as a Discipline

Design is a discipline with a long history and many branches or areas of specialty. The usability profession is primarily concerned with Interaction Design (IxD), a newer branch of design dedicated to defining the behavior of digital products and systems. More traditional branches of design include Industrial Design (ID), which focuses on optimizing the function, value and appearance of physical objects, and Graphic Design (GD), which has strong roots in graphic arts and print media, and focuses on bringing together the meaning and appearance of a product. All branches of design involve innovating a new "form" or object that fits well into the context in which it will be used (Alexander, 1970).

Design as a Process

There are established processes for interaction design in the context of a User-Centered Design (UCD) methodology. Designers must balance a variety of considerations, including the needs and goals of the users, the constraints imposed by the context of use, and the challenges that arise naturally from the interaction between humans and machines; to come up with solutions. Commonly used design methods include paper prototyping and cognitive walkthroughs. The design process is "iterative" meaning that proposed solutions are refined through repeated cycles of prototype evaluation.

Design can occur on several different levels, which build on one another (Garrett, 2002). At a minimum, we can distinguish:

Conceptual design is a basic foundation that defines the structure of the solution, including the functional elements of the product, their relationships and the system behavior. Conceptual design is the vital stage of the product creation that defines the success or failure of the product usability.

Physical design is a more refined level that defines the aesthetics of the solution. This includes, for example language (and, to some extent, content) and branding. In contrast with conceptual design, physical design defines the success or failure of the product appeal.

Design as an Artifact

The design process results in producing design artifacts that feed the consequent stages of product development. Design artifacts include various system models, design specifications, style guides, and prototypes, including low-fidelity prototypes, such as sketches and wireframes, and high-fidelity prototypes, such as mockups and system demos.

Achieving Usability Through Interaction Design

Good, usable products never happen by chance. Rather, they are achieved through design that is based on an understanding of the natural physical, psychological, and emotional characteristics of human beings, their tasks and work environment; the constraints of the technology; and creating an interactive experience that best "fits" the context and enables the human users to be successful.

Well-designed products are easier to use (and/or learn to use) and are more beneficial to the user than poorly designed ones. Good design can increase productivity, satisfaction, and user acceptance. Good design can also focus limited resources towards building products which satisfy the goals of the user and away from products and features which do not (Cooper, 1999). Finally, design can impact commercial success: a usable design can be a decisive factor in a competitive marketplace.

Source: **https://www.usabilitybok.org/what-is-design**

Slide 2 - Link 4 (NPTEL Course)

What is Design?

Module 1 : What is Design

Lecture 1 : Design Definition

Greek Ceramics (plate 1A), ancient kitchenware from India (plate 1B), Japanese Tea Ceremony (plate 1C) and Java Puppet (plate 1D) all exhibit wide range of design applications from ancient period. Above products, display manifestations of their culture, heritage, and ethos to reflect their sentiment. In each case product expresses especial purpose and sentimental association. Design is common in each case however in each product design is representing very especial meaning for a very special community.

Therefore, understanding the meaning of design is the most relevant issue before we discuss anything.

Design is an art, which we can see, experience and interact with. Design implies a type of creativity that has purpose and executed in a systematic, innovative, and analytical manner to a solve problem.

Design process works on the basis of predetermined needs to help in planning solution through physical display and functioning. Design reflects socio-political-cultural issues of the society. Design changes according to the taste of people. It is never dead. It keeps on growing and changing like organic substance depending on the social need and aspirations. It survives by changing and accommodating various other surrounding factors. Design reflects the energy, prosperity, aspiration, innovations and living conditions of people. Manifestations of design are the mirror of the society. There is a saying, 'the chaotic road condition reflects the nature of a society.' The archeological finds from

Indus Valley Civilization reflects the prosperity, growth and the life-style of the people of their time. The advanced technology, creativity and innovations of IDV Civilization amaze historians and archeologists even today. Every little or large items of IDV Civilization illustrates the taste, desire and rich heritage of their society. The 'usability' of design reflects the desire and the functioning of the social fabrics.

Design has the inbuilt aesthetic quality that surrounds us all the time. It reflects the principal, broadest, and most advanced form of human non-artistic activity that conforms to the laws of beauty. It embraces the preparation, production and existence of things manufactured by industry to meet the requirements of utility, convenience and beauty.

"Design is creative work whose goal is to determine the formal properties of manufactured goods, including both their external characteristics and most important, the functional and structural interrelations which turn the article into a single whole both from the point of view of producer and customer.

The design is the world of objects created by man by means of industrial technology which meet the demands of the beautiful and the functional."

_ International Seminar on Design, Belgium 1964

Design Definition

Design reflects discipline, ethics, and taste of a community and nation. Design activity can be one of the most important indicators of the social growth and economy. Design combines usefulness and meaning in the form of practical objects that can also reflect user's identities and aspirations through forms and patterns. Some of the workable and acceptable definition of the term 'design'- ● Design is the quest for simplicity and order;

● Design is the process of inventing artifacts that display a new physical order, organization, and form in response to function;

● Design is a statement of order and organization. Its goal is the quest for order among various segments or parts;

● Design is a conscious and intuitive effort directed toward the ordering of the functional, material, and visual requirements of a problem;

● Design implies intention, meaning, and purpose;

● The planning and patterning of any act toward a desired, foreseeable end constitutes the design process;

● Design is creative problem solving.

"***Design is the creative work whose goal is to determine the formal properties of manufactured goods, including both their external characteristics, and most important, the functional and structural interactions which turns the article into a single whole both from the point of view of producer and consumer. Design is the world of the objects created by the man by means of Industrial technology which meets the demands of the beautiful and the laws of functional***."

__ Industrial Seminar of Design, Belgium 1964

Source: https://nptel.ac.in/courses/107/104/107104078/

Unit – 1 – Slide 30 - Link 1

What Is Design Thinking? A Comprehensive Beginner's Guide

BY EMILY STEVENS, UPDATED ON MAY 16TH, 2019Length: 22 Minutes

Design Thinking is both an ideology and a process, concerned with solving complex problems in a highly user-centric way. In this guide, we'll give you a detailed definition of Design Thinking, illustrate exactly what the process involves, and underline why it matters: What is the value of Design Thinking and in what contexts is it particularly useful? We'll also analyze the relationship between User Experience Design and Design Thinking and discuss two real-world case studies that show Design Thinking in action. All sound a little overwhelming? Don't worry–we've broken the guide down into digestible chunks.

1. What is Design Thinking?

Design Thinking is an approach used for practical and creative problem-solving. It is based heavily on the methods and processes that designers use (hence the name), but it has actually evolved from a range of different fields — including architecture, engineering and business. Design Thinking can also be applied to any field; it doesn't necessarily have to be design-specific.

Design Thinking is extremely user-centric. It focuses on humans first and foremost, seeking to understand people's needs and come up with effective solutions to meet those needs. It is what we call a solution-based approach to problem-solving.

What does this actually mean? Let's take a look.

What's the difference between Solution-Based and Problem-Based Thinking?

As the name suggests, solution-based thinking focuses on finding solutions; coming up with something constructive to effectively tackle a certain problem. This is the opposite of problem-based thinking, which tends to fixate on obstacles and limitations.

A good example of these two approaches in action is an empirical study carried out by Bryan Lawson, a Professor of Architecture at the University of Sheffield. Lawson wanted to investigate how a group of designers and a group of scientists would approach a particular problem. He set each group the task of creating one-layer structures from a set of coloured blocks. The perimeter of the structure had to use either as many red bricks or as many blue bricks as possible (we can think of this is as the solution, the desired outcome), but there were unspecified rules regarding the placement and relationship of some of the blocks (the problem or limitation).

Lawson published his findings in his book *How Designers Think*, in which he observed that the scientists focused on identifying the problem (problem-based thinking) whilst the designers prioritized the need to find the right solution:

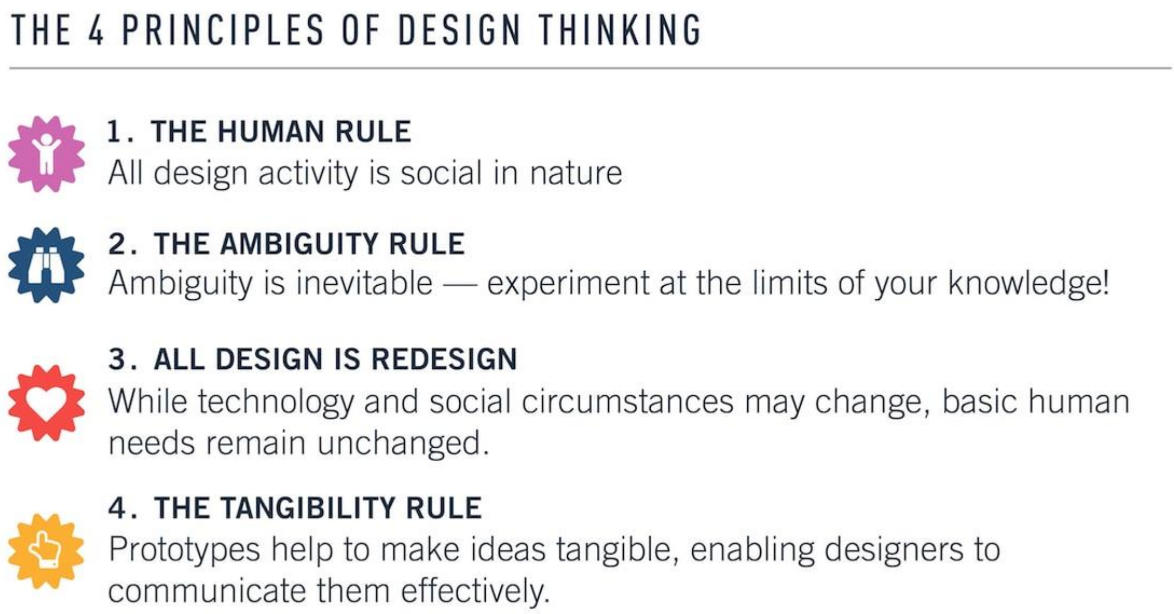
"The scientists adopted a technique of trying out a series of designs which used as many different blocks and combinations of blocks as possible as quickly as possible. Thus they tried to maximise the information available to them about the allowed combinations. If they could discover the rule governing which combinations of blocks were allowed, they

could then search for an arrangement which would optimise the required colour around the layout."
The designers, on the other hand:

"…selected their blocks in order to achieve the appropriately coloured perimeter. If this proved not to be an acceptable combination, then the next most favourably coloured block combination would be substituted and so on until an acceptable solution was discovered."
Lawson's findings go to the heart of what Design Thinking is all about: it's an iterative process which favours ongoing experimentation until the right solution is found.

2. What is the process of Design Thinking?

As already mentioned, the Design Thinking process is progressive and highly user-centric. Before looking at the process in more detail, let's consider the four principles of Design Thinking as laid out by Christoph Meinel and Harry Leifer of the Hasso-Plattner-Institute of Design at Stanford University, California.

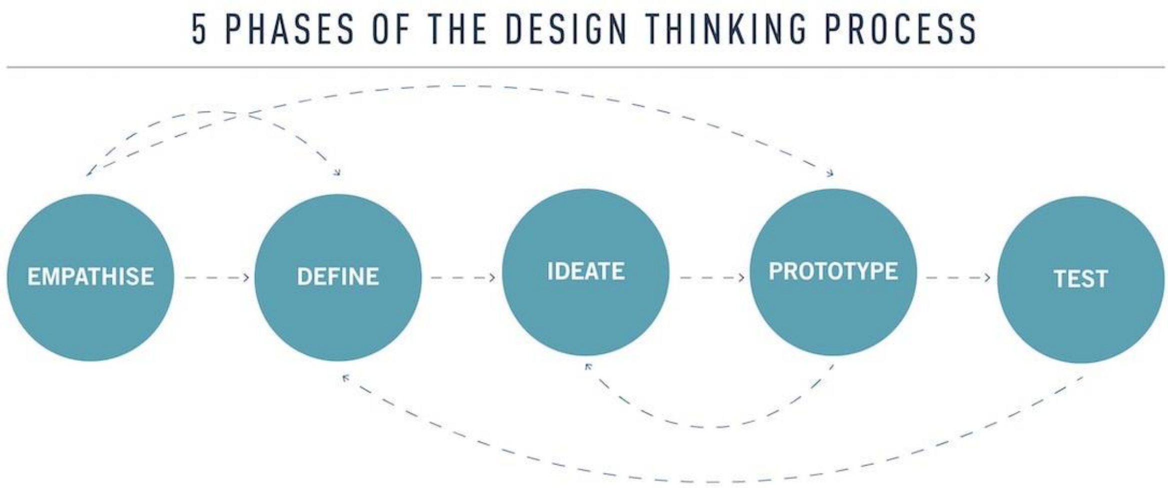


The Four Principles of Design Thinking

- **The human rule:** No matter what the context, all design activity is social in nature, and any social innovation will bring us back to the "human-centric point of view".
- **The ambiguity rule:** Ambiguity is inevitable, and it cannot be removed or oversimplified. Experimenting at the limits of your knowledge and ability is crucial in being able to see things differently.
- **The redesign rule:** All design is redesign. While technology and social circumstances may change and evolve, basic human needs remain unchanged. We essentially only redesign the means of fulfilling these needs or reaching desired outcomes.
- **The tangibility rule:** Making ideas tangible in the form of prototypes enables designers to communicate them more effectively.

The Five Phases of Design Thinking

Based on these four principles, the Design Thinking process can be broken down into five steps or phases, as per the aforementioned Hasso-Plattner-Institute of Design at Stanford (otherwise known as d.school): Empathise, Define, Ideate, Prototype and Test. Let's explore each of these in more detail.



Phase 1: Empathise

Empathy provides the critical starting point for Design Thinking. The first stage of the process is spent getting to know the user and understanding their wants, needs and objectives. This means observing and engaging with people in order to understand them on a psychological and emotional level. During this phase, the designer seeks to set aside their assumptions and gather real insights about the user. Learn all about key empathy-building methods here.

Phase 2: Define

The second stage in the Design Thinking process is dedicated to defining the problem. You'll gather all of your findings from the empathise phase and start to make sense of them: what difficulties and barriers are your users coming up against? What patterns do you observe? What is the big user problem that your team needs to solve? By the end of the define phase, you will have a clear problem statement. The key here is to frame the problem in a user-centered way; rather than saying "We need to…", frame it in terms of your user: "Retirees in the Bay area need…"

Once you've formulated the problem into words, you can start to come up with solutions and ideas — which brings us onto stage three.

Phase 3: Ideate

With a solid understanding of your users and a clear problem statement in mind, it's time to start working on potential solutions. The third phase in the Design Thinking process is where the creativity happens, and it's crucial to point out that the ideation stage is a judgement-free zone! Designers will hold ideation sessions in order to come up with as many new angles and ideas as possible. There are many different types of ideation technique that designers might use, from brainstorming and mind mapping to body storming (role-play scenarios) and provocation — an extreme lateral-thinking technique that gets the designer to challenge established beliefs and explore new options and alternatives. Towards the end of the ideation phase, you'll narrow it down to a few ideas with which to move forward. You can learn about all the most important ideation techniques here.

Phase 4: Prototype

The fourth step in the Design Thinking process is all about experimentation and turning ideas into tangible products. A prototype is basically a scaled-down version of the product which incorporates the potential solutions identified in the previous stages. This step is key in putting each solution to the test and highlighting any constraints and flaws. Throughout the prototype stage, the proposed solutions may be accepted, improved, redesigned or rejected depending on how they fare in prototype form. You can read all about the prototyping stage of Design Thinking in this in-depth guide.

Phase 5: Test

After prototyping comes user testing, but it's important to note that this is rarely the end of the Design Thinking process. In reality, the results of the testing phase will often lead you back to a previous step, providing the insights you need to redefine the original problem statement or to come up with new ideas you hadn't thought of before. Learn all about user testing in this guide.

Is Design Thinking a linear process?

No! You might look at these clearly defined steps and see a very logical sequence with a set order. However, the Design Thinking process is not linear; it is flexible and fluid, looping back and around and in on itself! With each new discovery that a certain phase brings, you'll need to rethink and redefine what you've done before — you'll never be moving in a straight line!

3. What is the purpose of Design Thinking?

Now we know more about how Design Thinking works, let's consider why it matters. There are many benefits of using a Design Thinking approach — be it in a business, educational, personal or social context.

First and foremost, Design Thinking fosters creativity and innovation. As human beings, we rely on the knowledge and experiences we have accumulated to inform our actions. We form patterns and habits that, while useful in certain situations, can limit our view of things when it comes to problem-solving. Rather than repeating the same tried-and-tested methods, Design Thinking encourages us to remove our blinkers and consider alternative solutions. The entire process lends itself to challenging assumptions and exploring new pathways and ideas.

Design Thinking is often cited as the healthy middle ground of problem-solving — it is not steeped wholly in emotion and intuition, nor does it rely solely on analytics, science and rationale; it uses a mixture of both.

Another great benefit of Design Thinking is that it puts humans first. By focusing so heavily on empathy, it encourages businesses and organizations to consider the real people who use their products and services — meaning they are much more likely to hit the mark when it comes to creating meaningful user experiences. For the user, this means better, more useful products that actually improve our lives. For businesses, this means happy customers and a healthier bottom line.

What's a "wicked problem" in Design Thinking?

Design Thinking is especially useful when it comes to solving "wicked problems". The term "wicked problem" was coined by design theorist Horst Rittel in the 1970s to describe particularly tricky problems that are highly ambiguous in nature. With wicked problems, there are many unknown factors; unlike "tame" problems, there is no definitive solution. In fact, solving one aspect of a wicked problem is likely to reveal or give rise to further challenges. Another key characteristic of wicked problems is that they have no stopping point; as the nature of the problem changes over time, so must the solution. Solving wicked problems is therefore an ongoing process that requires Design Thinking! Some examples of wicked problems in our society today include things like poverty, hunger and climate change.

4. Design thinking in the workplace: How do Design Thinking, lean, and agile work together?

Now we know what Design Thinking is, let's consider how it fits into the overall product design process. You may be familiar with the terms "lean" and "agile"—and, as a UX designer, it's important to understand how these three approaches work together.

What are lean and agile?

Based on the principles of lean manufacturing, lean UX focuses on streamlining the design process as much as possible—minimizing waste and maximizing value. Some core tenets of lean UX are:

- Cross-functional collaboration between designers, engineers, and product managers.
- Gathering feedback quickly and continuously, ensuring that you're constantly learning and adapting as you go.
- Deciding as late as possible and delivering fast, with less focus on long-term deliverables.
- A strong emphasis on how the team operates as a whole.

Lean UX is a technique that works in conjunction with agile development methods. Agile is a software development process that works in iterative, incremental cycles known as sprints. Unlike traditional development methods, agile is flexible and adaptive. Based on the Agile Development Manifesto created in 2001, agile adheres to the following principles:

- Individuals and interactions over processes and tools.
- Working software over comprehensive documentation.
- Customer collaboration over contract negotiation.
- Responding to change over following a plan.

Combining Design Thinking with lean and agile

Design Thinking, lean, and agile are often seen as three separate approaches. Companies and teams will ask themselves whether to use lean *or* agile *or* Design Thinking—but actually, they can (and should!) be merged for optimal results.

Why? Because applying Design Thinking in a lean, agile environment helps to create a product development process that is not only user-centric, but also highly efficient from a business perspective. While it's true that each approach has its own *modus operandi*, there is also significant overlap. Combining principles from each can be crucial in keeping cross-functional teams on the same page—ensuring that designers, developers, product managers, and business stakeholders are all collaborating on one common vision.

So how do Design Thinking, lean, and agile work together?

As Jonny Schneider, Product Strategy and Design Principal at Thought Works, explains: "Design Thinking is how we explore and solve problems; Lean is our framework for testing our beliefs and learning our way to the right outcomes; Agile is how we adapt to changing conditions with software."

That's all well and good, but what does it look like in practice?

As we've learned, Design Thinking is a solution-based approach to exploring and solving problems. It focuses on generating ideas with a specific problem in mind, keeping the user at the heart of the process throughout. Once you've established and designed a suitable solution, you'll start to incorporate lean principles—testing your ideas, gathering quick and ongoing feedback to see what works—with particular emphasis on cross-team collaboration and overcoming departmental silos. Agile ties all of this into short sprint cycles, allowing for adaptability in the face of change. In an agile environment, products are improved and built upon incrementally. Again, cross-team collaboration plays a crucial role; agile is all about delivering value that benefits both the end user and the business as a whole.

Together, Design Thinking, lean, and agile cut out unnecessary processes and documentation, leveraging the contributions of all key stakeholders for continuous delivery and improvement.

5. What are the benefits of Design Thinking at work?

As a designer, you have a pivotal role to play in shaping the products and experiences that your company puts to market. Integrating Design Thinking into your process can add huge business value, ultimately ensuring that the products you design are not only desirable for customers, but also viable in terms of company budget and resources.

With that in mind, let's consider some of the main benefits of using Design Thinking at work:

- **Significantly reduces time-to-market:** With its emphasis on problem-solving and finding viable solutions, Design Thinking can significantly reduce the amount of time spent on design and development—especially in combination with lean and agile.
- **Cost savings and a great ROI:** Getting successful products to market faster ultimately saves the business money. Design Thinking has been proven to yield a significant return on investment; teams that are applying IBM's Design Thinking practices, for example, have calculated an ROI of up to 300% as a result.
- **Improves customer retention and loyalty:** Design Thinking ensures a user-centric approach, which ultimately boosts user engagement and customer retention in the long term.
- **Fosters innovation:** Design Thinking is all about challenging assumptions and established beliefs, encouraging all stakeholders to think outside the box. This fosters a culture of innovation which extends well beyond the design team.
- **Can be applied company-wide:** The great thing about Design Thinking is that it's not just for designers. It leverages group thinking and encourages cross-team collaboration. What's more, it can be applied to virtually any team in any industry.

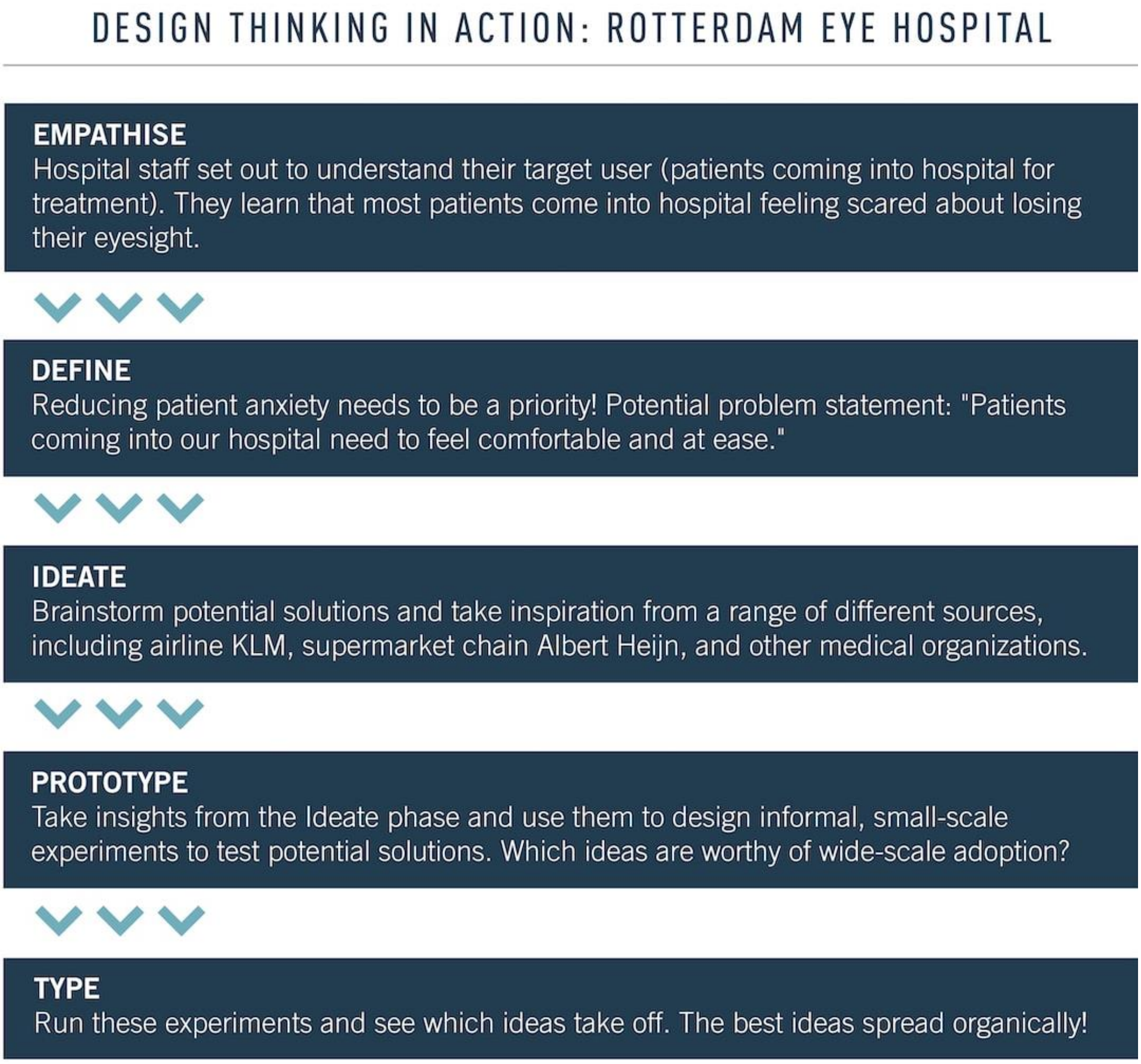
Whether you're establishing a Design Thinking culture on a company-wide scale, or simply trying to improve your approach to user-centric design, Design Thinking will help you to innovate, focus on the user, and ultimately design products that solve real user problems.

6. Design Thinking methodology in action: Case studies

So we've looked in quite some detail at the theory behind Design Thinking and the processes involved — but what does this look like in action? Let's explore some case studies where Design Thinking has made a huge real-world impact.

Healthcare Case Study: How Design Thinking transformed the Rotterdam Eye Hospital

Executives at the Rotterdam Eye Hospital wanted to transform the patient experience from the typically grim, anxiety-riddled affair into something much more pleasant and personal. To do this, they incorporated Design Thinking and design principles into their planning process. Here's how they did it:



Empathise

First, they set out to understand their target user — patients entering the hospital for treatment. The hospital CEO, CFO, managers, staff and doctors established that most patients came into hospital with the fear of going blind.

Define

Based on their findings from the empathise stage, they determined that fear reduction needed to be a priority. Their problem statement may have looked something like the following: “Patients coming into our hospital need to feel comfortable and at ease.”

Ideate

Armed with a deep understanding of their patients and a clear mission statement, they started to brainstorm potential solutions. As any good design thinker would, they sought inspiration from a range of both likely and unlikely sources. They looked to flagship airline KLM and supermarket chain Albert Heijn to learn about scheduling, for example, while turning to other medical organizations for inspiration on operational excellence.

Prototype

In the prototyping stage, the team presented the most promising ideas they had come up with so far to those in charge of caregiving at the hospital. These teams of caregivers then used these insights to design informal, small-scale experiments that could test a potential solution and see if it was worthy of wide-scale adoption.

Test

The testing phase consisted of running the aforementioned experiments and seeing if they took off. As Dirk Deichmann and Roel van der Heijde explain, the “transition to formal adoption of these ideas tended to be more gradual. If an idea worked, sooner or later other groups would ask if they could try it too, and the best ideas spread organically.”

The outcome

By adopting a Design Thinking approach, the Rotterdam Eye Hospital were able to get to the heart of their users’ needs and find effective solutions to fulfill them. In doing so, they have greatly improved the user experience: patient intake has risen 47%, and the hospital has since won several awards for safety, quality and design.

Business Case Study: How Design Thinking helped financial service provider MLP regain consumer trust

After the financial crisis hit, financial service provider MLP found that consumer trust was at an all-time low. They needed to re-engage with their target users and come up with new ways of building trust. In search of innovation, they decided to test out a Design Thinking approach. Here’s what they learned:

Empathise

By focusing on their users and making a conscious effort to understand their needs first-hand, MLP learned that the assumptions they’d been going on were not so accurate after all. As Thomas Freese, division manager for marketing at MLP, explains: “We always used to speak to customers about the goals they want to achieve. But they do not want to commit to a certain goal, as they often do not know themselves what that is. Rather, they want to talk about their ideas as it is more open and flexible regarding their financial planning."

Define

With this newfound empathy for their users, MLP were able to reframe their mission statement. They knew that they needed to rebuild consumer trust, and that the way to do this would be to speak to the customer in their own language and become a more relatable brand.

Ideate and Prototype

During the ideate and prototype phases, they decided to experiment with a completely new image. Instead of the formal business attire typically associated with the financial sector, the MLP team members went out in casual clothing. They tested Lego prototypes and homemade posters in designated hotspots — including a university campus and train stations.

Test

By testing this new approach, they learned some extremely valuable lessons about their users and how to communicate with them. They found that even something as simple as dressing more casually had a huge impact in reducing the negative connotations associated with financial services. They also learned the value of asking open questions; rather than trying to sell their prototype, Design Thinking taught them to ask questions that focus on the user's needs.

The Outcome

Their first foray into Design Thinking proved to be a huge learning curve for MLP. Taking the time to speak to their users gave them the insights they needed to redesign their messaging, allowing them to start marketing much more effectively. In light of their findings, MLP opened up a new office space in a student district, putting their editorial and social media teams in close proximity to their customer base. Of course, Design Thinking is an iterative process, so this is just one way in which MLP hopes to continue learning to speak their customers' language.

Source: https://careerfoundry.com/en/blog/ux-design/what-is-design-thinking-everything-you-need-to-know-to-get-started/

Unit – 1 – Slide 30 - Link 2

What is Design Thinking?

FILED UNDER: CREATIVE CONFIDENCE SERIES, DESIGN THINKING, INSIGHTS FOR INNOVATION

Design thinking is a process for creative problem solving.

Design thinking has a human-centered core. It encourages organizations to focus on the people they're creating for, which leads to better products, services, and internal processes. When you sit down to create a solution for a business need, the first question should always be what's the human need behind it?

In employing design thinking, you're pulling together what's desirable from a human point of view with what is technologically feasible and economically viable. It also allows those who aren't trained as designers to use creative tools to address a vast range of challenges. The process starts with taking action and understanding the right questions. It's about embracing simple mindset shifts and tackling problems from a new direction.

Why Is Design Thinking Important?

- It can help you or your team surface unmet needs of the people you are creating for.
- It reduces the risk associated with launching new ideas.
- It generates solutions that are revolutionary, not just incremental.
- It helps organizations learn faster.

3 Essential Pillars of Design Thinking

- Empathy — Understanding the needs of those you're designing for.
- Ideation — Generating a lot of ideas. Brainstorming is one technique, but there are many others.
- Experimentation — Testing those ideas with prototyping.

Done Right, Design Thinking...

- Captures the mindsets and needs of the people you're creating for.
- Paints a picture of the opportunities based on the needs of these people.
- Leads you to innovative new solutions starting with quick, low-fidelity experiments that provide learning and gradually increase in fidelity.

Areas Where Design Thinking Can Apply

- Product design
- Service and experience design
- Business design
- Leadership
- Organizational change

What Does It Look Like to Be Good at Design Thinking?

The great beauty of design thinking is that the essential elements combine to form an iterative approach. It may not always proceed linearly, but there's a roadmap to help move you toward your solution. It starts with identifying a driving question that inspires you and your team to think about who you're really designing for, and what they actually need. Next, you gather inspiration—what other solutions out in the world can help you rethink the way you're working? Use that to push past obvious solutions, and arrive at breakthrough ideas. Build rough prototypes to make those ideas tangible, and find what's working and what's not. Gather feedback, go back to the drawing board, and keep going. And once you've arrived at the right solution, craft a story to introduce it to your colleagues, clients, and its users. Some of those steps may happen several times, and you may even jump back and forth between them. But that roadmap can take you from a blank slate to a new, innovative idea.

Source: https://www.ideou.com/blogs/inspiration/what-is-design-thinking

Unit – 1 – Slide 30 - Link 3

What is Design Thinking?

Design Thinking: Lessons for the Classroom

The art of deep, productive focus

By Betty Ray
January 3, 2012
Much has been written about changing role of the teacher from "sage on the stage" to "guide on the side." Design thinking, which is a dynamic, creative and collaborative approach to problem solving, presents a unique model for educators who wish to facilitate from within the class, rather than impart knowledge to it.

The Design Thinking Process

While design thinking has its roots in the innovation/design sector, the process itself can be used anywhere. Indeed, it is a great tool for teaching 21st century skills, as participants must solve problems by finding and sorting through information, collaborating with others, and iterating their solutions based on real world, authentic experience and feedback. (It is also a great tool to develop and run a school, but that's a different post for a different day.)

I had the good fortune to participate in a collaborative workshop at the Big Ideas Fest, where we practiced design thinking with about 12 other educators over a three-day period. The idea was to give us a first-hand experience with design thinking, and to demonstrate how the model could work within the classroom.

Practitioners of design thinking have different steps depending on their needs. At BIF2011, we used these steps:

1) Identify Opportunity
2) Design
3) Prototype
4) Get Feedback
5) Scale and Spread
6) Present

In design thinking, you work through the steps together in small groups (or "Collabs" as they were called at BIF2011). Our task was to explore the question: How might we create ways to assess learning geared to making tangible progress toward meaningful goals?

With driving question in hand, each Collab is led by a trained facilitator. There are basic ground rules for working together (like saying "yes, and" rather than "yes, but" when disagreeing with someone), and using elements from improv comedy to help maintain a culture of positivity, risk-taking, support and flexibility.

This is important, as the goal is to break through the negative thinking that plagues the big, thorny issues, and to come up with one prototype idea for solving one aspect of the problem.

This right here is another novel idea! We're not tasked with fixing the whole system. This is an approach positing that small changes in the right places can have big impacts on outcome.

Six Design Thinking Steps

To solve these problems, we follow this six-step format from design thinking:

Step 1: Identify Opportunity

To deepen our understanding of the issues surrounding inadequate assessment of 21st century skills, our cohort split into two groups, each of which interviewed two educators: a public school teacher who wanted to assess soft skills in addition to state standards; and an independent school teacher who wanted a means of assessing kids that didn't interrupt their learning.

These interviews gave our group a specific goal: What system or product could we come up with to meet the needs of these two educators in assessing 21st century skills?

Step 1 in the classroom: Identify a big issue that is plaguing your school or community. Is there a fundraising challenge? A school resource issue? A civic concern or an environmental problem? You can also do a quick community needs assessment, but don't get too bogged down in this. The idea is to pick a need and move through the process. You can always iterate later.

Once you've identified your issue, invite two to three parents or other community members who are personally affected by this issue to share their perspective with your students. You can have them there in person or via Skype. Let students ask lots of questions. These are the people for whom the students will be designing solutions.

Step 2: Design Process

Here, we reviewed the stories in Step 1 and brainstormed solutions. We needed to come up with an assessment idea that was accurate and authentic, and it had to provide meaningful data to real world public school educators. With a "no idea is too stupid" mantra, we wrote brainstorms on sticky notes and posted them on a whiteboard. By the end of this process, we began to see themes emerge: it should give students feedback about where they are lacking and where they need to go; it should also be student-centered, longitudinal, with real time feedback. We organized the sticky notes into these bigger themes to prep for tomorrow.

Step 2 in the classroom: Once students have heard the issues facing their community via Step 1, give them sticky notes and pens and let them brainstorm solutions. Invite them to be inspired by each other and build off each others' ideas. Remember, no idea is too stupid! Once they've finished brainstorming, identify the main themes that have emerged, and break students into small groups to research their initial ideas. Here is where the "guide on the side" can really make a difference. The students may have some wonderfully creative but entirely impossible ideas! At this point, the teacher should guide them with real world experience to help ensure that they have a good start.

Step 3: Prototype Phase

Next, we review the themes and select one to prototype. This prototype need not solve all of the problems, just one aspect of the problem voiced by one of the speakers in Step 1. (Note the incredible discipline intrinsic in this process. At this point, we are focusing on one solution to one aspect of one problem.)

Our idea is an assessment "dashboard" called iGPS. This device would assess student progress much the same way a GPS in the car works; it pinpoints a student's current skill level, identifying target skill level along with specific waypoints to keep the student on the path to achieving the stated goal/skill level.

We used paper, markers, pipe cleaners and glue to make a prototype of our idea, which looked like a Google map from "where I am" to "where I need to be" plotted along a route that intersects specific skills. It was rough, but it communicated the concept.

Step 3 in the classroom: Get a bunch of creative materials together and let the groups flesh out their ideas into physical prototypes. As teams are creating, help them think through their prototypes: How will each feature help the people we interviewed in Step 1? Does this mesh with the research they did? How will the prototype work? Which materials are the best for the job?

Once they're done, tell students they're going be pitching their ideas to experts. Give them a chance to practice and refine their presentations so they're comfortable and confident!

Step 4: Feedback

Over lunch, all groups shared their prototypes to a panel of experts for feedback. All groups got to see everyone's presentations. Most prototypes were digital software tools, though not all.

Two experts from two different stakeholder groups offered their feedback: A) An educator who was looking for ways to make the idea more useful for a real-world classroom setting, and B) a social investor, who was looking to see if there was a viable market, and if the product would make a viable business.

Step 4 in the classroom: Invite people who are experts and/or stakeholders in the field to come to your school and have students present their prototypes to them. Ask each expert to review each pitch and prototype, and give students explicit feedback: what works with this idea, and what can be improved?

Step 5: Scale and Spread

Taking the feedback we received, we hone in even further on our prototype. To do this, our team breaks into four subgroups to address the questions raised. How can this assess both individual and group work? How does a student earn points (their quantifiable score)? What does the product itself look like? And finally, assuming our product is successful as an assessment tool for 21st century skills, what's the best way to market it to district administrators who will make the choice to adopt it? We answer these questions and quickly re-prototype to include these points.

Step 5 in the classroom: This step is yet another excellent opportunity to practice "guide on the side" facilitation. Help each group of students understand the feedback they got, and work with them to understand the best way to implement solutions. If there are multiple feedback points to be addressed, the groups can break into subgroups to address each point for efficiency. You might have students pick a project manager, and have all the subgroups report back to that person.

Step 6: Present

Most of the time, we go to these conferences and get fired up about all the great ideas there, and then we leave and nothing changes. The Big Ideas Fest culminated with a surprise. Three out of nine projects were selected to participate in the Big Ideas Fest in Beta, a new program which offers support to bringing these ideas to fruition. And furthermore, ISKME, the sponsor of the event, received a $50,000 matching grant from the Bill & Melinda Gates Foundation to support three groups with additional design workshops, access to ISKME's networks, services and other resources to help incubate their ideas.

So, after a grand total of six hours' total collaboration time, each of the nine groups had come up with some great prototypes, and three were going to get some support to build their prototypes into working products.

Source: https://www.edutopia.org/blog/design-thinking-betty-ray

Design Methods & Tools

User Centered Design Process

Research with focus on User (Human) is the core of the User Centered Design Process/Method.

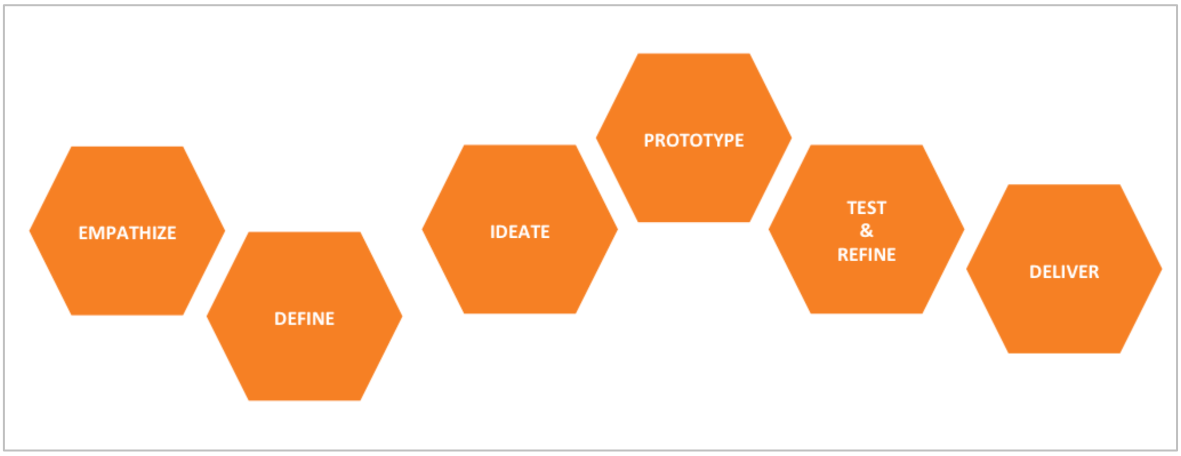


Fig. 2: Human-Centered Design Method

Why Research?

Research helps the designers in building understanding and gaining knowledge about the product domain, business needs, stakeholders including the end user need, their context, their aspirations and their experiences that helps us creating user models such as personas, user needs and how they would like to fulfill their needs, articulating business goals that may affect features and functions, understanding technical constraints and limitations. All these knowledge and understanding are critical and needed during the design phase.

It allows you to interpret intangible meaning of those experiences in order to uncover insights. These insights will lead you to the innovative solutions. The best solutions come out of the best insights into human behavior

A good researcher looks beyond obvious and discovers the things/information, which is under the surface. Note that the tip of the iceberg does not help you estimate the size of the same. If you need to know the real size of the iceberg, you need to take a deep dive inside the ocean and then only you will know how big the iceberg is. So as a researcher always be ready to deep dive into your research subject, when you are out for research.

Fig. 1: Iceberg and deep dive

Any research investigation revolve around the following 5 core queries:

1. WHO? (The people, context whom you want to research?)
2. WHERE? (Where those will be found?)
3. WHAT? (What is their context, needs, aspiration, activities, behavior, attitudes etc. are)
4. HOW? (How they use manage their needs/do work?)
5. WHY? (The reason behind their particular activity, behavior, attitude etc.)

Beginner's Mind Set – A Very Important Skill as a researcher

Remember when you were a small child, you had so many questions in your mind and you wanted the answer for those from your parents, teachers and friends. You have very high curiosity to know more about each and everything and you were not making any assumptions, as you have no experiences, understanding, expertise and stereotypes. To be a good user researcher it is important to assume yourself as a small child, you have to put yourself in beginner's mind-set. A beginner's (child's) mindset helps to put aside these biases, so that you can approach a design challenge afresh.

Empathy

As a human-centered designer the problems you are trying to solve are rarely your own—they are those of particular users; in order to design for your users, you must build **empathy** for who they are and what is important to them.

- Watching what people do and how they interact with their environment gives you clues about what they think and feel.
- It helps you to learn about what they need.

- It capture physical manifestations of their experiences, what they do and say.
- It allows you to interpret intangible meaning of those experiences in order to uncover insights. These insights will lead you to the innovative solutions. The best solutions come out of the best insights into human behavior

Research Tools for Empathise Phase

There are various methods and tools suggested by scholars and practitioners, few of them useful for design and user research are explained below:

1. User Interviews
2. Focus Group
3. Card Sorting
4. Ethnography – Contextual Enquiry
5. Shadowing
6. Survey

User Interview

The interview process is one of the most common and powerful ways to understand people. It can be considered the foundation for many of the methods designers use. The interview is a method for discovering facts and opinions held by potential users of the system being designed.

The predominant form of interviewing is face-to-face and one-to-one. The interview can be organized around a set of structured questions, follow a more open format through semi structured questions or be unstructured with no prior questions.

It is important that we prepare ourselves much prior to the actual interview sessions. We should be ready with a right questioner, which can help us get the best insight about them.

Focus Group

A focus group is a moderated discussion that typically involves 5 to 10 participants and chaired by an impartial moderator. Its aim is to solicit focused feedback on specific issues or design ideas, giving designers firsthand experience of user reaction. Through a focus group, one can learn about users' attitudes, beliefs, desires, and reactions to concepts. Focus groups are a traditional market research technique. In a typical focus group, participants talk. During the focus group users tell you about their experiences or expectations but you don't get to verify or observe these experiences.

Card Sorting

Card sorting is a research method used to understand the way that the intended users of a website naturally organize or think about different types of information or content. It's also a method service teams can use to sort and arrange. Card Sorting can be conducted in a variety of circumstances using various means – one-on-one, during workshops, by mail, or electronically.

Card sorting is very popular among researchers as this is an easy way to get user input and validation very early on in a project without requiring a lot of initial preparation. It is the simple technique that’s easy for participants and clients to understand. It’s relatively inexpensive and easily demonstrates its value. Online card sorting lets you reach many participants, in diverse locations, in a very short period of time.

Ethnographic Research

Ethnography is a social research technique based on studying people’s behavior in everyday contexts, rather than under controlled conditions (such as a conference room in a focus group testing center). Ethnographic techniques focus on informal conversation and observing the subjects in their environments, instead of on questionnaires or set lists of topics. This approach will allow you to be efficient while unearthing the true attitudes and behaviors of users, as opposed to merely gathering statistics.

In design research, the ethnographic approaches to participant interaction clarify complex human needs, behaviors, and perspectives. Field immersions unearth contextual and environmental factors that shape user experience. Rigorous, old-fashioned desk research and expert consultation support the fieldwork. It is important to know that a good design research doesn’t end with good data.

Contextual Enquiries

In a contextual enquiry, you watch and listen as the user works. You don't usually give the user tasks or scenarios. To understand what a user is doing or thinking you can ask questions as the user navigates the site. The results are usually qualitative, observed data, rather than quantitative, measured data.

What You Learn From Contextual Interviews

Contextual interviews combine observations with interviewing. By going to the user, you see the user's environment and the actual technology the user works with. As a result, you’ll be able to answer questions such as:

- Any issues that users are facing
- Equipment they are working with
- How their space is set-up
- Preference between mouse and keyboard`
- The type of internet connection they have
- How long does it take to complete common or target tasks
- Whether there are people there and willing to assist the user if they need help completing a task

Shadowing

Shadowing is observing people in context. It is important that the people you are observing are not aware of the same since that might lead to change in their natural behavior. It allows the researcher and designer to develop design insights through observation and shared experience with users.

This method can help you with following:

1. This method can help determine the difference between what subjects say they do, and what they really do.
2. It helps in understanding the point of view of people. Successful design results from knowing the users.
3. Define Intent.
4. Can be used to evaluate the concepts.
5. Please note, It will be important to choose the right subject (user) to shadow.

Survey

Surveys, which are also called questionnaires, are one of the key ways to gather quantitative data for analysis. Surveys rely on asking the same question in the same way to a large number of people, and obtaining a lot of responses. These responses are then analyzed using statistical techniques to obtain information that can be generalized about the whole population.

Tools & Deliverables for Define Stage

Research produces a number of information and observations about people and context. Define is the stage where you systematically think through all these information and observations and extract valuable insights.

There are various deliverable as part of the define stage as provided below:

1. Personas
2. Scenarios
3. Empathy Mapping
4. Journey/Experience mapping

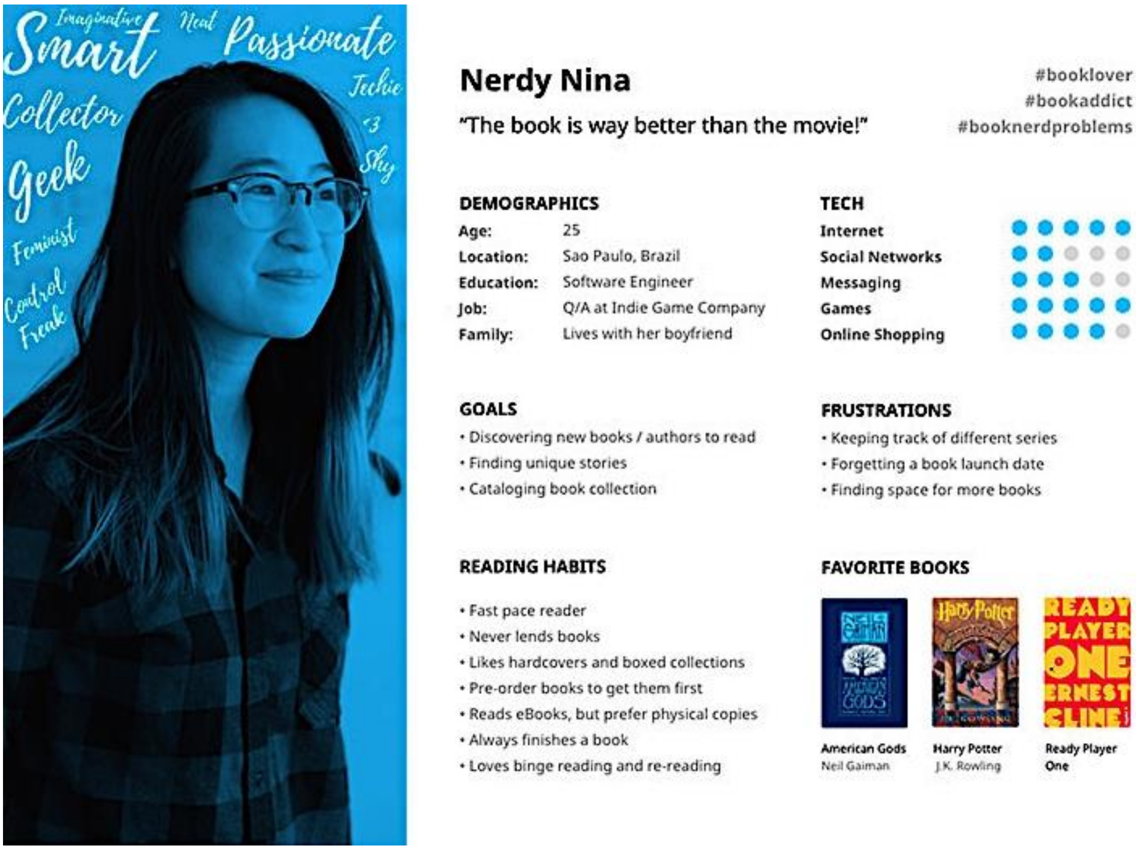
Personas

Persona is representative of a certain user groups. They are descriptions of fictional, archetypal users that include their goals, attitudes, characteristics, and expected use of a system. The purpose of personas is to create reliable and realistic representations of the key audience segments for reference.
The persona describes the user's goals and some of the interaction. It's not too specific in describing the actual UI because that will be created later. It should provide enough information so everyone involved in development can understand what a specific, representative, user wants to do and what doing the task would be like. It's good to include photos and names to make "the user" more realistic and memorable.
Personas are based on user research (qualitative and quantitative) findings, they should seem like descriptions of actual people, allowing the project team to keep a vivid picture of each user group in mind throughout a project.

- Personas describe real people with backgrounds, goals, and values.
- Personas are tangible and provide more specific, vivid portraits of users than the lists of general characteristics in user profiles.
- Personas provide details on the user skills and motivation.

- Personas express and focus on the major needs and expectations of the most important user groups.
- Personas give a clear picture about how they're likely to use the products.
- Personas aid in uncovering universal features and functionality.
- Personas are easier for people to relate to, and are more interesting, quicker and easier to read than most user research deliverables.

Example of a Persona



Source: https://wpamelia.com/user-persona-template/

Scenarios

Scenarios describe the stories and context behind why a specific user or user group will use a product, service or an application and will be helpful in designing as well as validating the design. It is really impossible to write down every scenario that every user has but it will be important to write down all the most common reasons that users have for using the product, service or an application and the tasks that users want to do. A good use scenario should include the following:

- Describes who is the user? User's goals and motivations.

- Describes a specific task or tasks that need to be accomplished by the user. What are their expectations?
- Describes how they might do it.
- Describes some of the interactions.
- Helps us construct the sequence of events that are necessary to address in our solution.

Scenarios also work with personas by serving as the stories behind why the particular persona would use the product, service or an application. What does the persona hope to accomplish? and What are characteristics of the persona that might help or hinder his or her interaction with the product, service or an application?

Scenario Example

The following is a sample scenario describing a user withdrawing money from an ATM.

"It's Monday morning and Suresh Tyagi is travelling from Kanpur to Delhi. He doesn't have enough money to hire a cab from IIT Kanpur Campus to Lucknow airport, and he's running late. He goes to the ICICI ATM located near football field and specifies Rs. 5000 from his savings account. He doesn't want a printed receipt, as he doesn't bother keeping track of transactions in this account."

Empathy Mapping

Good design is grounded in a deep understanding of the person for whom you are designing. Designers have many techniques for developing this sort of empathy. An Empathy Map is one tool to help you synthesize your observations and draw out unexpected insights.

How to use an Empathy Map

- Identify Needs: "Needs" are human emotional or physical necessities. Needs help define your design challenge.
- Remember that "Needs" are verbs (activities and desires with which your user could use help), not nouns (solutions).
- Identify needs directly out of the user traits you noted, or from contradictions between two traits – such as a disconnect between what they says and what they do.
- Write down needs on the side of your Empathy Map.

Insights often grow from contradictions between two user attributes (either within a quadrant or from two different quadrants) or from asking yourself "Why?" when you notice strange behavior. Write down potential insights on the side of your Empathy Map. One way to identify the seeds of insights is to capture "tensions" and "contradictions" as you work.

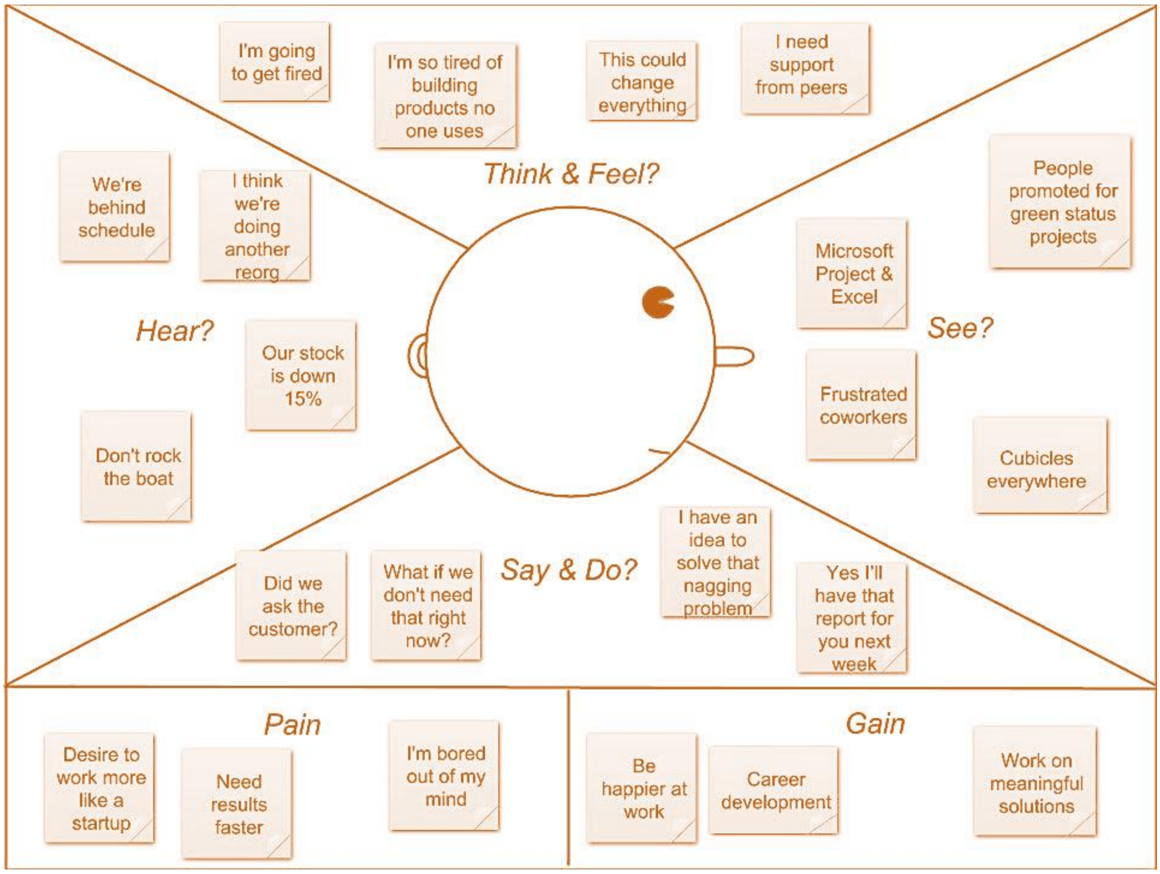


Fig. 3: Empathy Maps

Image source: minimumviableinc.com/book

Tools for Ideation Stage

Ideation

"Ideation is the mode of the design process in which you concentrate on idea generation. Mentally it represents a process of 'going wide' in terms of concepts and outcomes. Ideation provides both the fuel and also the source material for building prototypes and getting innovative solutions into the hands of your users."
– d.school, An Introduction to Design Thinking PROCESS GUIDE

Ideation is the process where you generate ideas and solutions through sessions such as Sketching, Prototyping, Brainstorming, Brain writing, Worst Possible Idea, and a wealth of other ideation techniques. Ideation is also the third stage in the Design Thinking process.

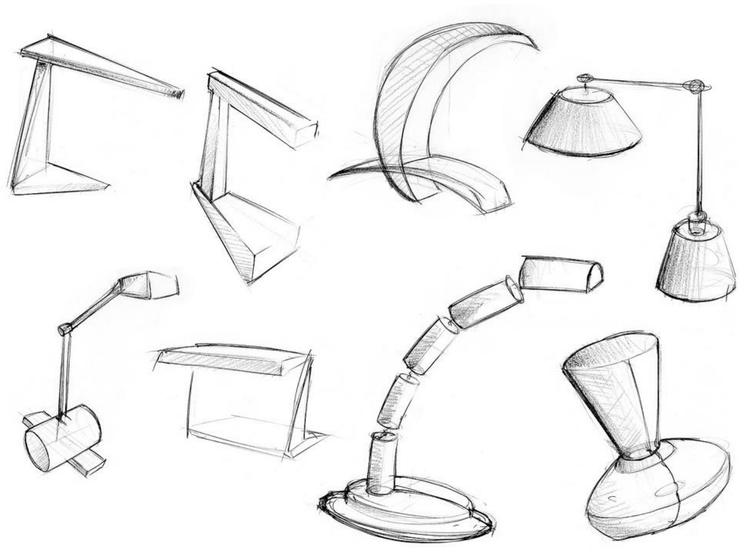


Fig. 5: Desk Lamp Ideation 3 Greg Hayter

Image source http://getdrawings.com/desk-lamp-drawing#desk-lamp-drawing-35.jpg

Brainstorming

Brainstorming is a method for generating ideas to solve a design problem. It usually involves a group, under the direction of a facilitator. The strength of brainstorming is the potential participants have in drawing associations between their ideas in a free-thinking environment, thereby broadening the solution space.

Brainstorming combines a relaxed, informal approach to problem solving with lateral thinking. It encourages people to come up with thoughts and ideas that can, at first, seem a bit crazy. Some of these ideas can be crafted into original, creative solutions to a problem, while others can spark even more ideas. This helps to get people unstuck by "jolting" them out of their normal ways of thinking.
Therefore, during brainstorming sessions, people should avoid criticizing or rewarding ideas. You're trying to open up possibilities and break down incorrect assumptions about the problem's limits. Judgment and analysis at this stage stunts idea generation and limit creativity.

SOURCES:

https://www.interaction-design.org/literature/topics/brainstorming
https://www.mindtools.com/brainstm.html
https://dschool.stanford.edu/resources/design-thinking-bootleg
http://getdrawings.com/desk-lamp-drawing#desk-lamp-drawing-35.jpg
https://wpamelia.com/user-persona-template/
Image source: minimumviableinc.com/book

SESSION 2 - DESIGN FUNDAMENTAL

1. GEOMETRY AND SPACE

The geometry and space concept is applicable everywhere in design theory and practice. We can talk about geometry in prints and how the space in print design is planned from a design point of view. We can also plan space in interior design of a building as humans interact with space and its element in that building. For example, humans sit on office chairs and work on computer on a table. The space around the table and char is vacant. So, a designer has to plan where she will keep the table, and where she will keep the computer, depending on total area, proximity to door or light from the window.

Similarly, in Graphic design field, a designer plans the type of geometrical shapes will be placed in a website for a fashion company. Geometrical shapes here will be seen as texts, pictures and graphics along with the colors that you plan to represent the theme of the garment category.

The basic principle of how we see design elements in a space is known as Gestalt principle of psychology. The following theory is explained below through visuals.

What are Gestalt Principles?

The Gestalt Principles are a set of laws arising from 1920s' psychology, describing how humans typically see objects by grouping similar elements, recognizing patterns and simplifying complex images. Designers use these to engage users via powerful -yet natural- "tricks" of perspective and best practice design standards.

The Gestalt Principles – a Background

The Gestalt Principles of grouping ("Gestalt" is German for "unified whole") represent the culmination of the work of early 20th-century German psychologists Max Wertheimer, Kurt Koffka and Wolfgang Kohler, who sought to understand how humans typically gain meaningful perceptions from chaotic stimuli around them. Wertheimer and company identified a set of laws addressing this natural compulsion to seek order amid disorder, where the mind "informs" what the eye sees by making sense of a series of elements as an image, or illusion. Early graphic designers soon began applying the Gestalt Principles in advertising, encapsulating company values within iconic logos. In the century since, designers have deployed Gestalt Principles extensively, crafting designs with well-placed elements that catch the eye as larger, whole images so viewers instantly make positive connections with the organizations represented.

"The whole is other than the sum of the parts."

- Kurt Koffka

"Gestalt psychology is a school of thought that looks at the human mind and behavior as a whole. When trying to make sense of the world around us, Gestalt psychology suggests that we do not simply focus on every small component.

Instead, our minds tend to perceive objects as part of a greater whole and as elements of more complex systems. This school of psychology played a major role in the modern development of the study of human sensation and perception."

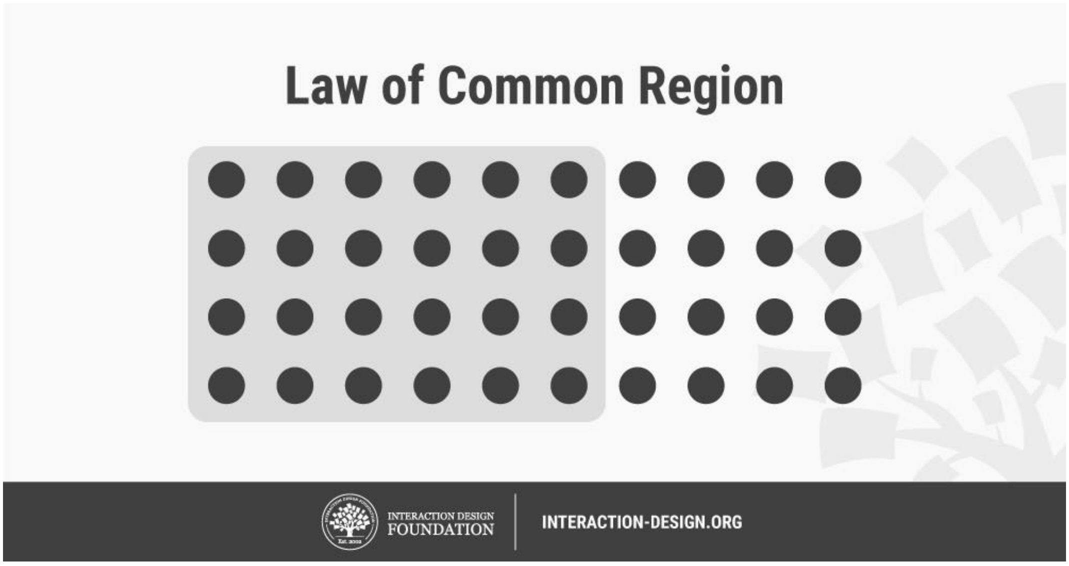
Source: verywellmind

Gestalt Principles

Some of the most widely recognized Gestalt Principles include:
Closure (Reification): Preferring complete shapes, we automatically fill in gaps between elements to perceive a complete image; so, we see the whole first.

Common Fate: We group elements that move in the same direction.

Common Region: We group elements that are in the same closed region.

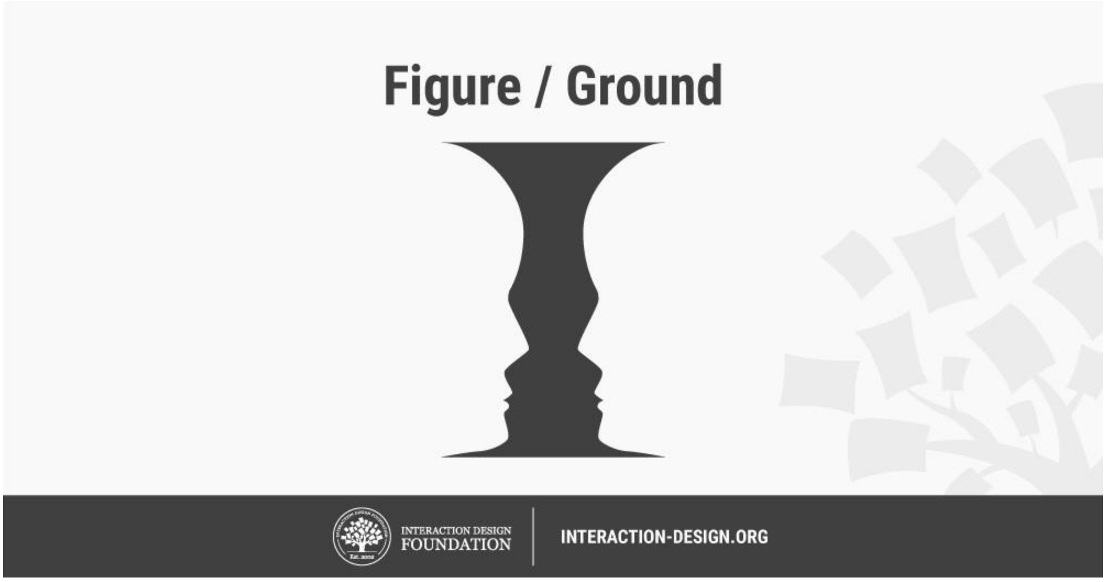


Continuation: We follow and "flow with" lines.

Convexity: We perceive convex shapes ahead of concave ones.

Element Connectedness: We group elements linked by other elements.

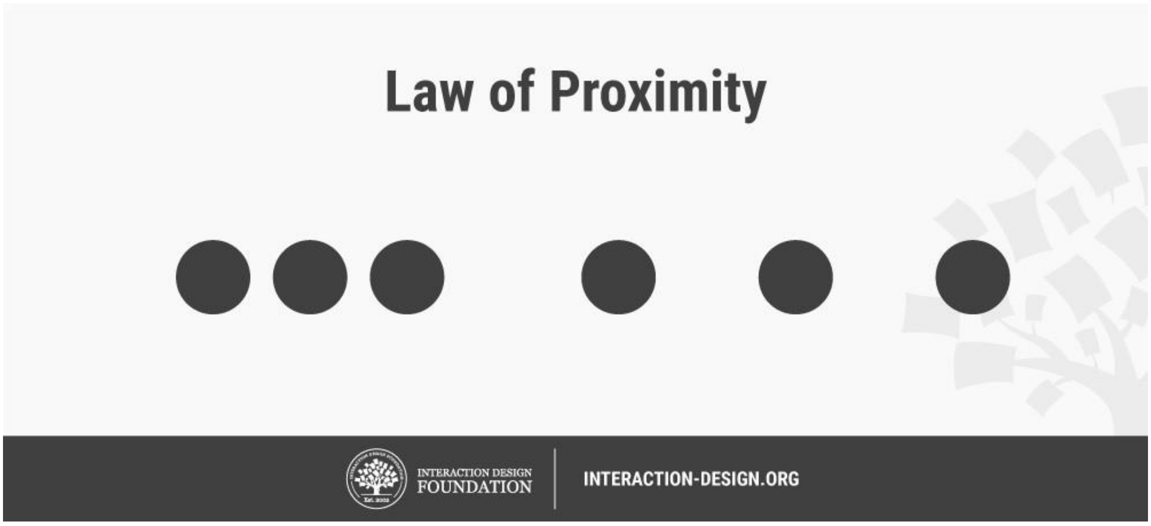
Figure/Ground (Multi-stability): Disliking uncertainty, we look for solid, stable items. Unless an image is truly ambiguous, its foreground catches the eye first.



Good Form: We differentiate elements that are similar in color, form, pattern, etc. from others—even when they overlap—and cluster them together.

Meaningfulness (Familiarity): We group elements if they form a meaningful or personally relevant image. We perceive complex or ambiguous images as simple ones.

Proximity (Emergence): We group closer-together elements, separating them from those farther apart.



Regularity: Sorting items, we tend to group some into larger shapes, and connect any elements that form a pattern.

Similarity (Invariance): We seek differences and similarities in an image and link similar elements.

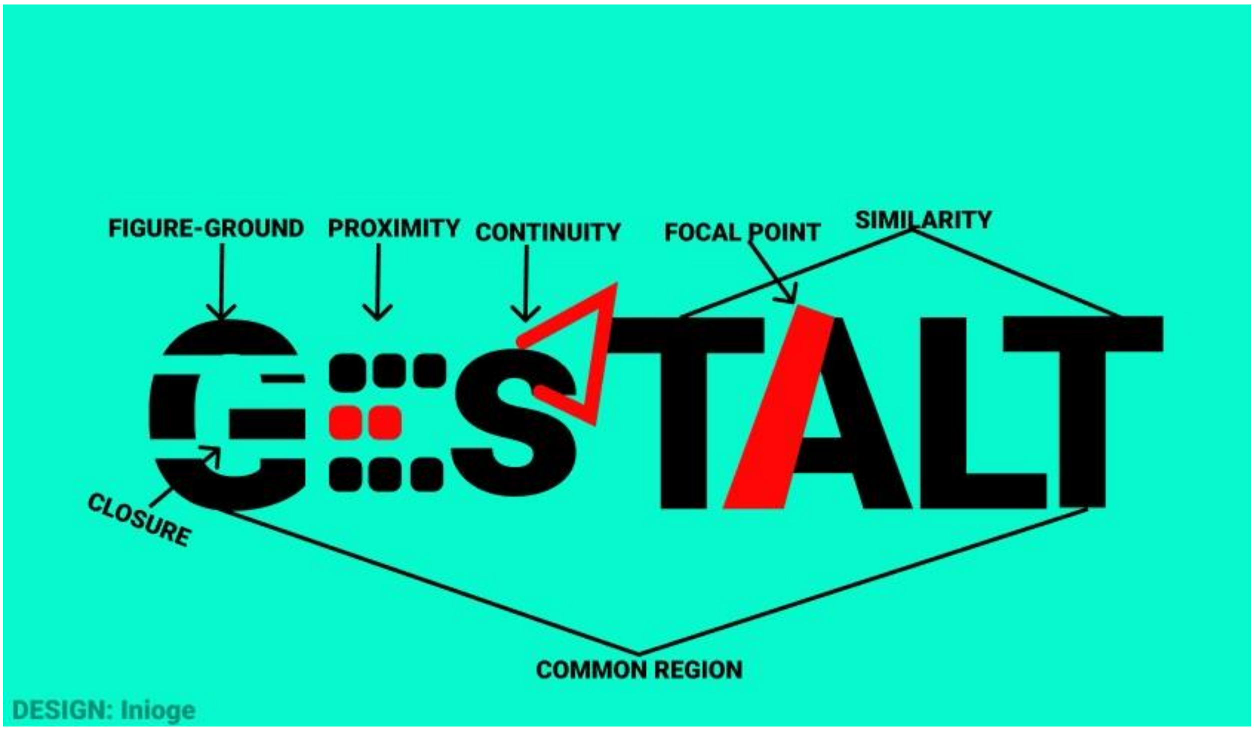
Symmetry: We seek balance and order in designs, struggling to do so if they aren't readily apparent.

Synchrony: We group static visual elements that appear at the same time.

Gestalt Principles are in the Mind, Not the Eye

The Gestalt Principles are pivotal in visual design, notably in Graphic and Interfaces, as users must be able to understand what they see—and find what they want—at a glance.

A good example are the principles of proximity and common region, as seen in the figure below – where colors and graphics divide the page into separate regions. Without it, users will struggle to make associations between unrelated clustered-together items, and leave. For designers, the true trick of Gestalt is never to confuse or delay users, but to guide them to identify their options and identify with organizations/brands rapidly.



Gestalt in Practice

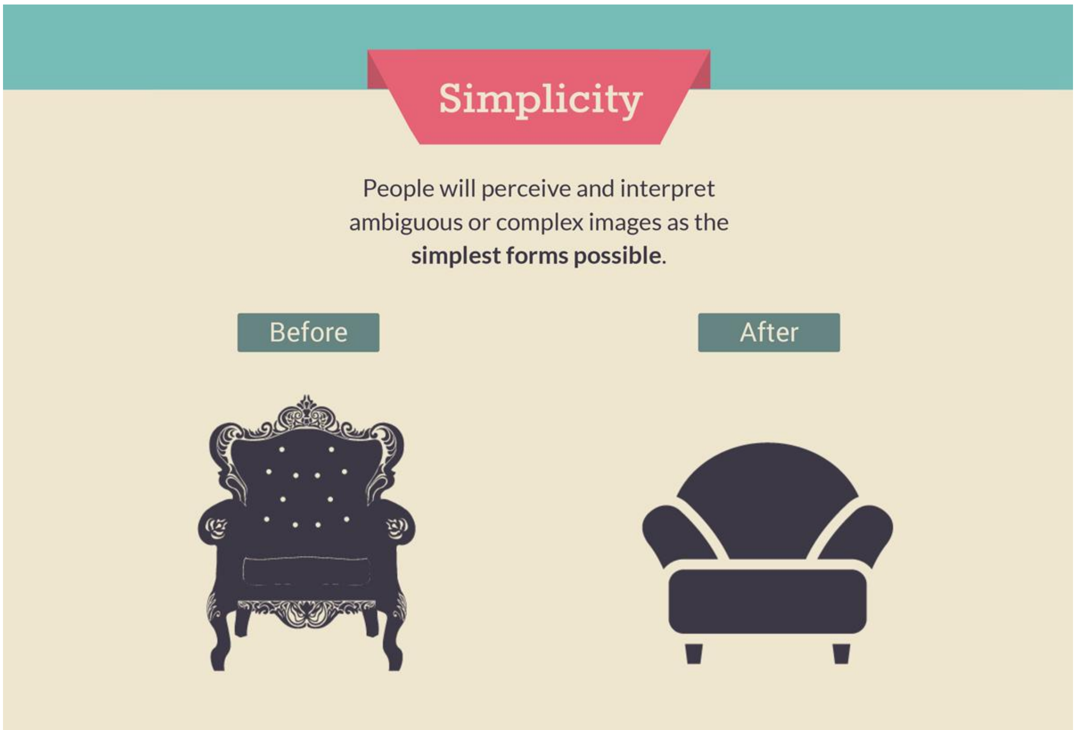
The idea that a whole is perceived as different or more than the sum of its parts is commonly employed in design, even if the artist is consciously unaware of its use. The following eight design principles are derived from Gestalt theory:

image: https://visme.co/blog/wp-content/uploads/2017/09/How-to-Apply-Gestalt-Principles-to-Your-Designs-for-Maximum-Impact-Infographic-1-1.png

8 Gestalt Design Principles with Examples

1 Gestalt Law of Simplicity

image: https://visme.co/blog/wp-content/uploads/2017/09/Gestalt-Principles-Simplicity.png



According to the first Gestalt design principle, also commonly referred to as emergence, people perceive and **interpret ambiguous or complex images in their simplest form**.

Consider, for example, the Girl Scouts of America logo below. While the design consists of irregular shapes with negative space in between, we see three silhouettes. Even more simply, those who have seen the image before are most likely to perceive the whole as a single logo instead of even three faces. We don't have to stop and think about it first. It's just what we see.

image: https://visme.co/blog/wp-content/uploads/2017/09/Girl_Scouts-1.png

According to psychologists, when we identify an object, we first seek to identify its outline. We then compare it to known shapes and patterns. Without even realizing we’re taking these steps, we finally combine the identified elements to recognize the whole.

Therefore, a simple and well-defined design will more quickly communicate the desired message than detailed illustrations with ambiguous contours.

2 Gestalt Law of Similarity

image: https://visme.co/blog/wp-content/uploads/2017/09/Gestalt-Principles-Similarity.png

Similarity

Objects that look similar in shape, size or color are perceived as being **grouped together** or **related**.

Based on Shape

Before

After

Based on Size

Before

After

Based on Color

Before

After

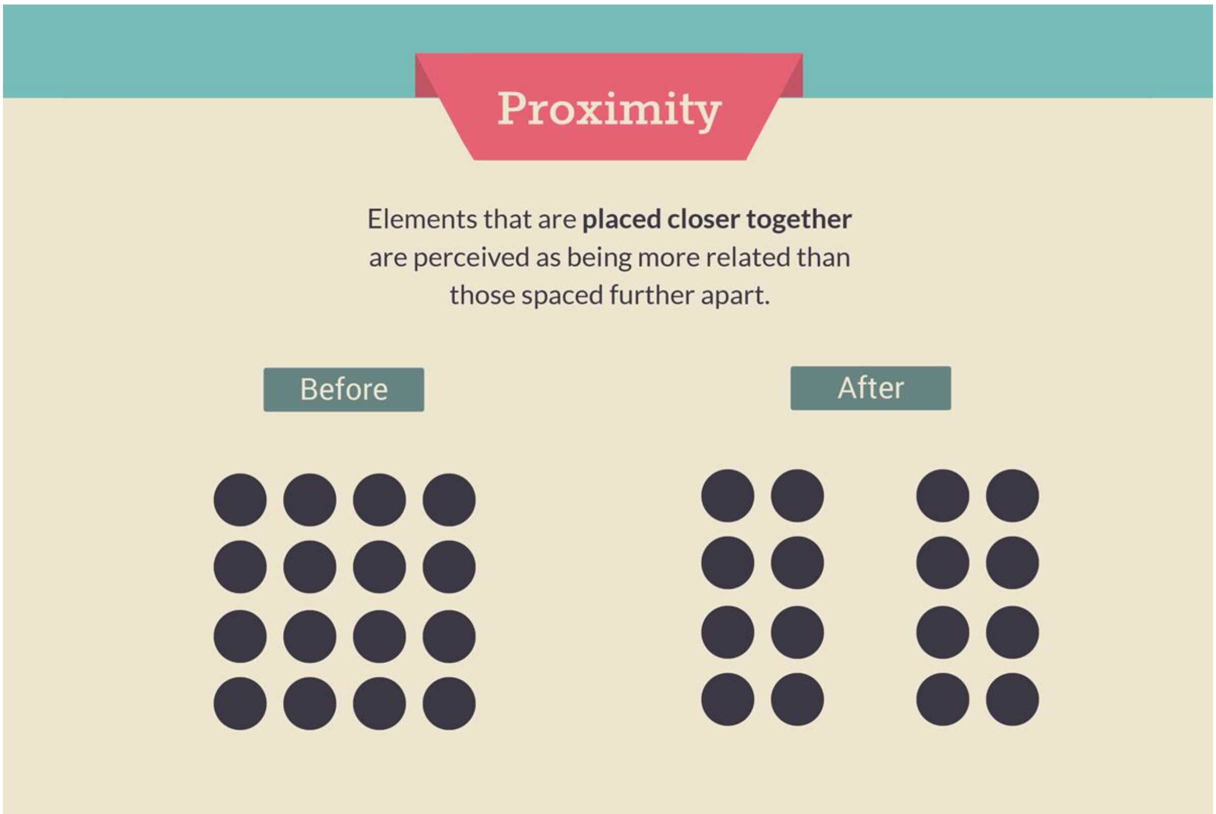
According to this Gestalt design principle, **objects with similar characteristics are perceived as more closely related** than objects that share no similar features. Our minds simply group the similar objects together regardless of their proximity to one another.

Think about a group of shapes consisting of three squares, a triangle, a circle, a hexagon and a star. Most will perceive the three squares as a group apart from the other shapes. The same effect occurs with a group of squares that are either blue or green. Even though they are all the same shape, the blue shapes will be perceived as related, as will the green shapes.

Design elements can be perceived as related by sharing any sort of characteristic, including color, shape, size and texture.

3 Gestalt Law of Proximity

image: https://visme.co/blog/wp-content/uploads/2017/09/Gestalt-Principles-Proximity.png



Also an essential element of visual hierarchy, proximity is a common way to group design elements. Simply speaking, **objects that are close together are generally perceived as more related** than objects farther apart.

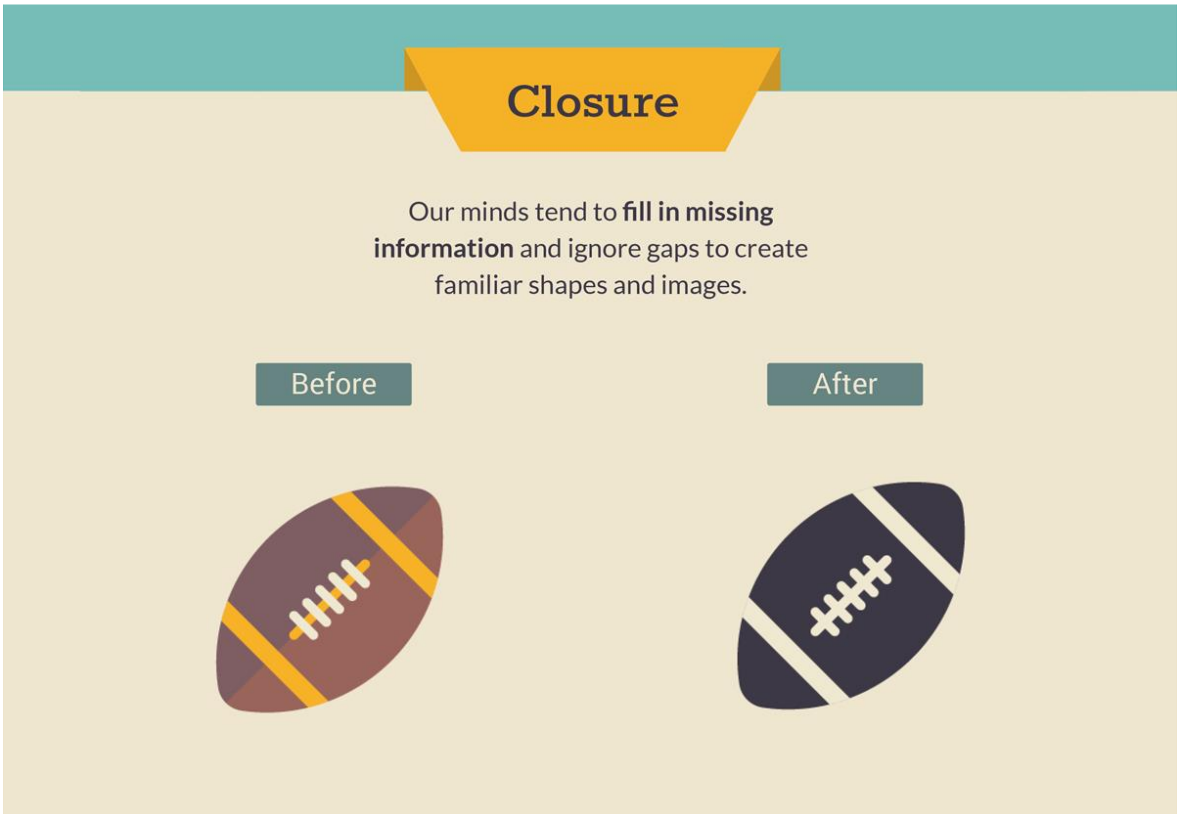
In the above example, the group of 16 circles on the left is perceived as a single group, while the same 16 circles on the right is instead seen as two separate groups of 8. The only difference is the space between.

Based on this Gestalt design principle of proximity, objects placed close to each other don’t even have to share any characteristics to be perceived as a group. A design could include 16 different shapes of varying colors, but if they are within close proximity to each other as compared to other elements, they will be perceived as a group.

RELATED: 11 Rules of Composition for Non-Designers

4 Gestalt Law of Closure

image: https://visme.co/blog/wp-content/uploads/2017/09/Gestalt-Principles-Closure.png



The closure principle dictates that **a complete outline isn’t necessary to convey the same message as a partial outline**. Even if parts are missing, the human psyche will make every attempt to match it to a known object just as long as the designer includes enough information that viewers can fill in the gaps. If too much is missing, the design will instead appear as its separate parts.

image: https://visme.co/blog/wp-content/uploads/2017/09/WWF-logo-Closure.png

Consider the World Wildlife Fund logo, for example. What would otherwise be a group of irregular shapes combine to form a recognizable design? Notice that some upper portions of the outline are missing, and the design is somewhat incomplete. We still instantly recognize the shape as a panda.

5 Gestalt Law of Figure and Ground

image: https://visme.co/blog/wp-content/uploads/2017/09/Gestalt-Principles-Figure-and-Ground.png

In any design, elements are perceived as **either the focal point in the foreground or part of the background**. The figure is generally described as the focal point, while the ground is the element on which the figure rests. In most cases, designs with a definitive point of interest, emphasis or contrast capture and hold viewers' attention more effectively than designs without a focal point.

People tend to determine the figure and ground relationship before making any other resolutions about what they see. We've evolved to prioritize this perception so we can better navigate our surroundings. Without it, we'd be running into objects and tripping over sidewalks.

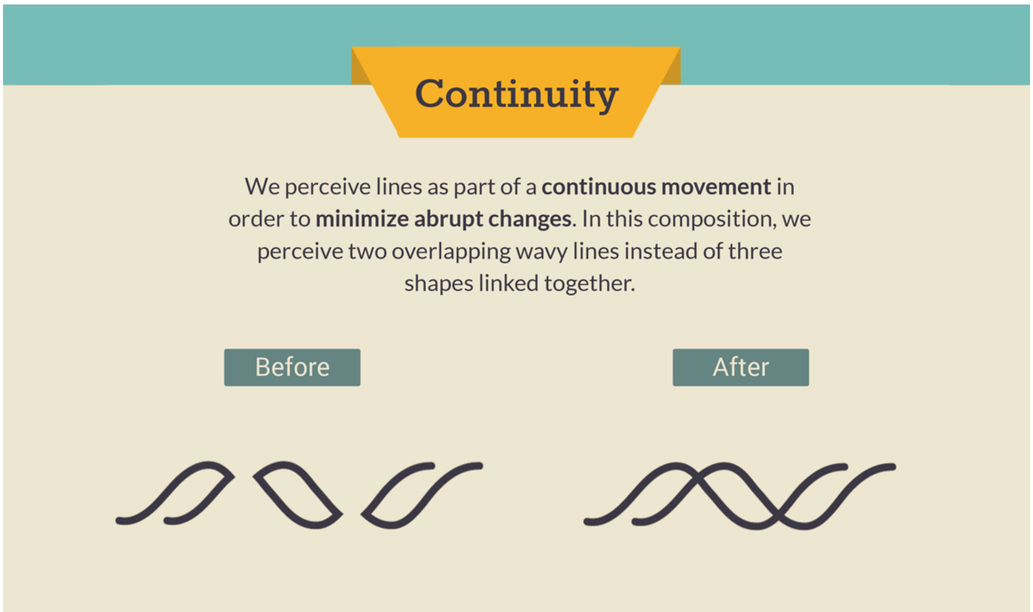
image: https://visme.co/blog/wp-content/uploads/2017/09/How-to-Apply-Gestalt-Principles-to-Your-Designs-for-Maximum-Impact-Figure-and-Ground-10.png

Sometimes designers can use this principle to draw attention to their creations. Consider the above book cover. Do you see a silhouette of Batman or the Penguin? Both are there. What we see depends on whether we view the yellow or the black as the figure, while the other remains in the ground.

6 Gestalt Law of Continuity

According to the principle of continuity, **elements arranged in a line or curves are generally assumed to continue beyond their defined end point**. In other words, once our eyes begin to follow a line or curve, we believe that line will continue in the same direction until it encounters another object.

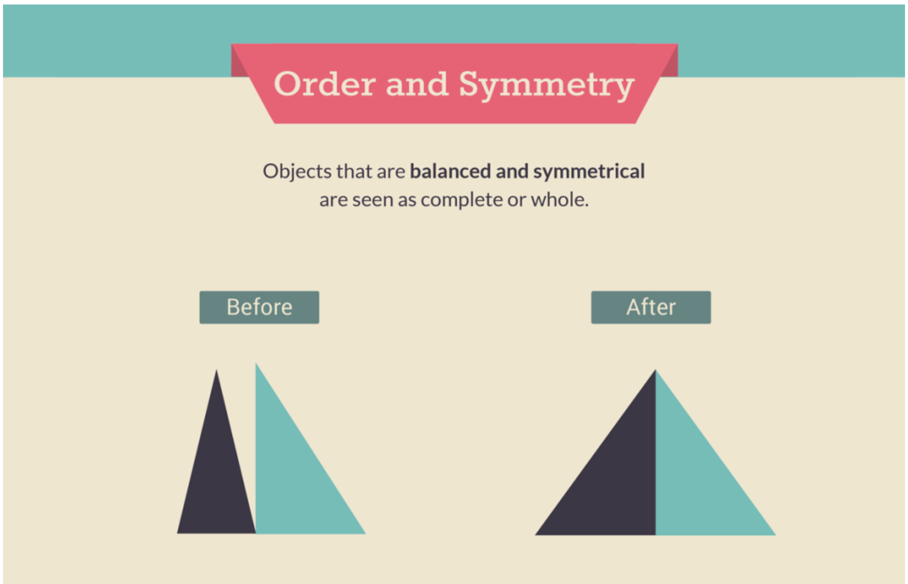
image: https://visme.co/blog/wp-content/uploads/2017/09/Gestalt-Principles-Continuity.png



Think about when you look at a road. Many times, it will expand into the distance further than the eye can see. But that doesn't mean you believe the road stops at the horizon. Instead, you automatically assume it continues along the same line beyond what you can see.

7 Gestalt Law of Symmetry

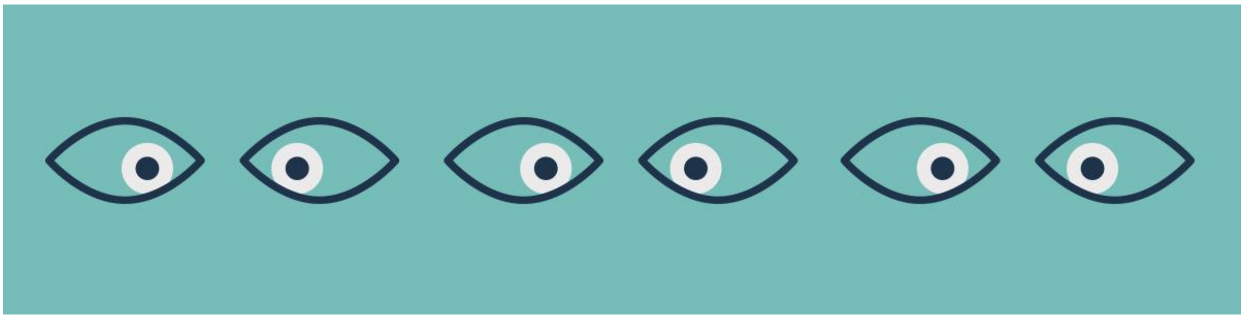
image: https://visme.co/blog/wp-content/uploads/2017/09/Gestalt-Principles-Order-and-Simmetry.png



People tend to **perceive objects as symmetrical shapes whenever possible**. It's simply human nature to look for order among chaos. Therefore, designers should attempt to provide balance over disorder.

Symmetry doesn't have to be taken literally to be effective, however. Balance can be created by use of a harmonic color scheme or by a similar but inexact group of elements on each side of a page.

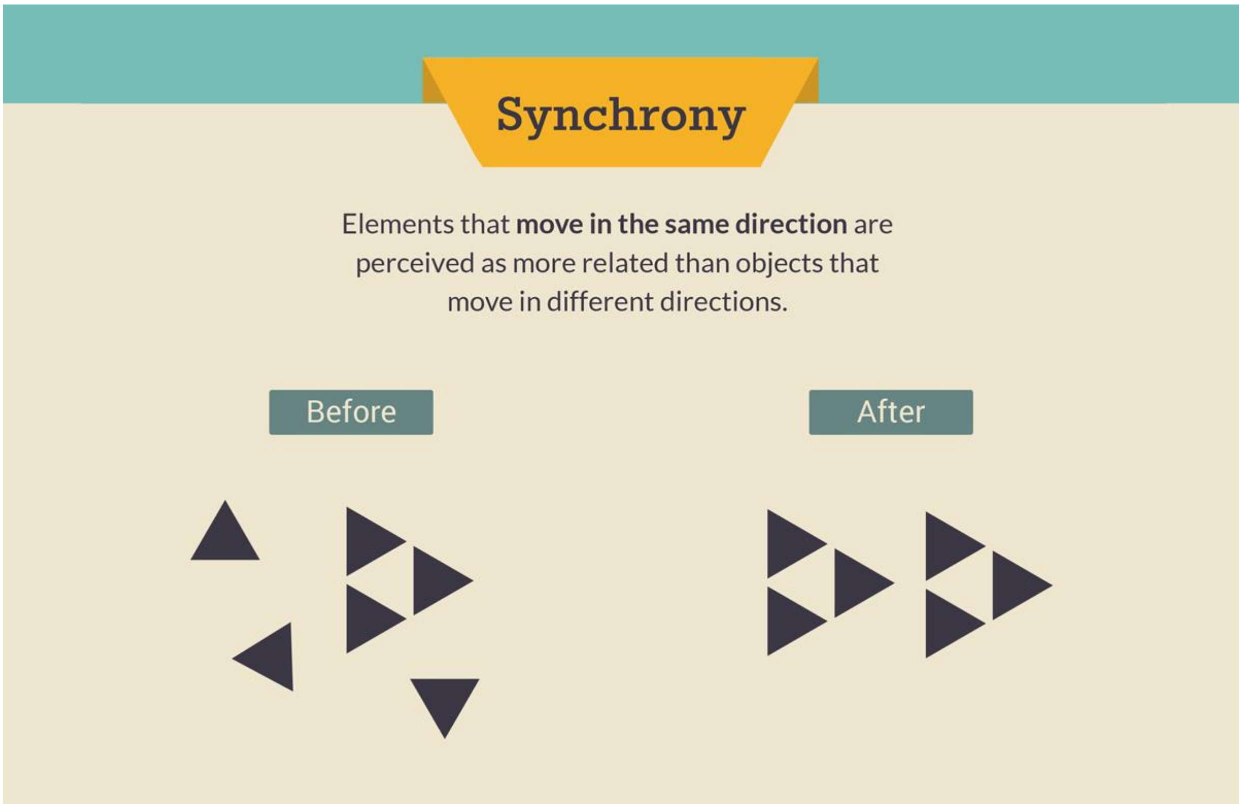
image: https://visme.co/blog/wp-content/uploads/2017/09/How-to-Apply-Gestalt-Principles-to-Your-Designs-for-Maximum-Impact-Order-and-Symmetry.jpg



Consider the above group of eyes. Because our minds strive to recognize symmetry whenever possible, most will immediately recognize three sets of eyes rather than six separate items, even though their proximity from one another is equal.

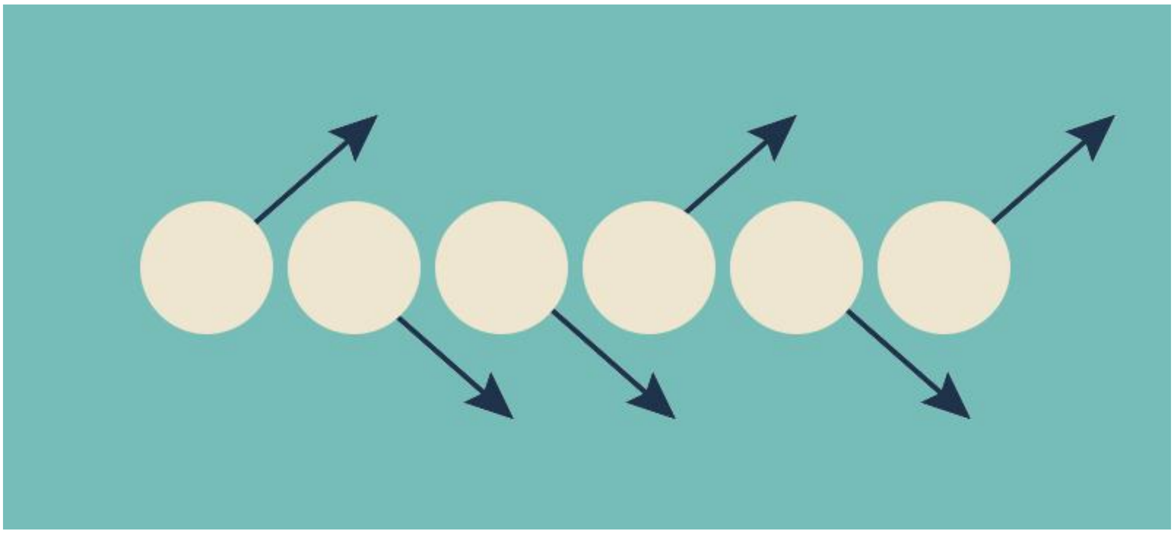
8 Gestalt Law of Synchrony

image: https://visme.co/blog/wp-content/uploads/2017/09/Gestalt-Principles-Synchrony.png



Also commonly known as common fate, the Gestalt design principle of synchrony dictates that **elements moving in the same direction are perceived as more related** than the same elements moving in different directions. Regardless of their placement or how dissimilar they may be, we perceive elements that move in the same direction as related.

image: https://visme.co/blog/wp-content/uploads/2017/09/How-to-Apply-Gestalt-Principles-to-Your-Designs-for-Maximum-Impact-Synchron-001.jpg



Elements don't have to be moving literally for the principle to apply. Consider the above design, for example. Most will instantly associate the circles with the upward-pointing arrows as related as opposed to the group with the downward-pointing arrows, even though they aren't physically grouped together.

Exercises for students

Gestalt design principles help take the guesswork out of design. By employing these psychological tenets, designers and non-designers can understand why they make certain decisions and better predict how audiences will perceive various elements.

And this doesn't just apply to product and visual design projects. They can also be applied to your own **presentations and blogs and, even page design on instagram and Word press.**

Exercise 1

1. **Create a theme for your imaginary product and design one A 4 size visuals using pictures that are cut and paste from magazines and newspapers. For examples – given the theme of "jungle" and create book cover for 6 years old boy.**

2. **What will be the design elements in this visual and why?**

3. **What role geometry and space play in designing this visual? What role did color play here?**

4. **Design two more alternatives with change of color theory – eg, monochromatic theme.**

Exercise 2

Try designing the same visual using Word, Paint or Photoshop software. You can go to internet café and design your visual there if these are not available at home or school.

Think about how the use of technology changes your perspective and outcome. Explain in a write up of your project.

Exercise 3

Take the visual of first exercise and scan it using the facility of internet café. Scanned image will be exported to Photoshop software. Try changing the image using simple edit tools.

Use some other photo editing tools of mobile phone and give it a new color scheme. Try changing fonts and inserting new logo or text.

Try changing the visual using color tones and other visual effects for changing a photo. Write about your experience. Present the same in class in the form of a ppt.

GESTALT THEORY FOR INTERIOR AND ARCHITECTURE DESIGN

When applying the laws, and principles of Gestalt to Architecture, and interior design, it has a completely different approach to what it shows in art as the human brain has to observe the information in front of them that is reality rather than what is on a canvas, and this brings more of an impact to the viewer.

The Harajuku Protestant Church in above visual, situated in Japan is a relative example of how gestalt justifies working in a public space. The figure ground/relationship that is in the space is the form that creates the multiple arches that continue down the space in a sequence of patterns that overlook the seating layout, this is defined by more principles such as common fate, symmetry and order, and proximity, and also the gestalt law emergence as the arches stand out from the design, and brings itself in the viewers filed of vision. When looking at closure in an interior space the viewer will have to fill in the missing information on a space that is not completely closed, like for example in between each form there are gaps that allow natural light into the space, but if the missing information on this is filled then it could be intended to give the impression of a holy biblical open sky, these arches are a collective together as one unit. The design is very innovating and beautiful to look at, and the design serving as a function, and the overall concept of the design hugely relates to its context of being a church.

In Interior Design there are so many attributes that are considered, and can be played with in order for a designer to have total control over the designs, like environment, textures, colours, furniture etc., and with using Gestalt Principles, and it's theories into the design, it does give that total control with very interesting designs, and multiple functions. Also the use of the principles communicating to the viewer in a certain way, which is by the visual perception where certain different perspectives of the space are viewed, and the visual design arrangement within the space, as the viewer pieces together, and views the space completely as it's whole, and uses it, and never noticing the separate elements, like the seating, or the stage etc., everything combines together as a whole. What is importantly considered when designing an interior space is to know the space, and experimenting with it and what is in the space's architecture? What could be placed within the space? This is the relationships between form, shape, colours, texture, light etc., and gestalt theory can use these attributes to enrich the space when combining with the principles, and bring personality to the space, by how elements relate, and work in parallel with each other as a group. Symmetry is another thing that can be spotted from the seating arrangement of the chairs, and the forms in the arches almost mirror each other if you were to fold one of them in half, but there are a lot of similar elements within the space that relate to each other, like the majority of curved outlines, and the rectangle forms on the walls.

Applying Gestalt to an interior space gives the space a beautiful atmosphere, function, and creativeness, in a way it is like applying art, and motion in a space, which is what the pulsate studio shows, and the repeating arches going down the space in the Harajuku Church, the motion interpretation is like what Max Wertheimer had discovered when he noticed the flashing lights as previously mentioned when he was on a train, and he could see the lights rushing past, with the church design each element is observed each as the eye moves each one after the other. Like when gestalt principles being painted on the canvas, the eyes move back and forth in between the figure/ground relationships or the positive/negative

The use of Gestalt principles and laws must be related to how they can perceive, and make up a space, and Gestalt psychology will be the visual perception of the space from how the viewer feels when standing in it, as even just viewing the space from perspective alone is one of the Gestalt principles, as visual perception is the main element. The way that a person can just absorb knowledge from what they see in a space, gives designers more knowledge of how designing this way affects human behaviour, and what the designer is trying to communicate with the viewer. How person can just observe all the elements in the space at once, again reflecting back to the quote made by Koffta "that the whole is more than the sum of its parts" even in architectural, and interior design.

The use of Gestalt Theory being applied in architecture are the same reasons that it is being applied in Interior Design, and on how they form a relationship with people from how design is perceived. There are not many examples where designers demonstrate that they have used gestalt principles in the designs of their buildings, but they can show these principles even without being known that they are using it, as gestalt is considered in everything we do as designers, it's about recognising the principles, and deciding wither Gestalt theory can be seen in the design, even if it is not intentionally used.

Here is an interesting example which is **The Wave Resort skyscraper in Queensland**, Australia that could show the principles of gestalt theory in its design by how the group of wavy forms that are seen as one whole of the building stack upon each other provide a function in the context by relating to its surroundings, by either the natural elements of the wind, and or could relate to the similarity of the ripple waves of the sea, and for the human occupants on the building's exterior, as the wavy forms make up the shape of the balconies, and controls how the use of natural light hits the exterior, so more areas are mixed with shade and sunlight, this relates to symmetry, and order by how the waves have been carefully arranged in order to enable the design.

Although the use of wavy elements on the building's façade are very creative, and eye-catching people will always try to commute a single recognizable pattern from the design when looking at it. The wavy patterns give a sense of movement, like an illusion that it could almost become apart of natural environment, and strongly relating the design to its context. People look at the object, and try to piece together what it is, gathering information from it, trying to make sense of the design.

Gestalt theory is something we encounter every day, everything we look at may have the use of the theory that attracts the eye, it comes across as what is more simulating to the eye, and what the design communicates, the main conception in gestalt theory is that when the viewer looks at something automatically their eyes will merge the separate entities into one whole, as cognition is important as the information is there for the viewer to progress, gestalt needs the human senses so the principles rules can be followed, and noticed e.g. how the viewer notices the similar forms, and groups them, looking at the object of focus etc.

Each one of the gestalt principles does something, and affects the viewer in a different way, but visual perception is the one main thing that all the principles share in common. Gestalt is all around us, and how the human brain captures the information from the object, defines what the designer is trying to say, like how we are supposed to gather the information like the designer did when they first interpreted the design,

Gestalt theory is innovative use on how data is pieced together to give them significance as a whole but still the separate elements feed information to the viewer whilst the whole form can have its own structure to be easily noticed prior, therefore it is concluded that gestalt theory does affect how people visually describe what they see, and how it affects the human mind, because in a way we automatically process the information in front us from a visual perspective in order to make sense the design, the visual idea in this is what the artist or designers is trying to communicate to the viewer because the forms, patterns etc. have a specific and functional use that speaks to the viewer in its own right. Looking at gestalt theory now it is absorbed by the term of psychology, unsettling ways of the human mind, and perceptions, making us think in intense ways.

Source - https://amyrebeccarichards.weebly.com/dissertation.html

Applying the Gestalt Principle to the Web Design Workflow

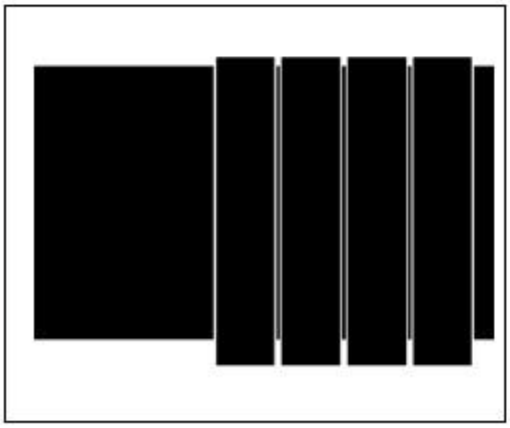
Below are a few web examples and their respective layout silhouettes. The silhouette view is what the brain identifies as the page shape. Trying to change anything other than the main shape will result, more or less, in the same design... and going back to your client with the same design after they've requested changes will make the client feel that nothing has been done.

...the design will look the same until you've changes the structural gestalt.

You'll be surprised at how many designers make this mistake and wonder why the client still hates a design or feel nothing has been changed or added, even though they've worked tirelessly on improving the individual elements.

Alright, let's look at a few actual designs on left and their silhouettes on right:


PHOTO PORTFOLIO
people
animals
objects
nature

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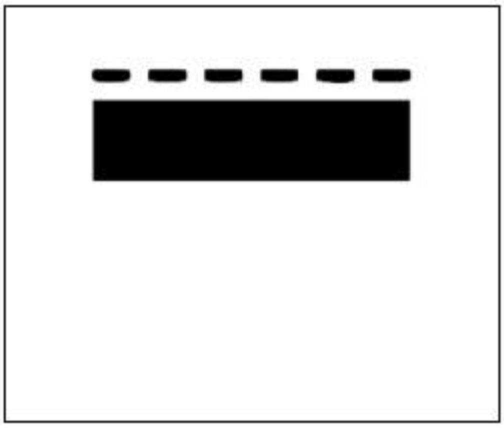


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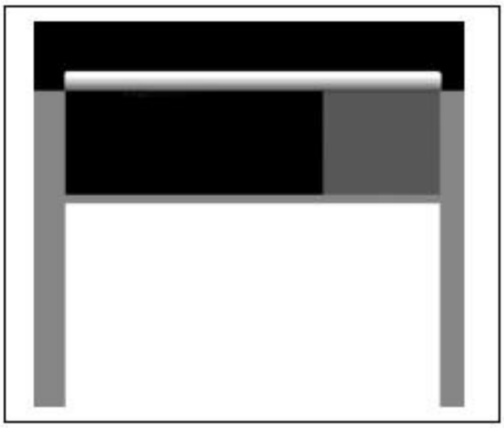
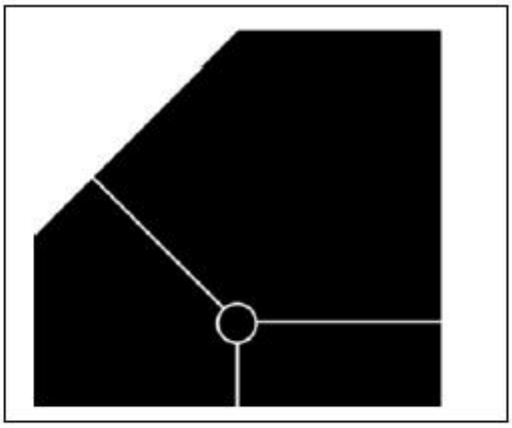
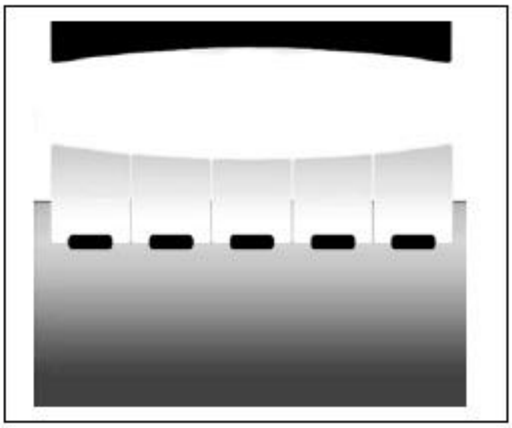
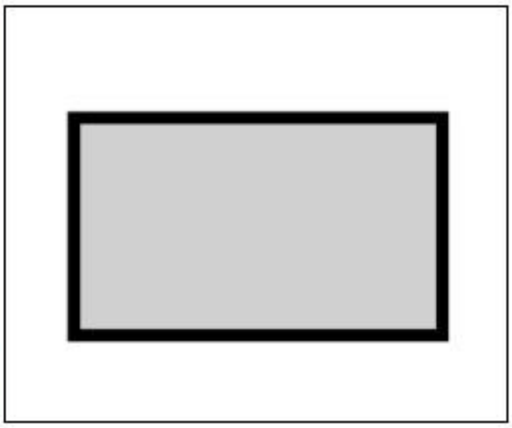








Usually, sticking to the safe and generally square-like design (as in the 4 bottom layouts from the examples above) will result in an ordinary design, nothing very creative. Try to always experiment with the "containing shell" of your design. Try rotating the box a few degrees or cutting out and changing one of the corners... all of this adds to your design's uniqueness and creativity.

You should always start with the container, or the overall structural shell of a design; Forget the details and individual components for now.

When that is done and you and the client are satisfied with the structure, grab your wireframes and start working on the details. You will be surprised at how many times a design ends up as a neatly colored wireframe when you start from the inside out. I've seen several designers working on the header and navigation first, then start laying out the components, and before you know it you have a neatly packed and nicely colored page full of content which may be from a usability perspective well placed and correct, however from a design perspective it would never be creative or stand out.

Think of your design as a chocolate covered peanut, if you start with the peanut, from the inside out, the outer layer which everyone sees (the chocolate layer) will always depend on the peanut shape and you will have little control on the result.

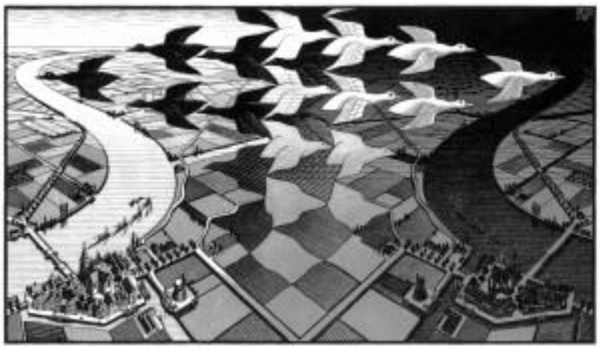
However if you treat your design like a chocolate egg, working on the outer layer first, and shape it as you desire – fitting your inner content to match the shell, then it really doesn't matter what you fill it with, the design will always be the egg-shape that you intended.

Source: https://webdesign.tutsplus.com/articles/the-gestalt-principle-design-theory-for-web-designers--webdesign-1756

Gestalt in Art and Painting

Although Gestalt psychology began in Germany in 1910, it took around 15 years before it was picked up as a concept in the art world. However the principal had been used as part of the normal compositional techniques for thousands of years.

he other great artist that I feel had a 'consistent ' Gestalt feel to their work were Van Gough, and MC Escher. Van Gough brush work combined, proximity, similarity, closure and continuity to his work that could engage the viewer for house. Many of MC Escher's work are superb examples of combining the Gestalt laws of proximity, similarity, closure and continuity in a way that creates illusion, through and art techniques, visual understanding and mathematics.



Art and Gestalt Rules

This section briefly looks at the different Gestalt rules and links them to famous artist.

Figure/Ground

One of the major aspects of Gestalt psychology is the theory of figure-ground perception. Gestalt psychologists believed when people are shown pictures of items or "figures" against a background, the figures tend to stand out from the background behind them. For example, if we were shown a picture of a piano against a wall, we would immediately notice the piano (object) stands out, rather than the wall (background). Even when humans are shown vague images made of ink shading or spots, they are inclined to perceive a picture of a specific figure.

This is the idea that speaks to the human mind's tendency to separate figures from their backgrounds. These differences can be furthered by utilizing a number of different techniques which can include contrast, color, intensity, and size.

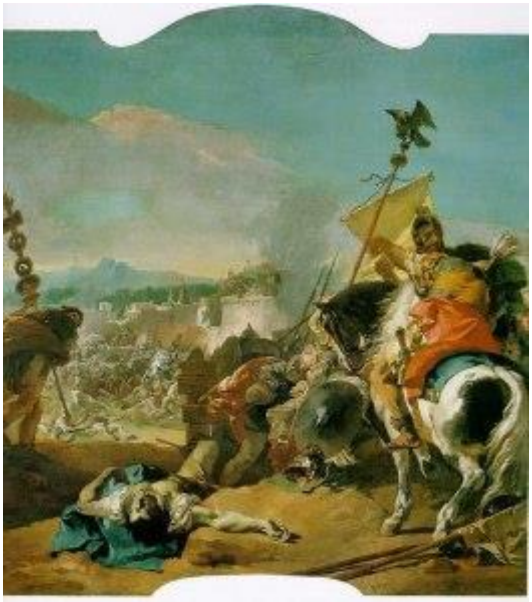
In contrast to how Matisse used Gestalt principles, (see closure below), to make his figures stand out in space, the French artist Vuillard played around with blending the background and the figures present in the image below. Notice how the woman who is closest to us seems to almost disappear into the background while the man at the door has a sharp contrast against the pattern. Vuillard was playing with the principles of Gestalt here to highlight how our eyes generally view paintings. By making the man at the door seem to pop to the front this creates a tension in the painting that some find desirable.

Similarity

This is the Gestalt theory that states that the viewer tends to group together objects which share the same characteristics such as shape, size, color, texture, and value. In the Degas painting below he employed many different circle shapes (in the form of the hats) in order to create a sense of unity throughout the painting. The hats also have similar textures which help group them together. Notice how powerful color intensity is and how the hats which are brighter are easily grouped together while the other hats which are darker are a different group altogether

Proximity

Proximity can be referred to as grouping which are similar or have similarity. However, there is a difference between similarity and proximity as we can see that the objects don't need to all be the same size in order to be grouped by the brain. In the Chardin painting below you can see how the apples are grouped together even though they are different sizes. Grouping can be achieved by shape, color, tone, and space.



Symmetry and Order

Symmetry and Order refers to the idea of how balance and symmetry give the composition an overall feeling of solidity and structure. In Raphael's painting below we can see how by having a clear sense of symmetry adds to the structure of the entire composition. Notice how the figures aren't perfectly symmetrical on both sides of the work, however they are still balanced and neither side seems too "heavy". – In fact we prefer a slight imbalance to hold our interest – and to give us a sense of truth – see photo of the legs – if they were perfect then we would think them false. The larger idea at play here is that viewers want to "read" a painting in a systematic and organized manner. Some viewers who find a painting which is too difficult to read may spend less time trying to comprehend it. While clearly balanced compositions will be more accessible. This is not to say that every composition needs to be perfectly balanced and symmetrical, there are many examples of artists who play with the idea of symmetry and balance and still are quite successful. – MC Escher for example – see below.

Source: https://isolationphotos.wordpress.com/2013/10/05/gestalt-and-art/

IS THE THEORY RELEVANT TODAY AS WELL?

However, there are rumors that the Gestalt psychology, developed over 100 years ago, is not relevant in the digital age, e.g.; it can be very confusing, it has multiple basic principles, and fuzziness in many of its basic definition… According to Johan Wagemans; ***rumors are greatly exaggerated; Gestalt theory is still very relevant in psychology of visions in modern day marketing… These principles are fundamental building blocks for creating effective visual meaning…***According to Kurt Koffka; the *central principle of Gestalt theory can be summarized as– the whole is other than the sum of the parts…* Application of Gestalt principles creates very compelling and engaging visual experiences and presentations…
In the article ***Gestalt Theory: Characteristics, Laws, Applications*** by Alegandra Salazar writes: Gestalt explores the relationships that connect the various elements of reality: ***Humans do not perceive reality in the same way– each person structures information received according to their previous experiences.*** **Their mental representations often do not correspond completely with those that exist in reality, they construct it themselves…** Gestalt theorists focus on seeking– simple explanations for understanding the natural way humans perceive reality. ***Hence through their perceptions, humans are able to acquire knowledge of the world, interact with it and connect with others…*** The Gestaltists tended to favor the notion that these principles are among the fundamental properties of the human perceptual system, providing the basis for the ability to make sense of their sensory signals…

An opposed view is that the Gestalt principles are heuristics derived from some general features of the external world based on a person's experience with things and their properties, e.g.; objects in the world are usually located in front of some background (figure-ground articulation), or have overall texture different from the background (similarity), or consist of parts which are near each other (proximity), or parts that move as a whole (common fate), or closed contours (closure) that are continuous (continuity). ***The value of Gestalt principles lies in their power to create truly appealing content that drives engagement and inspires action based on how the audience's brains perceive visual information…***

In the article ***Gestalt Principles*** by Mads Soegaard writes: The Gestalt principles or laws are rules that describe how the human brain perceives visual elements. ***These principles aim to show how complex scenes can be reduced to more simple shapes.*** They also aim to explain how the brains perceive the shapes as a single, united form rather than the separate simpler elements involved. Researchers have integrated all of these theories to show how people unconsciously connect and link design elements.

In visualizing the world, the human brain works hard to fit all it see into familiar patterns, matching each sensation to pre-existing mental models. ***Hence often a person may see things which are not really there, or perhaps are only partly there.*** The human brain is always helpfully, but often it's fooled– what and how it sees things… An object may be partially obscured, so the outline is incomplete, yet the brain recognizes what it is by completing both the outline and other details…

The human brain looks for patterns– at the most biological level, it's how humans evolved (or hard-wired). Giving people the opportunity to identify simple patterns motivates them to keep looking. ***The lesson: In marketing, advertising, web design, logos, and other visual forms… to be effective– do not confuse the brain with complexity– keep it simple… Strive for simplicity, give viewer's brain opportunity to find patterns and symmetry…***

Source: https://bizshifts-trends.com/death-of-gestalt-theory-is-greatly-exaggerated-key-psychology-in-marketing-advertising-web-design/

2. SIMPLE PRODUCT DESIGN

Product design. ... In a systematic approach, **product designers** conceptualize and evaluate ideas, turning them into tangible inventions and **products**. The **product designer's** role is to combine art, science, and technology to create new **products** that people can use.

Product design consists in imagining and creating objects meant for mass production. The definition encompasses the physical aspects as well as the functionalities products should possess.

Product design definition-

Designing a new product goes through an analytical process and relies on a problem-solving approach to improve the quality of life of the end user and his or her interaction with the environment. It is about problem-solving, about visualizing the needs of the user and bringing a solution.

Product designers also work with other professionals such as engineers and marketers. While not in charge of designing the purely mechanical and technological aspects of the product, they are however concerned with usability.

Product design has many fields of application: medical devices, tableware, jewelry, sports and leisure, food preservation appliances, furniture, etc.

It takes into consideration also the production cost, the manufacturing processes and the regulations.

Product design process-

The design process is divided into many different phases, which include various form of sketching and prototyping. However, sometimes the idea starts from a problem people may experience, and designing a solution to solve it. It is about establishing a link between the user and the environment, using an object to address a need.

Product designers then give life to their ideas through sketching and drawing. They can also use 3D and computer-aided industrial design software. Also, to fully experience and test the item they envision, designers will craft prototypes.

Product design examples-

There are of course infamous product design examples such as the Coca-Cola bottle, the IPod, or the Vespa. Aside from those, one can find many other innovative examples such as **the Dyson Pure Cool Link, an air purifier, winner of the 2016 reddote Award**.

The role of **design** is to create a marketable **product** from an innovation. **Design** is often the deciding factor in the success of a **product**. Many customers make purchasing decisions based primarily on **product design**, because good **product design** ensures quality, appearance, performance, ease of use, and reliability.

Style is more concerned with visuals or outer look of a product. It creates important aesthetic value for consumers. On the other hand, design is more concerned with the basic layout of a product with its core functionality and user experience in mind.

Now let's discuss each essential requirement of a good product design.

- Function. The product must be designed in such a way that it optimally performs the main task or function for which it is purchased by a buyer. ...
- Repairability. ...
- Reliability. ...
- Aesthetics. ...
- Durability. ...
- Producibility. ...
- Simplicity. ...
- Compact.

EXERCISE 1

Design a chair for elderly in your family.

Survey the user in various ways – How do you feel on the current chair options you have? Difficulties in rising up from these chairs? Would you like to have cushioned chair? Do you want a back rest? Is the size sufficient and comfortable?

You can use various formats – Interview, photographic evidence, videos, and many more….

Collect this information and define your problem.

Analyze the problem and give options of various solutions.

Keep material character in mind while designing a chair, for example, how wooden chair is better than an iron or plastic chair.

Sketch out the product design – more than one!!

Color the sketch and write its measurements.

Give reasons that why your chair design is better than what is being used till now.

Unit 2

DESIGN TOOLS AND TECHNIQUES

Session 1: Basic Materials

1. Categorization of basic materials and related properties
2. Introduction to materials and material selection

Objective

• Designers need to study the nature of materials
• Property classification of materials that determines their applicability
• Relation between design, production and utilization of materials

Classifying materials

In manufacturing of a product, a raw material is converted into a finished product. There are various types of classifications available in the literature. Materials come under three basic categories:
metals, ceramics and polymers. A mixture of these fundamental types forms a composite.
Two classification schemes are shown below:

Type 1 classification

• Engineering materials can be classified into six broad families
– Metals
– Polymers
– Elastomers
– Ceramics
– Glasses
– Hybrid composite materials

Type 2 classification

In this type of classification, engineering material can be classified into two categories: Metals and non-metals. Again non-metals are classified into organic & inorganic respectively. Metals can be classified into two categories: ferrous and non-ferrous metals. Ferrous metals contain iron in it. Pure iron has limited use but when alloyed with carbon it has a great commercial value. Some of the common alloys of iron are steel and cast iron which contain different percentages of carbon in it. Steel contains 0.02%to 2.11% of carbon and rest iron, manganese, chromium, nickel, and molybdenum in it. Cast iron contains 2% to 4% of carbon in it and the rest are iron & silicon.
Non-Ferrous metals contain other metallic elements other than iron in it. They include metals aluminum, copper, gold etc.

Ceramics are compounds. These compounds contain a metallic and a non-metallic part. Then on-metals can be oxygen, nitrogen and carbon. Examples of ceramics include carbides, clay, silica, alumina etc.

Polymers are compounds which consist of repeating units in them called as “mers”. Mersshare electrons to form very large molecules - usually of carbon and some other elements like oxygen, hydrogen, nitrogen, chlorine etc. Polymers are further classified into thermosetting, thermoplastics and elastomers. Some of the common polymers are polythene, PVC, etc.

Composites consist of two or more phases of materials. The phases are processed separately and then bonded together to achieve properties superior to the constituents. Some of the materials used in the phases are wood or fiber etc. which are a homogenous mass bonded together with epoxy. Some of the common applications of composites are aircraft, tennis rackets, car bodies, etc.

Material selection for product design

Material selection seeks to improve the following five basic elements:

- the life cycle performance of a material in an application
- the design and manufacturing of a component taking advantage of a material's characteristics
- the properties of a material
- the structure of a material
- synthesis and processing of the material

3. Working on basic materials

Material Design is a design system created by Google. It provides a way for designers and developers to create UIs that are usable and beautiful.

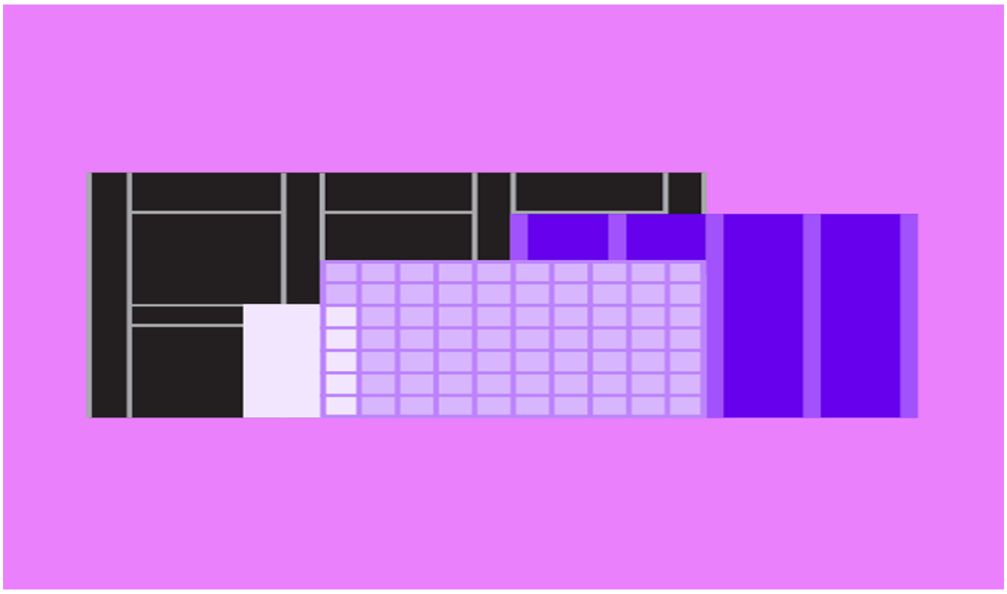
This site provides instructions on how to implement Material for your UI, including design and developer guidance, open-sourcecomponents, icons, fonts, and resources.

Design guidelines

These guidelines describe the look, interactions, and customization possibilities for UIs that use Material — including how to apply color, typography, shape, and layout. They also show how each component is structured: its usage, types, anatomy, placement, behavior, and customization.

Open-source components

Material components are interactive UI elements that make up the UI — including buttons, app bars, and navigation menus. Setup instructions and customization details for each component.



SESSION 2: BASIC PRODUCTION PROCESSES

• BASIC PRODUCTION PROCESSES IN TEXTILE INDUSTRY

The **textile industry** is primarily concerned with the design, production and distribution of yarn, cloth and clothing. The raw material may be natural or synthetic using products of the chemical **industry**.

The first step in creating **fabric** is yarn production. Here, the raw materials that have been harvested and processed are transformed from raw fibers into yarn and threads. This **process** of joining the yarn together is called weaving. Weaving is done on a machine known as a loom and requires two sets of yarn. The weaving done in traditional ways is called “Handloom Industry” and the ones produced with automated machines are called “Power-loom Industry”.

Spinning is the twisting together of drawn-out strands of fibers to form **yarn**, and is a major part of the **textile** industry. The **yarn** is then used to create **textiles**, which are then used to make clothing and many other products. **Weaving** is a method of **textile** production in which two distinct sets of yarns or threads are interlaced at right angles to form a **fabric** or cloth. The longitudinal threads are called the warp and the lateral threads are the weft or filling.

A '**handloom**' is a loom that is used to weave cloth without the use of any electricity. Hand weaving is done on pit looms or frame looms generally located in weavers' homes. Hand spun yarns take time and are part of handicraft sector in our cottage and village industry. The hand spun yarn uses Charkha or spinning when where cotton or wool fibres are twisted to make yarn. The KHADI fabrics are one example of fabric made with hand spun yarn and handloom weaving. Khadi can be in silk, cotton, wool or flax yarn where both yarn and fabrics are made with hand in traditional way which is eco-friendly and consumes very less of electrical or heat energy.
Measuring units:

1. **Yarn count**. The **yarn count** is a numerical expression which defines its fineness or coarseness. It also expresses weather the **yarn** is thick or thin. A definition is given by the textile institute – “**Count** is a number which indicates the mass per unit length or the length per unit mass of **yarn**.”
2. The indirect system or fixed weight system is the yarn count system where the count of a yarn is calculated by measuring the length of a fixed / definite mass.
3. In this system, the count of yarn is the number of length units in one weight unit. So, the count number indicates the length per unit mass of the yarn. That is why, higher the count, finer the yarn. In indirect count system, the mass of yarn is fixed and the length of yarn varies according to its fineness. This system is widely used for measuring count of cotton yarns.
4. Fabric thickness is measure with **GSM method** – gram per square meters
5. **Fabric**, **cloth** typically produced by **weaving**, knitting or knotting **textile** fibers, yarns or threads, is **measured** in units such as the momme, thread count (a **measure** of the coarseness or fineness of **fabric**), ends per inch (e.p.i) and picks per inch (p.p.i).
6. In general, the higher the ends per inch, the finer the fabric is. The current fashion is to wear T-shirts with a higher thread count, such as soft and comfortable "30 single" tee shirt that has 30 threads per inch as contrasted to the standard T-shirt with an 18 thread count per inch.
7. The number of ends per inch in a piece of woven cloth varies depending on the stage of manufacture. Before the cloth is woven, the warp has a certain number of

ends per inch, which is directly related to the size reed being used. After weaving, the number of ends per inch will increase, and it will increase again after being washed. This increase in the number of ends per inch (and picks per inch) and shrinkage in the size of the fabric is known as the **take-up**. The take-up is dependent on many factors, including the material and how tightly the cloth is woven. Tightly woven fabric shrinks more (and thus the number of ends per inch increases more) than loosely woven fabric, as do more elastic yarns and fibers.

8. **Picks per inch/Inch** (or p.p.i.) is the number of weft threads per inch of woven fabric. A pick is a single weft thread hence the term. In general, the higher the picks per inch, the finer the fabric is.
9. ***Weaving*** is a method of ***textile*** production in which two distinct sets of yarns or threads are interlaced at right angles to form a ***fabric*** or cloth- Warp (tana in hindi) is in the lengthwise direction, and Weft (Bana in Hindi) is in the cross wise or width direction. Other methods are knitting, crocheting, felting, and braiding or plaiting.
10. ***Fabric length*** – is measured in Inches and centimetres.
11. ***Garment sizing*** – inches are used for US market and Centimetre is used for European market.

Source: https://en.wikipedia.org/wiki/Units_of_textile_measurement#Ends_per_inch

Sources and types.

Textiles are made from many materials, with four main sources: animal (wool, silk), plant (cotton, flax, jute, bamboo), mineral (asbestos, glass fibre), and synthetic (nylon, polyester, acrylic, rayon). The first three are natural.

Natural **fibres** also consist of polymers (in this case, biologically **produced** compounds such as cellulose and protein), but they emerge from the textile manufacturing process in a relatively unaltered state. ... Rayon and acetate therefore belong to a group of **man-made fibres** known as regenerated **fibres**.

Nylon, the **first** synthetic **fiber** in the "fully synthetic" sense of that term, was developed by Wallace Carothers, an American researcher at the chemical firm DuPont in the 1930s. It soon **made** its debut in the United States as a replacement for silk, just in time for the introduction of rationing during World War II.

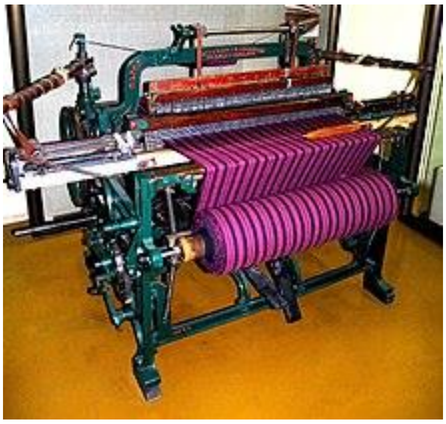
Synthetic **polyester** is **made** using a chemical reaction involving coal, petroleum, air and water. **Polyester** is **made** up of purified terephthalic acid (PTS) or its dimethyl ester dimethyl terephthalate (DMT) and monotheluene glycol (MEG).

Textiles Mills and Production Cycle

A **textile** mill is a manufacturing facility where different types of fibers such as yarn or fabric are produced and processed into usable products. This could be apparel, sheets, towels, **textile** bags, and many more.

There are **two main types** of fabrics: natural and synthetic. Natural fabrics such as wool, cotton, silk, and linen are made from animal coats, cotton-plant seed pods, fibers from silkworms, and flax (fiber from the stalk of a plant), respectively.

The ***handloom weaving process*** can be complicated, as the weaver has to precisely dye the threads and then place them exactly in the right pattern on the loom so that it is woven correctly. The design ***process*** takes up to 5 hours to complete, while the dyeing and drying ***process*** can take another 1–3 days for 24 meters.


Antique loom for woollen fabrics

Vertical loom for carpets and tapestry

Back strap loom of North East India – Silk and cotton weaving industry

Shuttle for Looms

Additional reading:

Article - Weaving: The complete process from thread to cloth
Available at: http://www.3springshandworks.com/Documents/Process.pdf

For ***handloom production***, yarn is colored / dyed in the hank form. Yarn dyeing for *handlooms* is a crucial pre loom activity. Natural and chemical colorants are used to dye hanks. This ***process*** of dyeing is done by hand, in small lots.

Traditionally, the dyes were sourced from nature in Indian textiles. For example, Indigo is a natural dye from leaves of the plant *Indigoferra Tinctoria* which is fermented to obtain the Indigo cakes or powder. The peel of Pomegranate (Anaar) gives yellow color and the root of Madder plant (Manjishta) gives red. It is an eco-friendly process with very less use of chemicals and energy. The artisans use wooden blocks to print natural fabrics which are world famous. Ajrakh block print of Gujrat and Bagru mud resist print of Jaipur are some of the famous hand printed textile techniques using natural dyes and wooden blocks to create patterns. The hand-painted natural dyes in the form of paintings were also famous from India. The water waste from these industries is not harmful for environment and for the workers involved in the dyeing process. The natural source dyes are skin friendly as well as impart health properties to the wearer as these natural compounds are anti-fungal and anti-bacterial in nature.

Additional reading – Case study of Dastkaar Andhra

https://www.dacottonhandlooms.in/the-long-story-about-processes-in-handloom/
https://www.dacottonhandlooms.in/the-long-story-about-processes-in-handloom/
https://www.dacottonhandlooms.in/glossory-handloom/

POWERLOOM

A **power loom** is a mechanized loom, and was one of the key developments in the industrialization of weaving during the early Industrial Revolution. The first power loom was designed in 1784 by **Edmund Cartwright** and first built in 1785. It was refined over the next 47 years until a design by Kenworthy and Bullough made the operation completely automatic.

By 1850 there were 260,000 power looms in operation in England. Fifty years later came the Northrop loom which replenished the shuttle when it was empty

The main components of the loom are the warp beam, heddles, harnesses, shuttle, reed, and take up roll. In the loom, yarn processing includes shedding, picking, battening and taking-up operations.

- *Shedding*. Shedding is the raising of the warp yarns to form a loop through which the filling yarn, carried by the shuttle, can be inserted. The shed is the vertical space between the raised and unraised warp yarns. On the modern loom, simple and intricate shedding operations are performed automatically by the heddle or heald frame, also known as a harness. This is a rectangular frame to which a series of wires, called heddles or healds, are attached. The yarns are passed through the eye holes of the heddles, which hang vertically from the harnesses. The weave pattern determines which harness controls which warp yarns, and the number of harnesses used depends on the complexity of the weave. Two common methods of controlling the heddles are dobbies and a Jacquard Head.
- *Picking*. As the harnesses raise the heddles or healds, which raise the warp yarns, the shed is created. The filling yarn is inserted through the shed by a small carrier device called a shuttle. The shuttle is normally pointed at each end to allow passage through the shed. In a traditional shuttle loom, the filling yarn is wound onto a quill, which in turn is mounted in the shuttle. The filling yarn emerges through a hole in the shuttle as it moves across the loom. A single crossing of the shuttle from one side of the loom to the other is known as a pick. As the shuttle moves back and forth across the shed, it weaves an edge, or selvage, on each side of the fabric to prevent the fabric from raveling.
- *Battening*. As the shuttle moves across the loom laying down the fill yarn, it also passes through openings in another frame called a reed (which resembles a comb). With each picking operation, the reed presses or battens each filling yarn against the portion of the fabric that has already been formed. The point where the fabric is formed is called the fell. Conventional shuttle looms can operate at speeds of about 150 to 200 picks per minute

With each weaving operation, the newly constructed fabric must be wound on a cloth beam. This process is called taking up. At the same time, the warp yarns must be let off or released from the warp beams. To become fully automatic, a loom needs a filling stop motion which will brake the loom, if the weft thread breaks.

Power looms reduced demand for skilled hand weavers, initially causing reduced wages and unemployment. Protests followed their introduction. For example, in 1816 two thousand rioting Calton weavers tried to destroy power loom mills and stoned the workers.[8] In the longer term, by making cloth more affordable the power loom increased demand and stimulated exports, causing a growth in industrial employment, albeit low-paid.[9] The power loom also opened up opportunities for women mill workers.[10] A darker side of the power loom's impact was the growth of employment of children in power loom mills.[11]

Dangers

When operated by a skilled and attentive weaver, looms are not dangerous by themselves. However, there are a number of inherent dangers in the machines, to which inattentive or poorly trained weavers can fall victim. The most obvious is the moving reed, the frames which hold the heddles and the "pinch" or "sand" roll utilized to keep the cloth tight as it passes over the front of the machine and onto the doff roll. The most common injury in weaving is pinched fingers from distracted or bored workers, though this is not the only such injury found. There are numerous accounts of weavers with long hair getting it tangled in the warp itself and having their scalp pulled away from the skull, or large chunks of hair pulled off.[12] As a result of this, it has become industry standard for companies to require weavers to either keep hair up and tied, or to keep their hair short so as not to allow it to become tangled. Also, due to possible pinch points on the front of machines, loose, baggy clothing is prohibited. One complication for weavers, in the terms of safety, is the loud nature in which weave mills operate. Because of this, it is nearly impossible to hear a person calling for help when entangled, and has led OSHA to outline specific guidelines [13] for companies to mitigate the chance of such circumstances from happening. However, even with such guidelines in place, injuries in textile production, due to the machines themselves, are still commonplace.

Source - https://en.wikipedia.org/wiki/Power_loom

Power loom

KNITTED FABRICS

The woven fabrics are made of warp and weft yarns. The knitted fabrics, as another category of fabrics, are made with interloping of yarns just like your mother used to knit woollen sweaters for you. The yarn can be of cotton, polyester or wool. The making process of knitted fabric is on machines only and they are characterized by their ability to stretch on body of the wearer. The T shirts and jogging pants used in sportswear category are made of knitted fabric.

A simple guide to design and production of knitted garments is given in slide below –

There are three types of fabric manufacturing process. They are weaving, knitting and non-weaving. Knitted fabric produced by loop forming. Such type of fabric have huge demand in present world. For manufacturing of knitted fabric, process flow chart of knitting technology is given below.

Circular Knitting

Process Flow Chart for Knitting

Yarn in package form
↓
Place the yarn package in the creel
↓
Feeding the yarn
↓
Set the m/c as per design & GSM
↓
Knitting
↓
Withdraw the roll fabric and weighting
↓
Roll marking
↓
Inspection
↓
Numbering
↓
Dispatching

Designing with fabric involves creativity and imagination. The industry process consists of planning, sourcing, executing and selling the products in accordance with customer needs, demands and fashion trends.

Additional reading

Fashion design https://en.wikipedia.org/wiki/Fashion_design
Textile Design https://en.wikipedia.org/wiki/Textile_design

Harmful effects of Textile industry

Textile production impacts the **environment** in many ways. Farms that grow crops like cotton use lots of water and spray their plants with **harmful** substances like herbicides and pesticides.

Textile dyeing, printing, and finishing processes often use **poisonous** chemicals like arsenic, formaldehyde, lead, and mercury. Organic **cotton** crop does not use **harmful** chemicals like synthetic fertilizers or pesticides. As a result, it doesn't poison the water, soil or air, and is even beneficial to the **environment**. **Cotton** workers on organic **cotton** farms are spared from health problems caused by chemicals in **cotton** farming. For example, indigenous cotton crop of Kutchch region in Gujrat uses only rain water and natural manure from animal droppings. This is called as “Kala Cotton” and has seen a revival in recent decades.

Due to awareness of this aspect, many designers and big companies are working with organic process of growing crops (cotton, hemp, jute), rearing sheep farms in eco-friendly ways and manufacturing fabric using solar energy in spinning wheels as well as natural dyeing process to avoid chemical based dyeing that has lead to soil and water pollution in big way.

Additional Reading

1. Environmental concern in Textile and Fashion industry

https://www.fibre2fashion.com/industry-article/6262/various-pollutants-released-into-environment-by-textile-industry
https://www.fibre2fashion.com/industry-article/6870/environmental-problems-caused-by-leather-processing-units

2. Pit loom weaving

https://www.youtube.com/watch?v=sruS4T6Rwb8

3. Making of cotton yarn video

https://www.youtube.com/watch?v=sruS4T6Rwb8

4. Silk Weaving video – natural dyes and weft ikat
   https://www.youtube.com/watch?v=QmqzxCcXeSA
5. Looms of Assam
   https://www.youtube.com/watch?v=mvpQsRpw1Aw
6. Working of Charkha – spinning wheel of Punjab
   https://www.youtube.com/watch?v=Urmtzb1_n-Y
7. Garment production process
   https://www.youtube.com/watch?v=OngDNbMhNOQ
8. Handloom weaving – Dastkar Andhra
   https://nomadicwoollenmills.com/wp-content/uploads/2015/12/dastkarandhrahandloombooklet.pdf
9. Bunkar documentary – trailer (Banarasi weaving Vs Powerloom) Video
   https://www.imdb.com/title/tt7202190/videoplayer/vi459782937?ref_=tt_ov_vi
10. Ajrakh printing of Gujrat
    https://www.news18.com/news/lifestyle/art-of-tiny-gujarat-village-attains-global-renown-1369309.html
11. The Design process in fashion product development
    https://www.fibre2fashion.com/industry-article/5723/the-design-process-in-fashion-product-development

• Basic production process in Wood industry

What Is Woodworking?

Woodworking means a lot of things, but here's reasonably boring definition I came up with that most hobbyists will probably agree with.

Woodworking is a productive craft that involves cutting, shaping, and joining wood to create decorative and/or useful things.

There is nothing physically demanding about woodworking and you can build at your own pace. The basic concepts are simple to learn, yet it's a hobby that will always remain fresh and challenging as your skills evolve. If you love problem-solving, you will love woodworking. I've been at this for over 40 years and face new challenges with every project I build. It's part of the process. It's also rewarding to produce really cool stuff for your home using your hands and brain. In general, woodworking is a very solitary experience: if you are a bit introverted and love taking on tasks from start to finish, you will love woodworking.

Who Are Woodworkers?

There used to be two stereotypes of woodworkers. The cranky shop teacher who taught a really boring class to kids who didn't want to be there, and the retired grandpa who puttered around in his garage with a lot of time to build an occasional birdhouse.

Thankfully, those stereotypes are no longer true. There is more diversity in woodworking now than ever before, thanks to online communities and the affordability of tools and materials.

In the past ten years there has been a huge rise in two groups of people making woodworking a hobby. **First, women.** It wasn't that long ago when a female woodworker was unusual. Today, women woodworkers are commonplace. There is nothing about woodworking that anyone can't do.

The second huge demographic spike has been among **millennials**, people in their 20s and 30s. I hear from people all the time who work in Silicon Valley or just have some sort of office job and feel the need to make things with their hands.

WHAT'S THE DIFFERENCE BETWEEN A "MAKER" AND A "WOODWORKER"?

A maker is a relatively new term that has cropped up in the past decade or so. It's an all-encompassing term for people who like to dabble in different crafts. This could mean a little woodworking, metalworking, epoxying, concreting, computer programming, electronics, 3D printing, baking, sewing, knitting, jewelry making, sculpting, ceramics, robotics, even playing with Legos. So basically, we are all makers.

A woodworker is a maker who is mostly interested in learning and refining the craft of creating things out of wood. Sometimes we bring other materials into our projects, but the focus is on the wood. It's an affordable, timeless material that's easy to build with.

WHAT'S THE DIFFERENCE BETWEEN WOODWORKING AND CARPENTRY?

This is a little vague, but I tend to think of carpenters as building structures…homes and buildings. Construction work. I don't think of framing a house out of posts, beams and 2x4s as woodworking. Woodworking tends to be building furniture and other items that are moveable. That said, there are a lot of people who refer to woodworkers as carpenters so it doesn't really matter.

WHAT'S THE DIFFERENCE BETWEEN CABINETMAKING AND FURNITURE MAKING?

Again, there is no solid line between these two terms but to me, cabinet makers build things that are permanently mounted into place, such as your kitchen cabinets and are mostly concerned with the surfaces that will be visible.

Furniture can be positioned anywhere the owner likes and therefore more parts of the finished piece can be visible.

Cabinets might use plywood more than most furniture and are assembled using screws and other mechanical fasteners, while furniture is often uses solid lumber and is usually assembled with stronger joinery and glue. Furniture making might demand higher precision.

But there is a lot of overlap here. I've built plenty of furniture with plywood and screws and I've seen some amazing cabinetry that rivals high-end furniture.

TYPES OF WOODWORKING

You might have an image in your mind of what woodworking will entail, but there are a few different ways people approach this craft.

HAND TOOL WOODWORKING

Hand tool woodworking has had a huge revival in the last 20 years. Hand tool woodworkers choose to use classical tools and methods to build things. Hand saws, chisels, scrapers and planes are preferred over anything that plugs into a wall.

Getting started can be very inexpensive, but as your skills improve and the mania sets in, you will discover that a $200 precision hand plane is not unusual.

Hand tool woodworkers probably feel more of a connection to the process than any other type of woodworker. It takes patience, has a longer learning curve, it's a slower way to build and a lot quieter. But the personal fulfillment and satisfaction can be enormous.

POWER TOOL WOODWORKING

I would guess that 90% of woodworkers today are power tool woodworkers. Everything I do on this channel and in my Weekend Woodworker courses are geared toward plugging in tools. Or charging batteries.

Power tools such as miter saws, table saws, drills, sanders are ubiquitous and can be a very affordable way to start building projects right away. Cutting a board on a table saw doesn't take anywhere near the skill and finesse of using a handsaw and takes a fraction of the time.

The biggest drawback to using power tools is that they have the potential to cause serious injuries. It's nothing that should prevent you from using them, but you need to really familiarize yourself with safety procedures. Please see my Safety Basics video for more tips.

DIGITAL WOODWORKING

Digital machines have been around for a while, but have become more affordable in the past few years and are appealing to more and more hobbyists. The primary tool here is the CNC machine that makes precision cuts on flat pieces of wood using a router. You will need to layout and design all of your work on a computer and the machine will take care of the rest, cutting out all your pieces. You don't even have to be in the same room when it's cutting.

The second tool some hobbyists invest in is a laser cutter or engraver. This tool allows you to make even more precise cuts than a CNC and create some beautiful art.

The biggest drawbacks to using digital machines are their cost. You can easily spend thousands of Rupees on them. They have their limitations and you will probably still want a table saw and other power tools in your shop. Some people feel digital tools make them less "connected" to their woodworking and remove the satisfaction of making things by hand.

BLENDED WOODWORKING

Most people have a mixture of hand tools and power tools in their shops. For instance blended approach to woodworking might make most cuts using a table saw, but use a chisel to hand cut dovetails. Some people find that hand tools offer greater precision and control for cutting technically demanding joints and enjoy improving their skills at these tasks.

SPECIALTY WOODWORKING

There are two types of woodworking that some enthusiasts, usually people with an artistic bent, specialize in. Woodturning and scrolling.

Woodturning involves using a lathe to create bowls, spindles and other rounded projects. It's kind of like sculpting clay on a potter's wheel, only with wood and chisels. The only real downside to getting into woodturning is that lathes can be pretty expensive.
Scrolling involves using a scroll saw which is capable of cutting extremely tiny curves and intricate patterns. It takes practice to become proficient, but it's relaxing and you can create some stunning art with a scroll saw. Unlike a lathe, scroll saws are relatively inexpensive. They are pretty quiet and don't make a huge mess.
You can certainly find uses for both tools in a standard woodworking shop, maybe you need to make occasional table legs or add some decorative scrollwork to a fancy bookcase, but in general they aren't tools you will use that often.

RAPID FIRE ROUND!

IS WOODWORKING DANGEROUS?

It's probably safer than driving, but not as safe as not woodworking. Understand how your tools work and learn how to use them correctly. Use common sense.

IS WOODWORKING EXPENSIVE?

Doesn't have to be.

DOES IT REQUIRE A LOT OF PHYSICAL STRENGTH?

Nope.

DOES IT TAKE A LOT OF TIME TO MAKE THINGS?

It can. But I prefer to make projects that I can complete in a weekend or two.

DO YOU NEED A LOT OF SPACE?

Nope. I used to build on the roof of my apartment.

IS THERE A LONG LEARNING CURVE?

No. The basics of woodworking are simple. In my weekend woodworker course, I teach you how to complete your first project in two days.

CAN I DO THIS?

Yes

REALLY?

Yes

WHY DO PEOPLE ENJOY WOODWORKING?

I think one of the reasons why woodworking has become a crazy popular hobby in the past few years is that it offers people a retreat from all the noise that fills our lives these days. When you step into a woodworking shop to build something, it's just you. You enter your shop with an idea of what you want to accomplish and can envision what it will look like when you're done. You'll create something from nothing using logic, intelligence, problem solving skills, and common sense. YOU will be fully responsible for every aspect of making a project, from finding a plan or designing your own, to selecting the tools you will use, obtaining lumber and other materials, to determining a course of action, and to overcoming challenges. It's a rewarding process.

Woodworking is fun and you get to make cool stuff for you house, but ultimately it's about discovering who we are and finding out that life can offer so many more internal rewards if we simply take the time to create. Unplug yourself for a few hours a week and plug in some power tools.

For additional resources sure to check out my video on the "7 Essential Power Tools for New Woodworkers". And for everything else you will need to get started, be sure to download my free guide to setting up a shop for under $1000 at mytoollist.com. You should also check out my video, "18 things every beginning woodworker should know."

Source: https://woodworkingformeremortals.com/what-is-woodworking-a-total-beginners-guide/

Wood industry in India

India Woodwork Industry is one of the fastest growing industries in India's economy. India possesses around 100,000 registered wood ware units and more than 200,000 artisans along with countless other woodworking related units in the sector. Wood has always been a major part of Indian handicrafts and various beautiful things are crafted out of it. India takes pride in manufacturing exquisite and handsome wooden handicrafts in diverse motifs.

Any industry which depends on forests for their raw material requirement is considered to be forest or wood based industry. India is one of the leading countries with mushrooming of wood based industries which include pulp and paper, match, saw wood, veneer and plywood, pencil and dendro biomass industries.

The wooden handicraft of India is draped with a vast cultural and ethnic diversity which is applied to a range of themes, techniques and crafts. These wooden handicrafts are unique in their own style and are claimed to be an absolute personification of the Indian heritage. India Woodwork Industry has not only specialized in serving architectural purpose but also manufactures furniture both in traditional as well as ultramodern style.

In the rural areas of India, furniture and other household utensils are carved out of wood in different shapes and styles. These simple objects are so uniquely blend that they in no way look like daily use stuffs. Animal figures are also an excellent example of India's ethnic woodwork. These wide ranging exclusive styles adopted by the India woodwork industry to carve out various stupefying objects are prepared in different parts of India. Some of the most well-known states of India involved in woodwork are as follows:

- **Gujarat -** Famous for woodwork in carved chests, almirahs, and wooden swings. The wooden swings vary from plain Hewn wood to lavishly embellished ones. There is also a tradition of embedding indigenously made gold, silver, and bronze hues on wood in a place called Sankheda village in Gujarat. Surat, another place in Gujarat, is well-known for its marquetry-work which is called as 'Sadeli' by local people.

- **Kashmir-** Famous for its exclusive Kashmir houseboat made out of a specially mollified wood that does not soak in water. Also, the houses in Kashmir are made of wood with latticework windows and geometrically patterned ceilings.

- **Hoshiarpur (Punjab) -** Gained immense popularity for carving inlaying ivory which is now replaced with plastic to cut down on the cost. Wooden furniture, trays, and mirror frames are usually crafted using intricate designs that were claimed to be the royal patronage ages back.

- **Saharanpur (U.P) -** The leading place for commercial purposes. Sheesham and Teak are the chief woods used for manufacturing traditional as well as contemporary designed products-screens, cigarette boxes, tables, trivets, bookends, and so on. Of late, Saharanpur is dealing with wood seasoning only.

- **Kerala -** Specializes in arena handicrafts that along with representing their customs and beliefs also portray their spiritual values and emotions.

- **Other areas -** West Bengal, Bihar, Orissa and Andhra Pradesh are also engaged in carving out various uniquely designed items out of wood.

India Woodwork Industry uses various kinds of woods, for example, Walnut, Sandalwood, Teak, Sheesham, Deodar, Ebony, Redwood, Rosewood, Red, Cedar, Sal, and many more. Recently, embedding of brass wires (Tarkashi) has gained lot of attention worldwide. India has set up over 3,000 woodworking units and the number is increasing with the passage of time.
Source: https://business.mapsofindia.com/india-industry/woodwork.html
The forest based industry is growing rapidly with the increasing demand for furniture, housing, construction material, packaging, agriculture good, sports goods, plywood, veneer, matches etc. Similarly the biomass based power generation industries are also on the raise across the country to generate electricity from forest biomass. This growing demand of wood and wood based industries will create a wood deficit of 20-70 million cubic meter by 2020.

The following are the major forest based industries which depend heavily on forest and agroforestry plantation to meet the raw material requirement.

1. Pulp and Paper Industries:
The pulp and paper industry is one of the key industries in India and it is highly fragmented. Today, there are about 700 paper mills in India with 33 in the large scale sector. During 1990s, the per capita consumption of paper was 3.3 kg which has now escalated to 8 kg, but still lower compared to the global average of 47.7 kg. The current production of raw material for pulp and paper production is 2.76 million tons as against the demand of 5.04 million tonnes. The shortfall is as high as 45 per cent.

2. Match Industries:
Match wood industry is one of the oldest wood based industries in India. About 75 per cent of the total match wood industries in the country are located in the state of Tamil Nadu which comprises nearly 6,000 match industries with mechanized, semi mechanized and as cottage industry. The per capita consumption of matches in India increased steadily from 2.45 kg (1970) to 4.25 kg (1987).

3. Timber and Sawn Wood Industries:
Traditionally people in the country predominantly use timber and other converted wood in all their domestic and industrial wood requirement. The rapid population growth, urbanization and industrialization resulted in greater usage of wood in furniture, housing

and construction material. During, 2010-2012 more than 500 million square feet of space is estimated to be built in urban areas of the country and the wood products were valued around US Dollar 3 billion.
With greater usage wood as a predominant material for housing and construction material in urban and semi urban areas there is going to be a great demand for timber and other sawn wood requirement. The Indian furniture market is estimated at 8 billion US Dollar and in most cases raw materials are imported from various countries.

Major Timber Species:

I Tectona grandis

ii. Terminalia spp.

iii. Albizia spp.

iv. Gmelina arborea

v. Azadirachta indica

vi. Pterocarpus spp.

vii. Mangifera indica

4. Plywood Industries:

One of the fastest growing in India is the plywood industry. The industrialization and urbanization and the increased interest on interior decorations have made great usage of plywood in the country. Wide range of species have been found amenable for making face, core and inner veneers resulted in establishment of more than 2,000 small scale industries involved in plywood manufacture.
The liberalization and privatization policy of government of India also significantly contributed towards establishment of new rural industries. These industries also depend heavily on various species which thereby attracted large scale promotion of plywood based industrial wood plantations.

Major Plywood Species:
i. Populus spp.
ii. Melia dubia
iii. Paulownia spp.

5. Particle Board Industries:

Particle board is reconstituted constructional panel particularly developed as a substitute for natural constructional wood and is made from low grade waste woods or from ligneous agricultural residues. These particle boards are predominantly used for wall paneling and interior decorations in domestic and industrial wood sector. In India, the first particle board industry was set up in late 1950s at Sitapur in Uttar Pradesh and from then onwards large number of industries has been installed across the country.

Major Raw Materials:
i. All types of wood waste
ii. All types of pine needles
iii. All types of Casuarina needles
iv. Ligneous agriculture residues

6. Fibre Board Industries:

Fibre board is constituted using sheet materials of widely varying diversities manufactured from refined or partially refined wood fibers or other vegetable fibers.

7. Dendro Biomass Power Generation Industries:

Biomass is an important fuel source in overall energy scenario. Biomass is produced through chemical storage of solar energy in plants and other organic matter as a result of photosynthesis. This biomass include plantation that produces energy crops, natural vegetable growth and other organic waste and residues.
Among all these biomass, the role of dendro biomass is very significant due to their higher calorific value and increased fuel efficiency. Hence, large number of dendro biomass based power plants has been established across the country to generate electricity.

8. Value Addition Industries:

The wood based industries have to store the harvested raw materials during rainy season in order to have sustainable raw material availability and to sustain the industrial process during lean season. The post-harvest management of huge volume of industrial wood necessitates proper handling, storage and utilization which demand a scientific intervention in order to reduce post-harvest losses due to biological agents particularly powder post beetles and pin hole borers.

These biological agents are taking heavy toll of stored industrial raw materials which need to be addressed. Hence large number wood seasoning and preservative industries have been established to avoid post-harvest losses. Similarly, the plantation and industrial processing activities accounts for 20-30 per cent of wood residues which are either unutilized or underutilized for want of suitable recycling technologies.

These plantation and industrial wood residues have been successfully value added into briquettes and as on today many industries have been established across the country and successful value addition using plantation residues have been evidenced. These value added briquettes acted as excellent feed stock for biomass power generation industry, boiler industries and other industries requiring biomass for meeting the energy demands. The entire value addition process of plantation residues is depicted in Figure below.

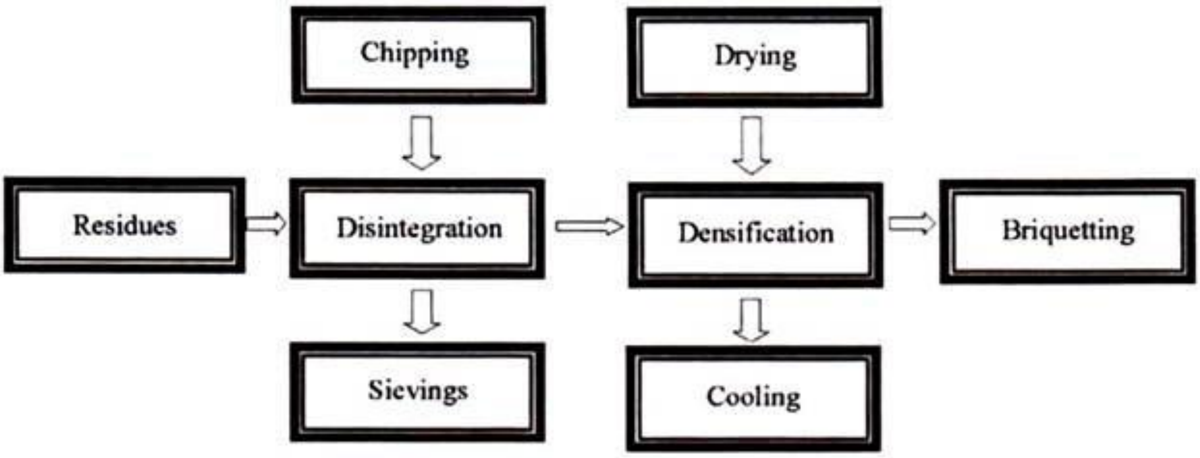


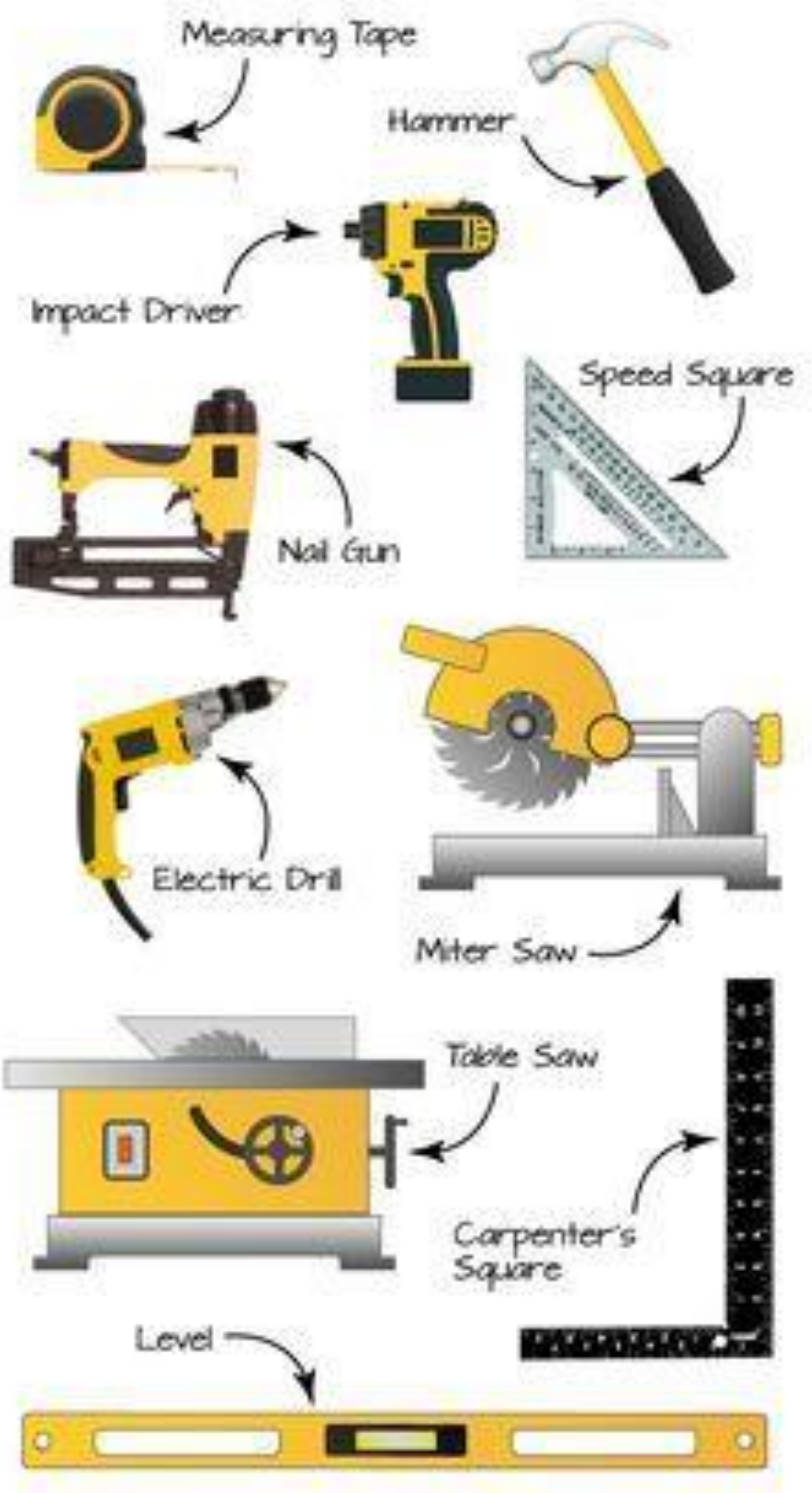
Fig. 25.2: Value Addition of Plantation Residues through Briquetting

Source: http://www.environmentalpollution.in/forestry/forest-based-industries/list-of-top-forest-based-industries-forestry/4752

Basic Carpentry tools
Hand tools list

- saw.
- hammer.
- cultivator.
- rake.
- ladder.
- file.
- gloves.
- wheelbarrow. mallet. chisel. screwdriver. wrench. hand drill. level. ax. pliers. clamp. bolt cutter. box cutter. shears. vise. nut. bolt. nail. screw. tape measure. shovel. Allen key. Power tools.


TOOLS & EQUIPMENT
NAILS
BOLT
NUT
SCREWS
SCREWDRIVER
BRADAWL
WRENCH
ADJUSTABLE WRENCH
PIPE WRENCH
HANDSAW
BACKSAW
COPING SAW
HACKSAW
CHAINSAW
MALLET
HAMMER
SPIRIT LEVEL
POCKETKNIFE
A PAIR OF SCISSORS
CORDLESS DRILL
BRACE
LINEMAN'S PLIERS
NEEDLE NOSE PLIERS
TOOLBOX
TAPE MEASURE
PLUNGER
ELECTRIC DRILL
CORKSCREW
DIAGONAL PLIERS
CAULKING GUN
SLIP JOINT PLIERS
STEPLADDER
7ESL.COM



Measuring tools

Woodworking machines trace their origins to 18th century England. They were important tools in the production of furniture. People also used them to make things such as, carts, wagons, axles, yokes and wheels. Currently, there are different categories of woodwork machinery for industrial use. Examples of woodworking machinery include:

• Jointers

Jointers are woodworking machines that flattens and straightens the edges of wood boards. Various industries also use it to smoothen bottom of the wood board. This allows the board to mover accurately through planers.

The structure of a jointer comprises an infeed table that is movable. Jointers also come embedded with outfeed tables and spinning heads. The latter contains knives.

• Table saws

Table saws consist of adjustable arbors with motors. They must also have a blade, fence and flat table for them to work properly. The functions of table saws majorly center on ripping and cross-cutting wood boards. In the former's case, industries cut the wood boards along their grains. This is the opposite case in cross-cutting, which involves cutting across the board's grain.

• Shapers

As their name suggests, shapers are woodworking machinery that bring shapes to timber. In conjunction with cutters, they are appropriate for manufacturing accents for Australian crown moldings or furniture.

• Chisel mortisers and chains

These woodworking machines are relevant when producing precise holes on pieces of wood. They have the ability to control the hole's depth as per the desired measurement.

• Routers

Routers are very important tools when seeking to make intricate circles, patterns or designs in timber. There are various kinds of routers that comprise mid-range, hobby, specialty and multi-axis routers. CNC Routers are a step above, favoured with very high end industrial woodworkers.

Regulations regarding woodworking machinery

Wood based industries need to take care of their woodworking machinery. Failure to do this results in various problems like physical injuries, inefficient tools and poor productivity. Central to the safety regulations for woodworking machinery is protective gear.

It is imperative that workers should don safety gears when operating woodworking equipment. For instance, they must use hearing protection aids when operating noisy tools. Safety glasses are a must for all woodworking machinery.

Also, woodworking machines need regular maintenance to keep them in tip-top condition. Examples of maintenance practices include blade sharpening, lubrication, greasing and consistent cleaning. Generally, they must be free from wood chippings, dust and scrap. This way, Australian wood shops can reduce risks and improve workers' productivity.

Source: https://www.business2community.com/tech-gadgets/woodworking-machinery-for-industrial-use-0244570

10 STAGES OF FURNITURE PRODUCTION **May 7, 2018**

Furniture. We use them every day. Without them, our apartments and houses would be empty and uncomfortable. But do we know how they arise? This article in a clear and transparent way will explain what steps wood goes through to become a beautiful and comfortable piece of furniture in our apartment.

Stage 1 – furniture design.

Before producers start producing furniture, they must be designed. Designers have many ideas for furniture in various styles. In recent years, apart from the appearance of furniture, great importance is attached to its functionality. The approved project is sent to the production hall, where the next stages of furniture creation follow.

Stage 2 – Selection of materials for the production of furniture.

The furniture production process begins with the preparation of the right material. The most common materials from which furniture is made are wood and wood-like products. Manufacturers of solid wood furniture must first select a tree species. Pine is the most commonly used tree species for furniture production. The furniture is made of oak, beech and ash wood, as well as ebony or cherry.

Stage 3 – Shearing and transport.

In the next stage, the trees of selected species are cut out. These works are carried out by qualified woodcutters using specialized equipment. Then the wood is transported to the sawmill. At this point, the wood is cut into boards and transported to the dryer.

Stage 4 – Drying.

The process of drying wood is extremely important, because it has a big impact on the quality of manufactured furniture. In a situation where the wood is very dry, it dries in the apartment as a finished piece of furniture. Then the deformation process takes place. The standard adopted for the production of furniture is humidity reduced to 8-10%. The use of this standard significantly affects the quality of furniture.

Stage 6 – Execution of individual pieces of furniture.

The next stage in creating furniture is to make all the elements of a particular piece of furniture in accordance with the design. Machines are used during this process, so it takes relatively quickly. The use of the latest technology and good quality equipment means that every piece of furniture is precise. The accuracy and precision of the individual elements is very important, because it affects the quality of furniture and makes it easier to adjust when assembling furniture.

Stage 7 – Grinding.

Each cut part after the finished stage goes to the appropriate departments. It's polished there. Thanks to this, the furniture is smooth and has no shards.

Stage 8 – Painting and varnishing.

The next stage of furniture production is giving it a final look. To give the wood shine and make it resistant to water, each piece of furniture overlaps with the preservative layer. It can be varnish, stain or wax. Then the elements are polished.

Stage 9 – Packaging and transporting items to the store.

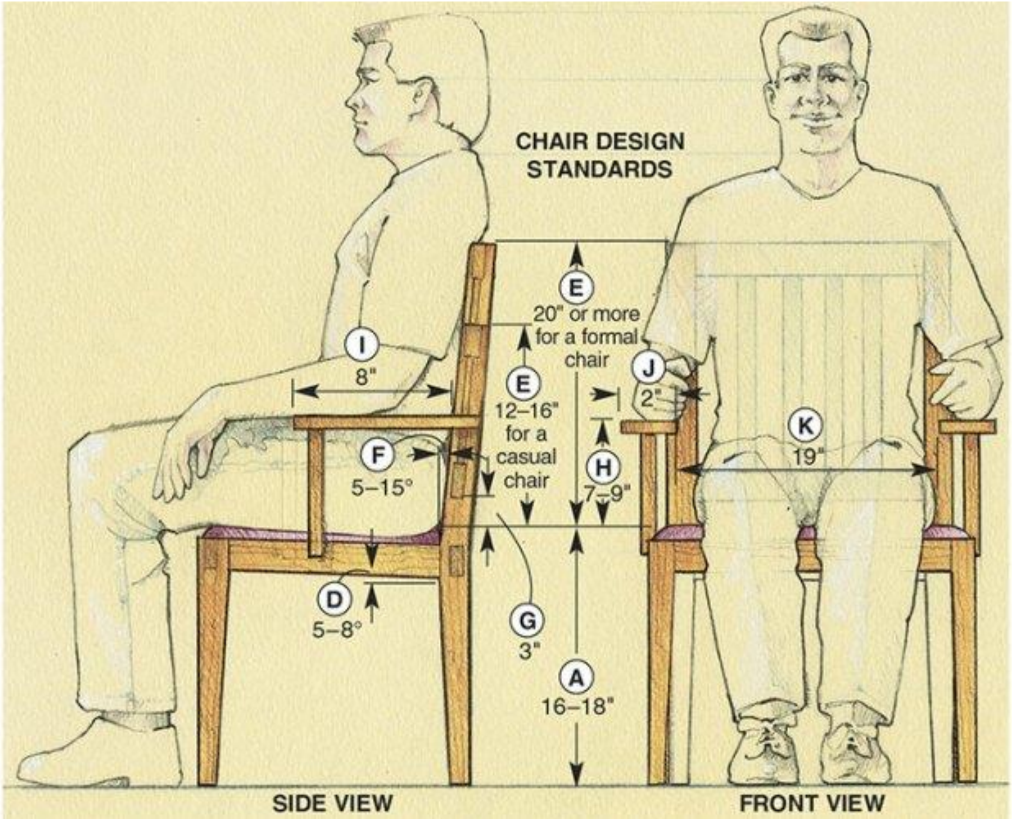
Finished furniture elements are packed and prepared for transport. Each package contains all the elements necessary to assemble furniture. The finished packages are transported to the store where you can buy them. Thanks to the fact that the furniture is spread, it is easier to carry.

Stage 10 – Assembly of furniture.

After purchase and delivery to the apartment, please send it. The packaging in which the furniture is located is accompanied by instructions. According to the recommendations, we will assemble the elements in the purchased furniture.

Source: http://www.furnituretop10.com/10-stages-of-furniture-production
"Drawing a piece's design plays a key role in the decision process between you, the maker, and your client. By seeing and agreeing to the final design, you know that the client will be delighted with the furniture on delivery."

In order to develop the design for a piece of furniture, a student needs to answer a series of questions in an organized way. Design must follow a systematic process.



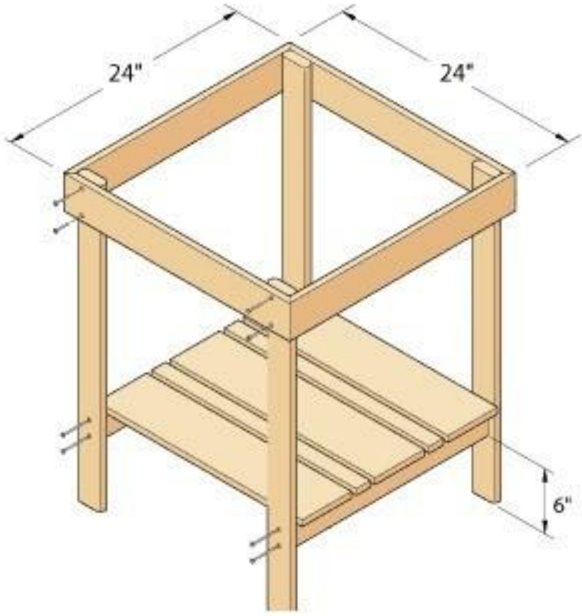
https://www.woodmagazine.com/must-have-measurements-for-comfortable-seating
Drawing video:
https://www.youtube.com/watch?v=8Kq6E_zKofE
How to draw Easy furniture - perspective drawing 12

Software

Furniture design software allows you to create amazing furniture items on your PC. Whether you work as a furniture designer or you simply want to design your own pieces of furniture, the tools that we're going to list in this article will help you get the job done. Some of these are –

Solid Works is very versatile furniture design software that you can use for living rooms, dining rooms, bedrooms and offices. The CAD models support a wide variety of materials, including stainless steel furniture, wooden furniture, as well as custom-design furniture.

CAD Pro Furniture Design Software



CAD Pro is drafting software that lets you design, visualize, and share your furniture design ideas. You can use this tool to design any piece of furniture that you want, from classic tables to extravagant chairs.

PRO100 Furniture Design Software

PRO100 is professional software for furniture and interior design. This tool will allow you to design the interior of kitchens, bathrooms and living rooms faster and more efficiently.

One of the main strong points of this tool is the quality of visualisation. The crystal-clear detailed images that PRO100 renders are very useful, allowing you to spot even the tinniest design details.

The latest version of the tool brings even more impressive features to the table:

- Design export to 3D panoramas (including VR glasses, mobile devices, web sites)
- Swap any part, e.g. handles, fittings, drawers
- Distribution tool (e.d. for shelves or lights arrangement at equal distances from each other)
- Export to *.jpg files

Source: https://windowsreport.com/furniture-design-software/

Furniture design articles and videos:

1. Furniture Design Principles: Making Prototypes and Scaled Models

https://www.youtube.com/watch?v=QEjdHCbZ8xs

2. Sutainable furniture designs

https://www.momtastic.com/webecoist/2009/01/13/creative-strange-sustainable-furniture-design/

3. Design trends in Interior Design – Recycling and sustainable furniture concepts

https://www.scmp.com/lifestyle/interiors-living/article/2180225/design-trends-2019-small-sustainable-scandinese-curves

4. Top 10 Eco-furniture pieces
   https://www.theguardian.com/environment/gallery/2008/jan/03/ethicalliving.ethicallliving
5. Best new green materials for your furniture

   https://www.thisoldhouse.com/ideas/best-new-green-materials-your-interior

• Basic production processes in metal industry

Fundamentals of Metal Forming

There are four basic production processes for producing desired shape of a product. These are casting, machining, joining (welding, mechanical fastners, epoxy, etc.), and deformation processes. Casting process exploit the fluidity of a metal in liquid state as it takes shape and solidifies in a mold. Machining processes provide desired shape with good accuracy and precision but tend to waste material in the generation of removed portions. Joining processes permit complex shapes to be constructed from simpler components and have a wide domain of applications.

Deformation processes exploit a remarkable property of metals, which is their ability to flow plastically in the solid state without deterioration of their properties. With the application of suitable pressures, the material is moved to obtain the desired shape with almost no wastage. The required pressures are generally high and the tools and equipment needed are quite expensive. Large production quantities are often necessary to justify the process.

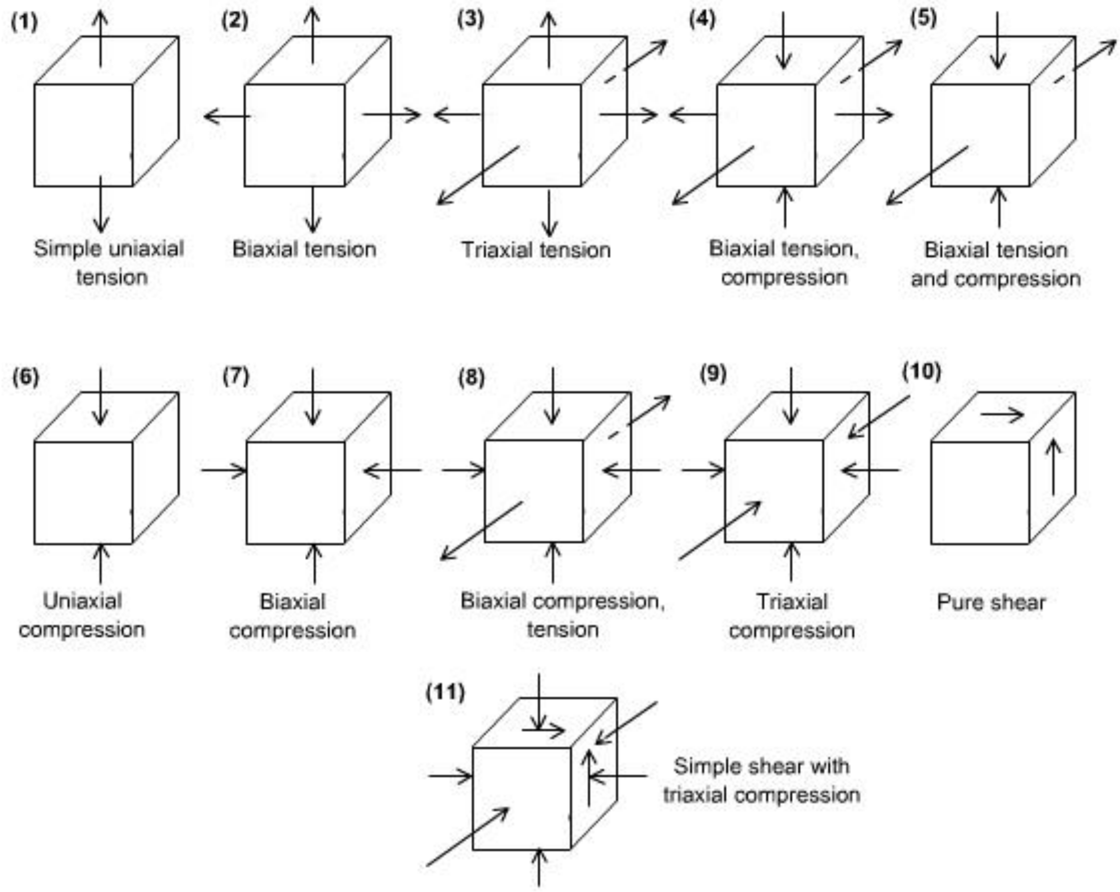
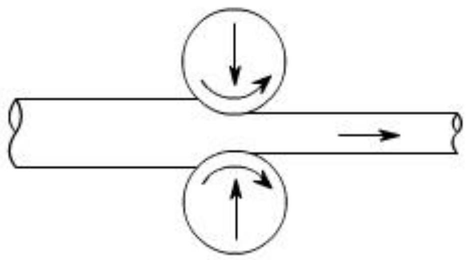
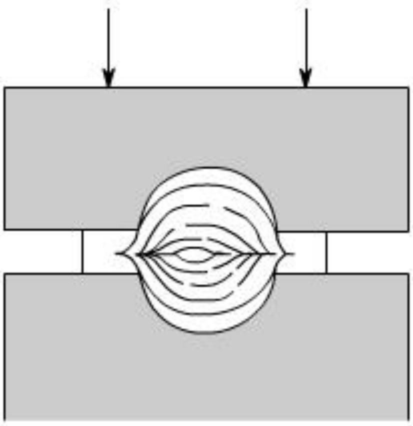
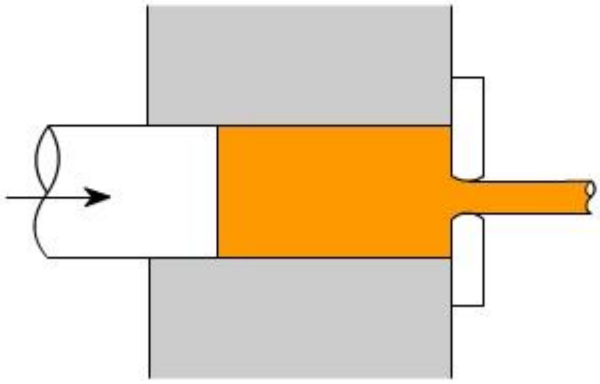
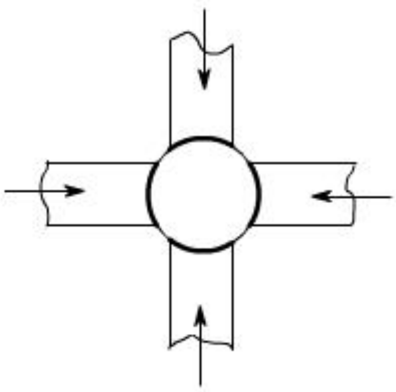


Fig 1.1 State of the stresses metal undergo during deformation.

As a metal is deformed (or formed, as often called) into useful shape, it experiences stresses such as tension, compression, shear, or various combinations thereof Fig 1.1 illustrates these states of stresses. Some common metal forming processes are schematically given in Fig 1.2 along with the state of stress(es) experienced by the metal during the process.

Number	Process	State of Stress in Main Part During Forming
1	Rolling 	Bi-axial compression

2	Forging 	Tri-axial compression
3	 Extrusion	Tri-axial compression
4	swaging 	Bi-axial compression
5	Deep	In flange of blank, bi-axial tension and compression. In wall of cup, simple uni-axial tension.

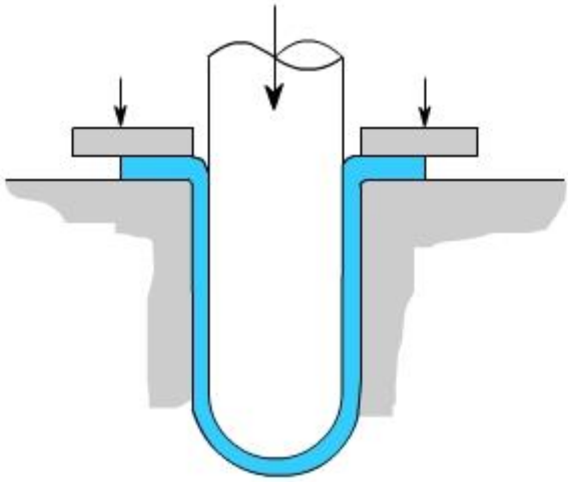
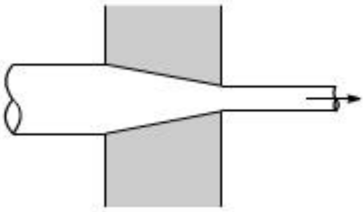
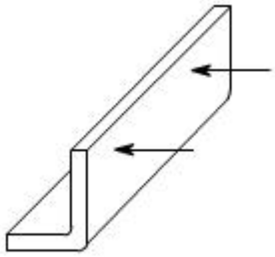
	 drawing	
6	Wire and tube drawing 	Bi-axial compression, tension.
7	Straight bending 	At bend, bi-axial compression and bi-axial tension

Fig 1.2 Common metal forming processes. State of stress experienced by metal is also given

To understand the forming of metal, it is important to know the structure of metals. Metals are crystalline in nature and consist of irregularly shaped grains of various sizes. Each grain is made up of atoms in an orderly arrangement, known as a lattice. The orientation of the atoms in a grain is uniform but differs in adjacent grains. When a force is applied to deform it or change its shape, a lot of changes occur in the grain structure. These include grain fragmentation, movement of atoms, and lattice distortion. Slip planes develop through the lattice structure at points where the atom bonds of attraction are the weakest and whole blocks of atoms are displaced. The orientation of atoms, however, does not change when slip occurs.

To deform the metal permanently, the stress must exceed the elastic limit. At room temperature, the metal is in a more rigid state than when at higher temperature. Thus, to deform the metal greater pressures are needed when it is in cold state than when in hot state.

When metal is formed in cold state, there is no recrystallization of grains and thus recovery from grain distortion or fragmentation does not take place. As grain deformation proceeds, greater resistance to this action results in increased hardness and strength. The metal is said to be strain hardened. There are several theories to explain this occurrence. In general, these refer to resistance build up in the grains by atomic dislocation, fragmentation, or lattice distortion, or a combination of the three phenomena.

The amount of deformation that a metal can undergo at room temperature depends on its ductility. The higher the ductility of a metal, the more the deformation it can undergo. Pure metals can withstand greater amount of deformation than metals having alloying elements, since alloying increases the tendency and rapidity of strain hardening. Metals having large grains are more ductile than those having smaller grains.

When metal is deformed in cold state, severe stresses known as *residual stresses* are set up in the material. These stresses are often undesirable, and to remove them the metal is heated to some temperature below the recrystallize range temperature. In this temperature range, the stresses are rendered ineffective without appreciable change in physical properties or grain structure.

Cold And Hot Working Of Metals

Cold Working:

Plastic deformation of metals below the recrystallization temperature is known as cold working. It is generally performed at room temperature. In some cases, slightly elevated temperatures may be used to provide increased ductility and reduced strength. Cold working offers a number of distinct advantages, and for this reason various cold-working processes have become extremely important. Significant advances in recent years have extended the use of cold forming, and the trend appears likely to continue.

In comparison with hot working, the advantages of cold working are:

1. No heating is required

2. Better surface finish is obtained

3. Better dimensional control is achieved; therefore no secondary machining is generally needed.

4. Products possess better reproducibility and interchangeability.

5. Better strength, fatigue, and wear properties of material.

6. Directional properties can be imparted.

7. Contamination problems are almost negligible.

Some disadvantages associated with cold-working processes are:

1. Higher forces are required for deformation.

2. Heavier and more powerful equipment is required.

3. Less ductility is available.

4. Metal surfaces must be clean and scale-free.

5. Strain hardening occurs (may require intermediate annealing).

6. Undesirable residual stresses may be produced

Cold forming processes, in general, are better suited to large-scale production of parts because of the cost of the required equipment and tooling.

Warm Working:

Metal deformation carried out at temperatures intermediate to hot and cold forming is called *Warm Forming.* Compared to cold forming, warm forming offers several advantages. These include:

• Lesser loads on tooling and equipment

• Greater metal ductility

• Fewer number of annealing operation (because of less strain hardening)

Compared to hot forming, warm forming offers the following advantages.

• Lesser amount of heat energy requirement

• Better precision of components

• Lesser scaling on parts

• Lesser decarburization of parts

• Better dimensional control

• Better surface finish

• Lesser thermal shock on tooling

• Lesser thermal fatigue to tooling, and so greater life of tooling.

Hot Working:

Plastic deformation of metal carried out at temperature above the recrystallization temperature, is called hot working. Under the action of heat and force, when the atoms of metal reach a certain higher energy level, the new crystals start forming. This is called recrystallization. When this happens, the old grain structure deformed by previously carried out mechanical working no longer exist, instead new crystals which are strain-free are formed.

In hot working, the temperature at which the working is completed is critical since any extra heat left in the material after working will promote grain growth, leading to poor mechanical properties of material.

In comparison with cold working, the advantages of hot working are:

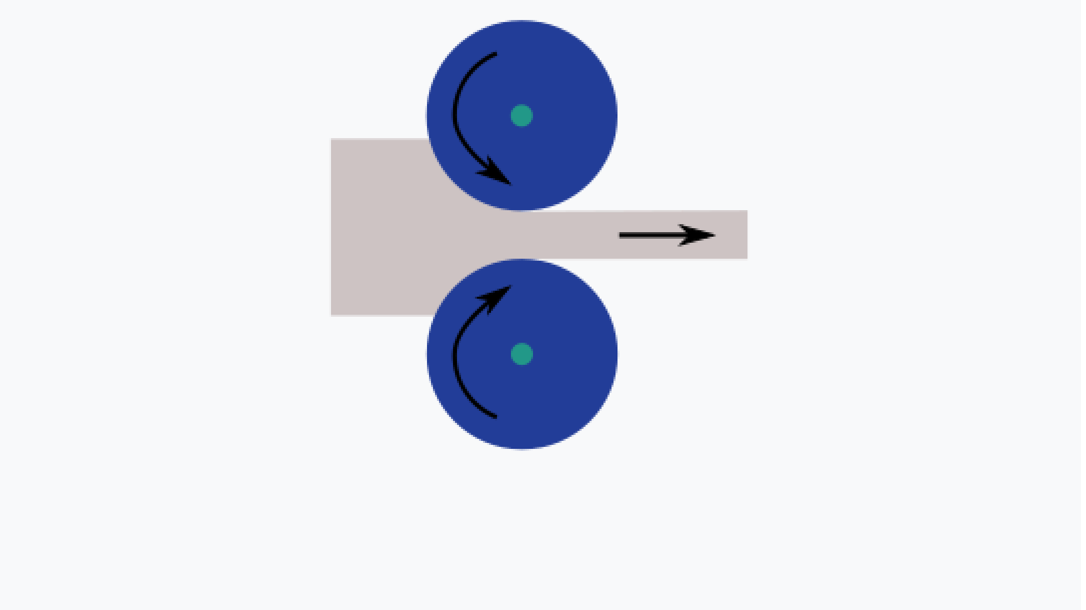
1. No strain hardening
2. Lesser forces are required for deformation
3. Greater ductility of material is available, and therefore more deformation is possible.
4. Favorable grain size is obtained leading to better mechanical properties of material
5. Equipment of lesser power is needed
6. No residual stresses in the material.

Some disadvantages associated in the hot-working of metals are:

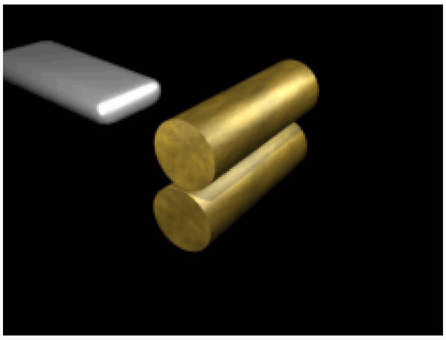
1. Heat energy is needed
2. Poor surface finish of material due to scaling of surface
3. Poor accuracy and dimensional control of parts
4. Poor reproducibility and interchangeability of parts
5. Handling and maintaining of hot metal is difficult and troublesome
6. Lower life of tooling and equipment.

Rolling (metalworking)

"Rolling mill" redirects here. For mills that use rollers to crush grain or stone, see roller mill.



Rolling schematic view

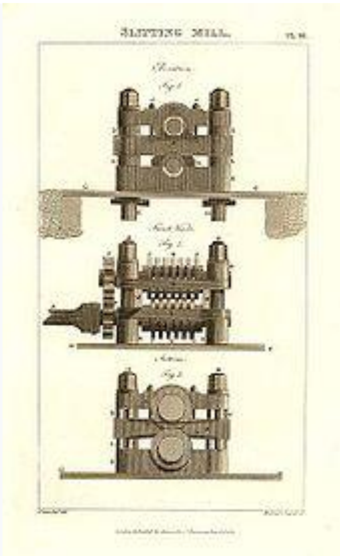


Rolling visualization. (Click on image to view animation.)

In metalworking, **rolling** is a metal forming process in which metal stock is passed through one or more pairs of **rolls** to reduce the thickness and to make the thickness uniform. The concept is similar to the rolling of dough. Rolling is classified according to the temperature of the metal rolled. If the temperature of the metal is above its recrystallization temperature, then the process is known as **hot rolling**. If the temperature of the metal is below its recrystallization temperature, the process is known as **cold rolling**. In terms of usage, hot rolling processes more tonnage than any other manufacturing process, and cold rolling processes the most tonnage out of all cold working processes.[1][2] **Roll stands** holding pairs of rolls are grouped together into **rolling mills** that can quickly process metal, typically steel, into products such as structural steel (I-beams, angle stock, channel stock), bar stock, and rails. Most steel mills have rolling mill divisions that convert the semi-finished casting products into finished products.

There are many types of rolling processes, including *ring rolling*, *roll bending*, *roll forming*, *profile rolling*, and *controlled rolling*.

Iron and steel



Slitting mill, 1813.

The invention of the rolling mill in Europe may be attributed to Leonardo da Vinci in his drawings.[3] The earliest rolling mills in crude form but the same basic principles were found in Middle East and South Asia as early as 600 BCE. Earliest rolling mills were slitting mills, which were introduced from what is now Belgium to England in 1590. These passed flat bars between rolls to form a plate of iron, which was then passed between grooved rolls (slitters) to produce rods of iron.[4] The first experiments at rolling iron for tinplate took place about 1670. In 1697, Major John Hanbury erected a mill at Pontypool to roll 'Pontypool plates'—blackplate.[citation needed] Later this began to be rerolled and tinned to make tinplate.[citation needed] The earlier production of plate iron in Europe had been in forges, not rolling mills.[citation needed]

The slitting mill was adapted to producing hoops (for barrels) and iron with a half-round or other sections by means that were the subject of two patents of c. 1679.[citation needed],

Some of the earliest literature on rolling mills can be traced back to Christopher Polhem in 1761 in *PatriotistaTestamente*, where he mentions rolling mills for both plate and bar iron.[5] He also explains how rolling mills can save on time and labor because a rolling mill can produce 10 to 20 or more bars at the same time.

A patent was granted to Thomas Blockley of England in 1759 for the polishing and rolling of metals. Another patent was granted in 1766 to Richard Ford of England for the first tandem mill.[6] A tandem mill is one in which the metal is rolled in successive stands; Ford's tandem mill was for hot rolling of wire rods. [citation needed]

Other metals

Rolling mills for lead seem to have existed by the late 17th century. Copper and brass were also rolled by the late 18th century.

Modern rolling

Properzi roller, MuseoNazionaledellaScienza e dellaTecnologia "Leonardo da Vinci", Milan

Modern rolling practice can be attributed to the pioneering efforts of Henry Cort of Funtley Iron Mills, near Fareham, England. In 1783, a patent was issued to Henry Cort for his use of grooved rolls for rolling iron bars.[7] With this new design, mills were able to produce 15 times more output per day than with a hammer.[8] Although Cort was not the first to use grooved rolls, he was the first to combine the use of many of the best features of various iron making and shaping processes known at the time. Thus modern writers have called him "father of modern rolling."

The first rail rolling mill was established by John Birkenshaw in 1820, where he produced fish bellied wrought iron rails in lengths of 15 to 18 feet.[8] With the advancement of technology in rolling mills, the size of rolling mills grew rapidly along with the size of the products being rolled. One example of this was at The Great Exhibition in 1851, where a plate 20 feet long, 3 ½ feet wide, and 7/16 of an inch thick, and weighing 1,125 pounds, was exhibited by the Consett Iron Company.[8] Further evolution of the rolling mill came with the introduction of three-high mills in 1853 used for rolling heavy sections.[citation needed]

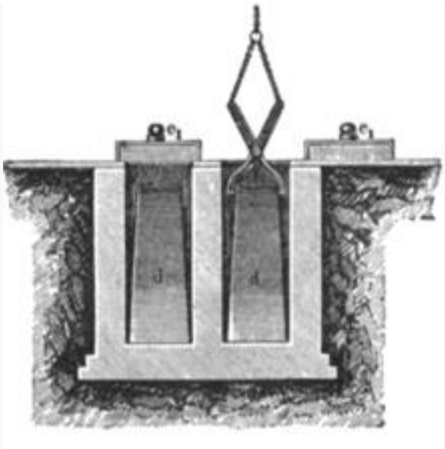
Hot and cold rolling

Hot rolling

A coil of hot-rolled steel

See also: Hot working

Hot rolling is a metalworking process that occurs above the recrystallization temperature of the material. After the grains deform during processing, they recrystallize, which maintains an equiaxed microstructure and prevents the metal from work hardening. The starting material is usually large pieces of metal, like semi-finished casting products, such as slabs, blooms, and billets. If these products came from a continuous casting operation the products are usually fed directly into the rolling mills at the proper temperature. In smaller operations, the material starts at room temperature and must be heated. This is done in a gas- or oil-fired soaking pit for larger work pieces; for smaller work pieces, induction heating is used. As the material is worked, the temperature must be monitored to make sure it remains above the recrystallization temperature. To maintain a safety factor a *finishing temperature* is defined above the recrystallization temperature; this is usually 50 to 100 °C (90 to 180 °F) above the recrystallization temperature. If the temperature does drop below this temperature the material must be re-heated before more hot rolling.[9]



SOAKING PITS.

Soaking pits used to heat steel ingots before rolling.

Hot-rolled metals generally have little directionality in their mechanical properties and deformation induced residual stresses. However, in certain instances non-metallic inclusions will impart some directionality and work pieces less than 20 mm (0.79 in) thick often have some directional properties. Also, non-uniform cooling will induce a lot of residual stresses, which usually occurs in shapes that have a non-uniform cross-section, such as I-beams. While the finished product is of good quality, the surface is covered in mill scale, which is an oxide that forms at high temperatures. It is usually removed via pickling or the smooth clean surface (SCS) process, which reveals a smooth surface.[10] Dimensional tolerances are usually 2 to 5% of the overall dimension.[11]

Hot-rolled mild steel seems to have a wider tolerance for amount of included carbon than does cold-rolled steel, and is, therefore, more difficult for a blacksmith to use. Also for similar metals, hot-rolled products seem to be less costly than cold-rolled ones.[12]

Hot rolling is used mainly to produce sheet metal or simple cross-sections, such as rail tracks. Other typical uses for hot-rolled metal [13]:

- Truck frames
- Automotive clutch plates, wheels and wheel rims
- Pipes and tubes
- Water heaters
- Agricultural equipment
- Strappings
- Stampings
- Compressor shells
- Metal buildings
- Railroad hopper cars and railcar components
- Doors and shelving
- Discs
- Guard rails for streets and highways

Shape rolling design

Rolling mills are often divided into roughing, intermediate and finishing rolling cages. During shape rolling, an initial billet (round or square) with edge of diameter typically ranging between 100–140 mm is continuously deformed to produce a certain finished product with smaller cross section dimension and geometry. Different sequences can be adopted to produce a certain final product starting from a given billet. However, since each rolling mill is significantly expensive (up to 2 million euros), a typical requirement is to contract the number or rolling passes. Different approaches have been achieved including empirical knowledge, employment of numerical models, and Artificial Intelligence techniques. Lambiase et al.[14][15] validated a finite element model (FE) for predicting the final shape of a rolled bar in round-flat pass. one of the major concern when designing rolling mills is to reduce the number of passes; a possible solution to such requirement is represented by the **slit pass** also called **split pass** which divided an incoming bar in two or more subpart thus virtually increasing the cross section reduction ratio per pass as reported by Lambiase.[16] Another solution for reducing the number of passes in the rolling mills is the employment of automated systems for Roll Pass Design as that proposed by Lambiase and Langella.[17] subsequently, Lambiase further developed an Automated System based on Artificial Intelligence and particularly an integrated system including an inferential engine based on Genetic Algorithms a knowledge database based on an Artificial Neural Network trained by a parametric Finite element model and to optimize and automatically design rolling mills.[18]

Cold rolling

See also: Cold-formed steel

Cold rolling occurs with the metal below its recrystallization temperature (usually at room temperature), which increases the strength via strain hardening up to 20%. It also improves the surface finish and holds tighter tolerances. Commonly cold-rolled products include sheets, strips, bars, and rods; these products are usually smaller than the same products that are hot rolled. Because of the smaller size of the workpieces and their greater strength, as compared to hot rolled stock, four-high or cluster mills are used.[2] Cold rolling cannot reduce the thickness of a workpiece as much as hot rolling in a single pass.

Cold-rolled sheets and strips come in various conditions: *full-hard*, *half-hard*, *quarter-hard*, and *skin-rolled*. Full-hard rolling reduces the thickness by 50%, while the others involve less of a reduction. Cold rolled steel is then annealed to induce ductility in the cold rolled steel which is simply known as a *Cold Rolled and Close Annealed*. Skin-rolling, also known as a *skin-pass*, involves the least amount of reduction: 0.5–1%. It is used to produce a smooth surface, a uniform thickness, and reduce the yield point phenomenon (by preventing Lüders bands from forming in later processing). It locks dislocations at the surface and thereby reduces the possibility of formation of Lüders bands. To avoid the formation of Lüders bands it is necessary to create substantial density of unpinned dislocations in ferrite matrix. It is also used to break up the spangles in galvanized steel. Skin-rolled stock is usually used in subsequent cold-working processes where good ductility is required.

Other shapes can be cold-rolled if the cross-section is relatively uniform and the transverse dimension is relatively small. Cold rolling shapes requires a series of shaping operations, usually along the lines of sizing, breakdown, roughing, semi-roughing, semi-finishing, and finishing.

If processed by a blacksmith, the smoother, more consistent, and lower levels of carbon encapsulated in the steel makes it easier to process, but at the cost of being more expensive.[19]

Typical uses for cold-rolled steel include metal furniture, desks, filing cabinets, tables, chairs, motorcycle exhaust pipes, computer cabinets and hardware, home appliances and components, shelving, lighting fixtures, hinges, tubing, steel drums, lawn mowers, electronic cabinetry, water heaters, metal containers, fan blades, frying pans, wall and ceiling mount kits, and a variety of construction-related products.[20]

Processes

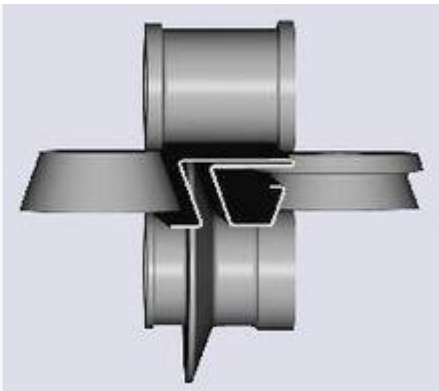
Roll bending

Roll bending

Main article: Roll bender

Roll bending produces a cylindrical shaped product from plate or steel metals .[21]

Roll forming



Roll forming

Main article: Roll forming

Roll forming, roll bending or plate rolling is a continuous bending operation in which a long strip of metal (typically coiled steel) is passed through consecutive sets of rolls, or stands, each performing only an incremental part of the bend, until the desired cross-section profile is obtained. Roll forming is ideal for producing parts with long lengths or in large quantities. There are 3 main processes: 4 rollers, 3 rollers and 2 rollers, each of which has as different advantages according to the desired specifications of the output plate.

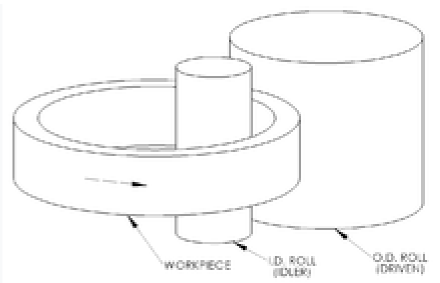
Flat rolling

Flat rolling is the most basic form of rolling with the starting and ending material having a rectangular cross-section. The material is fed in between two *rollers*, called *working rolls* that rotate in opposite directions. The gap between the two rolls is less than the thickness of the starting material, which causes it to deform. The decrease in material thickness causes the material to elongate. The friction at the interface between the material and the rolls causes the material to be pushed through. The amount of deformation possible in a single pass is limited by the friction between the rolls; if the change in thickness is too great the rolls just slip over the material and do not draw it in.[1] The final product is either sheet or plate, with the former being less than 6 mm (0.24 in) thick and the latter greater than; however, heavy plates tend to be formed using a press, which is termed *forging*, rather than rolling.[*citation needed*]

Often the rolls are heated to assist in the workability of the metal. Lubrication is often used to keep the work piece from sticking to the rolls.[*citation needed*] To fine-tune the process, the speed of the rolls and the temperature of the rollers are adjusted.[22]

h is sheet metal with a thickness less than 200 µm (0.0079 in).[*citation needed*] The rolling is done in a *cluster mill* because the small thickness requires a small diameter rolls.[9] To reduce the need for small rolls *pack rolling* is used, which rolls multiple sheets together to increase the effective starting thickness. As the foil sheets come through the rollers, they are trimmed and slitted with circular or razor-like knives. Trimming refers to the edges of the foil, while slitting involves cutting it into several sheets.[22] Aluminum foil is the most commonly produced product via pack rolling. This is evident from the two different surface finishes; the shiny side is on the roll side and the dull side is against the other sheet of foil.[23]

Ring rolling



A schematic of ring rolling

Ring rolling is a specialized type of hot rolling that **increases** the diameter of a ring. The starting material is a thick-walled ring. This work piece is placed between two rolls, an inner *idler roll* and a *driven roll*, which presses the ring from the outside. As the rolling occurs the wall thickness decreases as the diameter increases. The rolls may be shaped to form various cross-sectional shapes. The resulting grain structure is circumferential, which gives better mechanical properties. Diameters can be as large as 8 m (26 ft) and face heights as tall as 2 m (79 in). Common applications include railway tyres, bearings, gears, rockets, turbines, airplanes, pipes, and pressure vessels.[10]

Structural shape rolling

Cross-sections of continuously rolled structural shapes, showing the change induced by each rolling mill.

Main article: Structural shape rolling

Controlled rolling

Controlled rolling is a type of thermomechanical processing which integrates controlled deformation and heat treating. The heat which brings the work piece above the recrystallization temperature is also used to perform the heat treatments so that any subsequent heat treating is unnecessary. Types of heat treatments include the production of a fine grain structure; controlling the nature, size, and distribution of various transformation products (such as ferrite, austenite, pearlite, bainite,and marten site in steel); inducing precipitation hardening; and, controlling the toughness. In order to achieve the entire process must be closely monitored and controlled. Common variables in controlled rolling include the starting material composition and structure, deformation levels, temperatures at various stages, and cool-down conditions. The benefits of controlled rolling include better mechanical properties and energy savings.

Forge rolling

Forge rolling is a longitudinal rolling process to reduce the cross-sectional area of heated bars or billets by leading them between two contrary rotating roll segments. The process is mainly used to provide optimized material distribution for subsequent die forging processes. Owing to this a better material utilization, lower process forces and better surface quality of parts can be achieved in die forging processes.

Basically any forgeable metal can also be forge-rolled. Forge rolling is mainly used to preform long-scaled billets through targeted mass distribution for parts such as crankshafts, connection rods, steering knuckles and vehicle axles. Narrowest manufacturing tolerances can only partially be achieved by forge rolling. This is the main reason why forge rolling is rarely used for finishing, but mainly for preforming.

Characteristics of forge rolling:

- high productivity and high material utilization
- good surface quality of forge-rolled workpieces
- extended tool life-time
- small tools and low tool costs
- improved mechanical properties due to optimized grain flow compared to exclusively die forged work pieces

Mills

For the factory, see steel mill.

A *rolling mill*, also known as a *reduction mill* or *mill*, has a common construction independent of the specific type of rolling being performed:

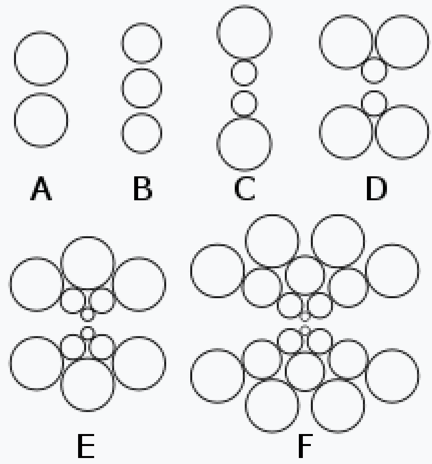
Rolling mills

Rolling mill for cold rolling metal sheet like this piece of brass sheet

- Work rolls
- Backup rolls - are intended to provide rigid support required by the working rolls to prevent bending under the rolling load
- Rolling balance system - to ensure that the upper work and back up rolls are maintained in proper position relative to lower rolls
- Roll changing devices - use of an overhead crane and a unit designed to attach to the neck of the roll to be removed from or inserted into the mill.
- Mill protection devices - to ensure that forces applied to the backup roll chocks are not of such a magnitude to fracture the roll necks or damage the mill housing
- Roll cooling and lubrication systems
- Pinions - gears to divide power between the two spindles, rotating them at the same speed but in different directions
- Gearing - to establish desired rolling speed
- Drive motors - rolling narrow foil product to thousands of horsepower
- Electrical controls - constant and variable voltages applied to the motors
- Coilers and uncoilers - to unroll and roll up coils of metal

Slabs are the feed material for hot strip mills or plate mills and blooms are rolled to billets in a billet mill or large sections in a structural mill. The output from a strip mill is coiled and, subsequently, used as the feed for a cold rolling mill or used directly by fabricators. Billets, for re-rolling, are subsequently rolled in either a merchant, bar or rod mill. Merchant or bar mills produce a variety of shaped products such as angles, channels, beams, rounds (long or coiled) and hexagons.

Configurations



Various rolling configurations. Key: A. 2-high B. 3-high C. 4-high D. 6-high E. 12-high cluster & F. 20-high Sendzimir Mill cluster

Mills are designed in different types of configurations, with the most basic being a *two-high non-reversing*, which means there are two rolls that only turn in one direction. The *two-high reversing* mill has rolls that can rotate in both directions, but the disadvantage is that the rolls must be stopped, reversed, and then brought back up to rolling speed between each pass. To resolve this, the *three-high* mill was invented, which uses three rolls that rotate in one direction; the metal is fed through two of the rolls and then returned through the other pair. The disadvantage to this system is the workpiece must be lifted and lowered using an elevator. All of these mills are usually used for primary rolling and the roll diameters range from 60 to 140 cm (24 to 55 in).

To minimize the roll diameter a *four-high* or *cluster* mill is used. A small roll diameter is advantageous because less roll is in contact with the material, which results in a lower force and power requirement. The problem with a small roll is a reduction of stiffness, which is overcome using *backup rolls*. These backup rolls are larger and contact the back side of the smaller rolls. A four-high mill has four rolls, two small and two large. A cluster mill has more than 4 rolls, usually in three tiers. These types of mills are commonly used to hot roll wide plates, most cold rolling applications, and to roll foils.

Historically mills were classified by the product produced:

- Blooming, cogging and slabbing mills, being the preparatory mills to rolling finished rails, shapes or plates, respectively. If reversing, they are from 34 to 48 inches in diameter, and if three-high, from 28 to 42 inches in diameter.
- Billet mills, three-high, rolls from 24 to 32 inches in diameter, used for the further reduction of blooms down to 1.5x1.5-inch billets, being the nub preparatory mills for the bar and rod
- Beam mills, three-high, rolls from 28 to 36 inches in diameter, for the production of heavy beams and channels 12 inches and over.
- Rail mills with rolls from 26 to 40 inches in diameter.
- Shape mills with rolls from 20 to 26 inches in diameter, for smaller sizes of beams and channels and other structural shapes.
- Merchant bar mills with rolls from 16 to 20 inches in diameter.
- Small merchant bar mills with finishing rolls from 8 to 16 inches in diameter, generally arranged with a larger size roughing stand.
- Rod and wire mills with finishing rolls from 8 to 12 inches in diameter, always arranged with larger size roughing stands.
- Hoop and cotton tie mills, similar to small merchant bar mills.

- Armour plate mills with rolls from 44 to 50 inches in diameter and 140 to 180-inch body.
- Plate mills with rolls from 28 to 44 inches in diameter.
- Sheet mills with rolls from 20 to 32 inches in diameter.
- Universal mills for the production of square-edged or so-called universal plates and various wide flanged shapes by a system of vertical and horizontal rolls.

Tandem mill

A tandem mill is a special type of modern rolling mill where rolling is done in one pass. In a traditional rolling mill rolling is done in several passes, but in tandem mill there are several *stands* (>=2 stands) and reductions take place successively. The number of stands ranges from 2 to 18. Tandem mills can be either of hot or cold rolling mill types.

Defects

In hot rolling, if the temperature of the workpiece is not uniform the flow of the material will occur more in the warmer parts and less in the cooler. If the temperature difference is great enough cracking and tearing can occur.

Flatness and shape

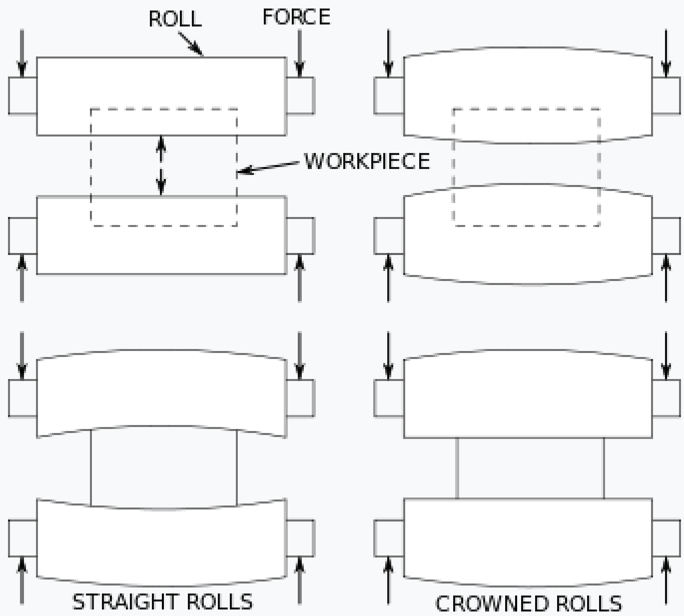
In a flat metal workpiece, the flatness is a descriptive attribute characterizing the extent of the geometric deviation from a reference plane. The deviation from complete flatness is the direct result of the workpiece relaxation after hot or cold rolling, due to the internal stress pattern caused by the non-uniform transversal compressive action of the rolls and the uneven geometrical properties of the entry material. The transverse distribution of differential strain/elongation-induced stress with respect to the material's average applied stress is commonly referenced to as shape. Due to the strict relationship between shape and flatness, these terms can be used in an interchangeable manner. In the case of metal strips and sheets, the flatness reflects the differential fiber elongation across the width of the workpiece. This property must be subject to an accurate feedback-based control in order to guarantee the machinability of the metal sheets in the final transformation processes. Some technological details about the feedback control of flatness are given in.

Profile

Profile is made up of the measurements of crown and wedge. Crown is the thickness in the center as compared to the average thickness at the edges of the workpiece. Wedge is a measure of the thickness at one edge as opposed to the other edge. Both may be expressed as absolute measurements or as relative measurements. For instance, one could have 2 mil of crown (the center of the workpiece is 2 mil thicker than the edges), or one could have 2% crown (the center of the workpiece is 2% thicker than the edges).

It is typically desirable to have some crown in the workpiece as this will cause the workpiece to tend to pull to the center of the mill, and thus will run with higher stability.

Flatness



Roll deflection

Maintaining a uniform gap between the rolls is difficult because the rolls deflect under the load required to deform the workpiece. The deflection causes the workpiece to be thinner on the edges and thicker in the middle. This can be overcome by using a crowned roller (parabolic crown), however the crowned roller will only compensate for one set of conditions, specifically the material, temperature, and amount of deformation.[11]

Other methods of compensating for roll deformation include continual varying crown (CVC), pair cross rolling, and work roll bending. CVC was developed by SMS-Siemag AG and involves grinding a third order polynomial curve into the work rolls and then shifting the work rolls laterally, equally, and opposite to each other. The effect is that the rolls will have a gap between them that is parabolic in shape, and will vary with lateral shift, thus allowing for control of the crown of the rolls dynamically. Pair cross rolling involves using either flat or parabolically crowned rolls, but shifting the ends at an angle so that the gap between the edges of the rolls will increase or decrease, thus allowing for dynamic crown control. Work roll bending involves using hydraulic cylinders at the ends of the rolls to counteract roll deflection.

Another way to overcome deflection issues is by decreasing the load on the rolls, which can be done by applying a longitudinal force; this is essentially drawing. Other method of decreasing roll deflection include increasing the elastic modulus of the roll material and adding back-up supports to the rolls.[11]

The different classifications for flatness defects are:

- Symmetrical edge wave - the edges on both sides of the work piece are "wavy" due to the material at the edges being longer than the material in the center.
- Asymmetrical edge wave - one edge is "wavy" due to the material at one side being longer than the other side.
- Center buckle - The center of the strip is "wavy" due to the strip in the center being longer than the strip at the edges.
- Quarter buckle - This is a rare defect where the fibers are elongated in the quarter regions (the portion of the strip between the center and the edge). This is normally attributed to using excessive roll bending force since the bending force may not compensate for the roll deflection across the entire length of the roll.

It is important to note that one could have a flatness defect even with the workpiece having the same thickness across the width. Also, one could have fairly high crown or wedge, but still produce material that is flat. In order to produce flat material, the material must be reduced by the same percentage across the width. This is important because mass flow of the material must be preserved, and the more a material is reduced, the more it is elongated. If a material is elongated in the same manner across the width, then the flatness coming into the mill will be preserved at the exit of the mill.

Draught

The difference between the thickness of initial and rolled metal piece is called Draught. Thus it is initial thickness and is final thickness, then the draught is given by the maximum draught that can be achieved via rollers of radius with coefficient of static friction between the roller and the metal surface is given by

This is the case when the frictional force on the metal from inlet contact matches the negative force from the exit contact.

Surface defect types

There are six types of surface defects: [30]

Lap

This type of defect occurs when a corner or fin is folded over and rolled but not welded into the metal.[31] They appear as seams across the surface of the metal.

Mill-shearing

These defects occur as a feather-like lap.

Rolled-in scale

This occurs when mill scale is rolled into metal.

Scabs

These are long patches of loose metal that have been rolled into the surface of the metal.

Seams

They are open, broken lines that run along the length of the metal and caused by the presence of scale as well as due to pass roughness of Roughing mill.

Slivers

Prominent surface ruptures.

Surface defect remediation

Many surface defects can be scarfed off the surface of semi-finished rolled products before further rolling. Methods of scarfing have included hand-chipping with chisels (18th and 19th centuries); powered chipping and grinding with air chisels and grinders; burning with an oxy-fuel torch, whose gas pressure blows away the metal or slag melted by the flame;[32] and laser scarfing.

Steel manufacturing methods have evolved dramatically since the processes of the industrial revolution began in the mid 19th century. However modern methods are still based on the Bessemer process which was practised over 150 years ago. This was a way to introduce oxygen into molten iron in order to reduce the amount of carbon contained within.

Modern-day steel production makes use of both traditional raw materials (iron) and recycled materials to turn them into steel. With this in mind, here are the 6 steps to modern steel production explained.

Step 1 – The iron making process

As iron is the main component of steel it firstly needs to be made. Iron ore, lime, and coke are placed into a blast furnace and melted. The resulting liquid known as molten iron is then formed. As molten iron still contains around 4% – 4.5% impurities such as carbon which in turn make the metal brittle, they need to be eradicated. Step 2 does exactly this.

Step 2 – Primary steel making

There are two main methods for making steel and these are Basic Oxygen Steel making (BOS) and Electric Ark Furnaces (EAF). BOS methods for example involve adding scrap (recycled) steel to the molten iron when in the furnace. Oxygen is then forced through the liquid (the Bessemer process) to cut the impurities in the molten metal down to 0.5% - 1.5%.

Alternatively with the EAF method, recycled steel is fed into an electrical ark furnace along with the molten iron which is then heated to around 1650 degrees Celsius in order to convert it into high-grade steel.

Step 3 – Secondary steel making

Next the newly formed molten steel needs to be adjusted to make the perfect steel composition. This is done by either manipulating the temperature and/or removing certain elements. This may include processes such as degassing, stirring, ladle injection, or argon bubbling

Step 4 – casting

Now we have the bones of our steel the next step is to pour it into cooled moulds. This causes the metal to cool quickly. Once cooled the metal is then cut into desired lengths depending upon the application eg, slabs for plates, blooms for sections such as beams, and billets for longer products such as wiring or thin pipes.

Step 5 – First forming

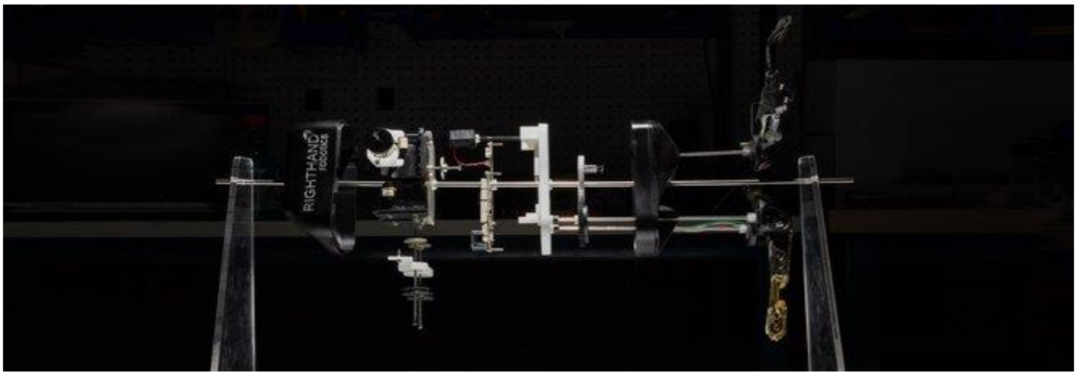
Also known as primary forming, the initial shapes of slabs, blooms, and billets are formed into their various shapes usually by hot rolling. Products that are hot rolled are then divided into flat products, long products, seamless tubes, and specialty products for one last stage of processing.

Step 6 – The manufacturing, fabrication and finishing process

Finally a variety of secondary forming techniques including shaping, machining, jointing and coating give the products their tell-tale shapes and properties.

So there you have it, the entire steel making process in 6 steps! If you’re in need of a particular metal part then why not contact Metro Steel. We have the skills and the experience to construct just about anything you want. Contact us on ***07 3204 1000*** for a competitive quote. Alternatively if you’re in the Deception Bay area of Brisbane, why not pop into our Kabi Circuit premises and talk to us first hand.

- **Basic production processes in plastic industry**



Plastics are the most common materials for producing end-use parts and products, for everything from consumer products to medical devices. Plastics are a versatile category of materials, with thousands of polymer options, each with their own specific mechanical properties.

Plastic manufacturing processes have been developed to cover a wide range of applications and part geometries. For any designer and engineer working in product development, it is critical to be familiar with the manufacturing options available today and the new developments that signal how parts will be made tomorrow.

This guide provides an overview of the most common manufacturing processes for producing plastic parts and guidelines to help you select the best option for your application.

How to Choose the Right Plastic Manufacturing Process

Consider the following factors when selecting a manufacturing process for your product:

Form: Do your parts have complex internal features or tight tolerance requirements? Depending on the geometry of a design, manufacturing options may be limited, or they may require significant design for manufacturing (DFM) optimization to make them economical to produce.

Volume/cost: What's the total or the annual volume of parts you're planning to manufacture? Some manufacturing processes have high front costs for tooling and setup, but produce parts that are inexpensive on a per-part basis. In contrast, low volume processes have low startup costs, but due to slower cycle times, less automation, and manual labor, cost per part remains constant or decreases only marginally when volume increases.

Lead time: How quickly do you need parts produced? Some processes create first parts within 24 hours, while tooling and setup for certain high volume production processes takes months.

Material: What stresses and strains will your product need to stand up to? The optimal material for a given application is determined by a number of factors. Cost must be balanced against functional and aesthetic requirements. Consider the ideal characteristics for your specific application and contrast them with the available choices in a given manufacturing processes.

Types of Plastics

Plastics come in thousands of varieties with different base chemistries, derivatives, and additives that are formulated to cover a wide range of functional and aesthetic properties. To simplify the process of finding the material best suited for a given part or product, let's look first at the two main categories of plastic: thermoplastics and thermosets.

Thermoplastics

Thermoplastics are the most commonly used type of plastic. The main feature that sets them apart from thermosets is their ability to go through numerous melt and solidification cycles without significant degradation. Thermoplastics are usually supplied in the form of small pellets or sheets that are heated and formed into the desired shape using various manufacturing processes. The process is completely reversible, as no chemical bonding takes place, which makes recycling or melting and reusing thermoplastics feasible.

Common materials:

- Acrylic (PMMA)
- Acrylonitrile butadiene styrene (ABS)
- Polyamide (PA)
- Polylactic acid (PLA)
- Polycarbonate (PC)
- Polyether ether ketone (PEEK)
- Polyethylene (PE)
- Polypropylene (PP)
- Polyvinyl chloride (PVC)

Thermosetting Plastics

In contrast with thermoplastics, thermosetting plastics (also referred to as thermosets) remain in a permanent solid state after curing. Polymers in thermosetting materials cross-link during a curing process that is induced by heat, light, or suitable radiation. This curing process forms an irreversible chemical bond. Thermosetting plastics decompose when heated rather than melting, and will not reform upon cooling. Recycling thermosets or returning the material back into its base ingredients is not possible.

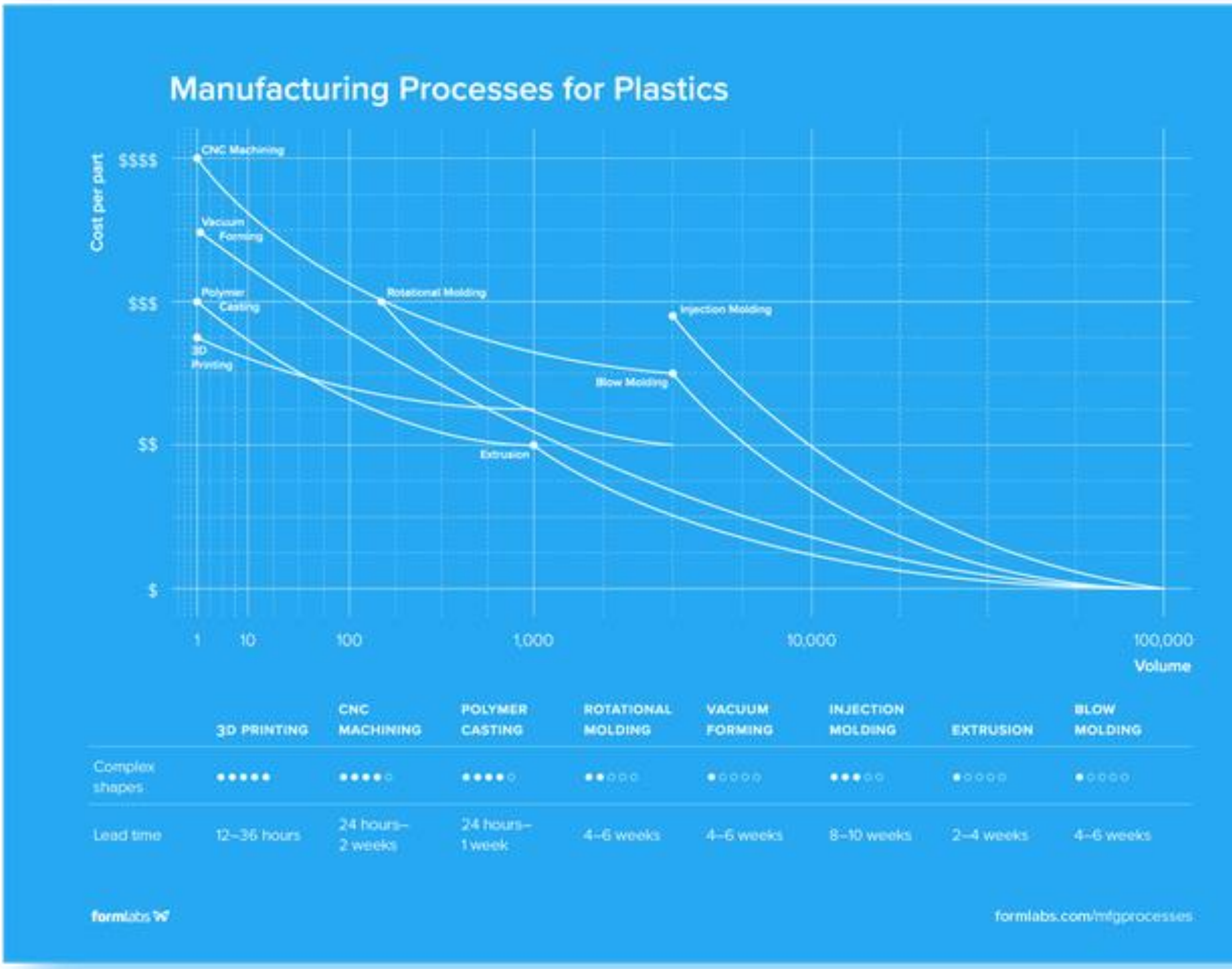
Common materials:

- Cyanate ester
- Epoxy
- Polyester
- Polyurethane
- Silicone
- Vulcanized rubber

Types of Manufacturing Processes

- **3D Printing**
- **CNC Machining**
- **Polymer Casting**
- **Rotational Molding**
- **Vacuum Forming**
- **Injection Molding**

- **Extrusion**
- **Blow Molding**



3D Printing

3D printers create three-dimensional parts directly from CAD models by building material layer by layer until a complete physical part is formed. https://www.youtube.com/watch?v=8a2xNaAkvLo

What is thermo plastic used for?
They are useful for a variety of applications, including consumer goods, machine parts, medical equipment and packaging and storage materials. **Thermoplastic** is the property of polymers in synthetic materials with which they becomes pliable and moldable on higher temperature and solidify on cooling –

WHY ARE THERMOSET PLASTICS USED?

Thermoset plastics offer enhanced:

- Chemical resistance
- Heat resistance
- Structural integrity

Thermosetting composites are created on a continuing basis to keep pace with the growing amount of complicated industrial applications. Thermoset plastic composites meet the material specifications of a huge variety of other production materials, at a much lower cost. **<u>Thermoset injection molding</u>** allows for a wide assortment of large and small parts. Huge volume requirements can be reached easily, and high-quality products can be delivered consistently through continuous batch processes. More importantly, complex, detailed geometric shapes that cannot be produced with metals or thermoplastics can be wholly produced in the mold itself. In this regard, thermosets offer an attractive alternative to metals and thermoplastics due to its exceptional physical properties and surface appearance, with little to no shrinkage when removed from the mold.

Elastomer materials are those materials that are made of polymers that are joined by chemical bonds, acquiring a final slightly cross-linked structure.

An elastomer we can assimilate to the following example, imagine that on a table we have a set of strings mixed, each of these strings it´s represent a polymer, we introduce a relatively small effort if we want to separate the strings each other's, now began to make knots between each of the strings, we see that as more knots that we made more ordered and rigid becomes all the strings, the knots of the strings is representing the chemical bonds, with a certain degree knots, or chemical bonds, more strongly stress need to apply to the strings in order to separate them, also we can observed that when we stress the string the length and the size of the strings increase and when we left to apply the stress the strings return to the initial length.

The main characteristic of elastomer materials is the high elongation and flexibility or elasticity of these materials, against its breaking or cracking.

Depending on the distribution and degree of the chemical bonds of the polymers, elastomeric materials can have properties or characteristics similar to thermosets or thermoplastics, so elastomeric materials can be classified into:

- Thermoset Elastomers - are those elastomer materials which do not melt when heated.
- Thermoplastic Elastomers - are those elastomers which melt when heated.

Properties of elastomer materials:

- Cannot melt, before melting they pass into a gaseous state
- Swell in the presence of certain solvents
- Are generally insoluble.
- Are flexible and elastic.
- Lower creep resistance than the thermoplastic materials

Examples and applications of elastomer plastic materials:

- Natural rubber - material used in the manufacture of gaskets, shoe heels...
- Polyurethanes - Polyurethanes are used in the textile industry for the manufacture of elastic clothing such as lycra, also used as foam, wheels, etc ...
- Polybutadiene - elastomer material used on the wheels or tires of vehicles, given the extraordinary wear resistance.
- Neoprene - Material used primarily in the manufacture of wetsuits is also used as wire insulation, industrial belts, etc ...
- Silicone - Material used in a wide range of materials and areas due their excellent thermal and chemical resistance, silicones are used in the manufacture of pacifiers, medical prostheses, lubricants, mold, etc ...

Examples of elastomers adhesives:

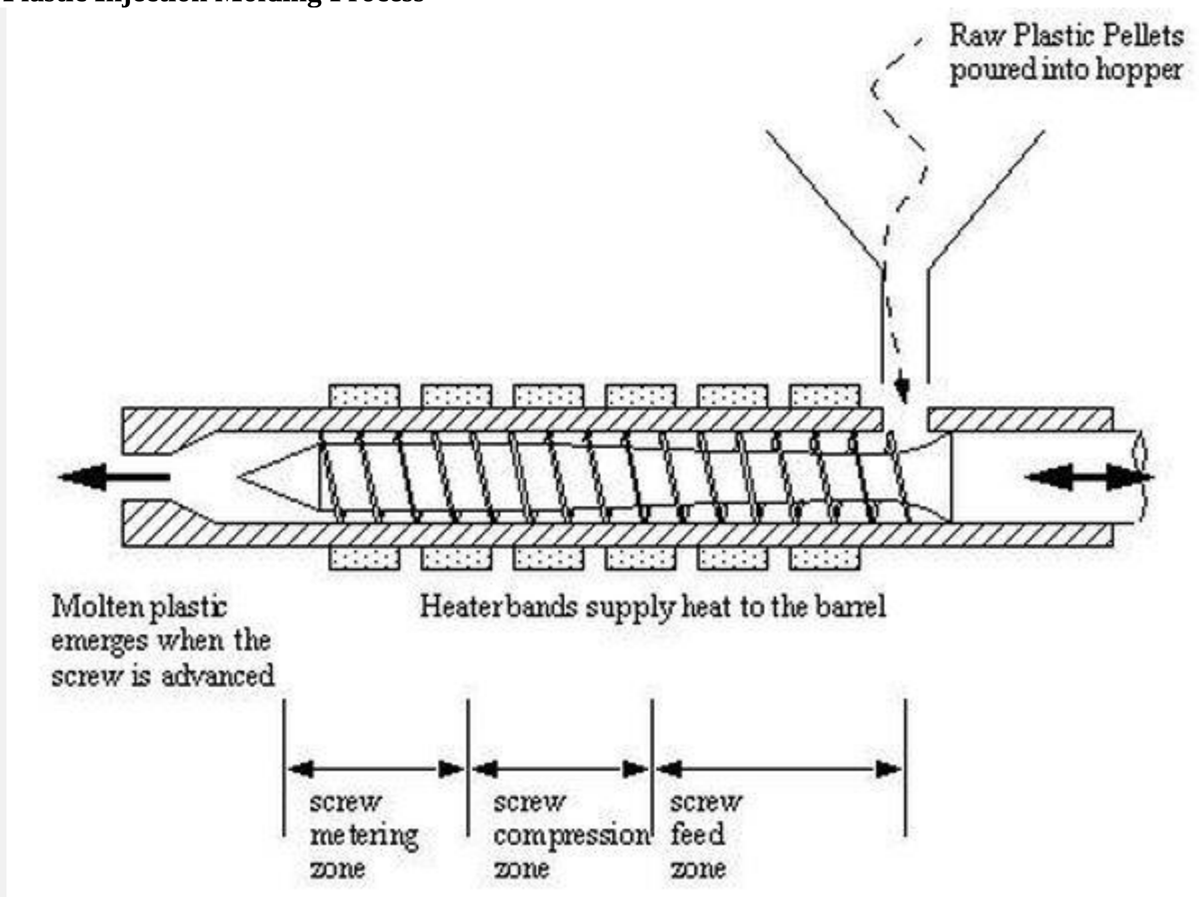
- Polyurethane adhesive 2 components.
- Polyurethane adhesive by curing 1 component moisture.
- Adhesives based on silicones
- Adhesives based on modified saline

Now that you know the elastomers, did you know that all the tires of any vehicle are made with elastomer materials?

The Plastic Manufacturing Process

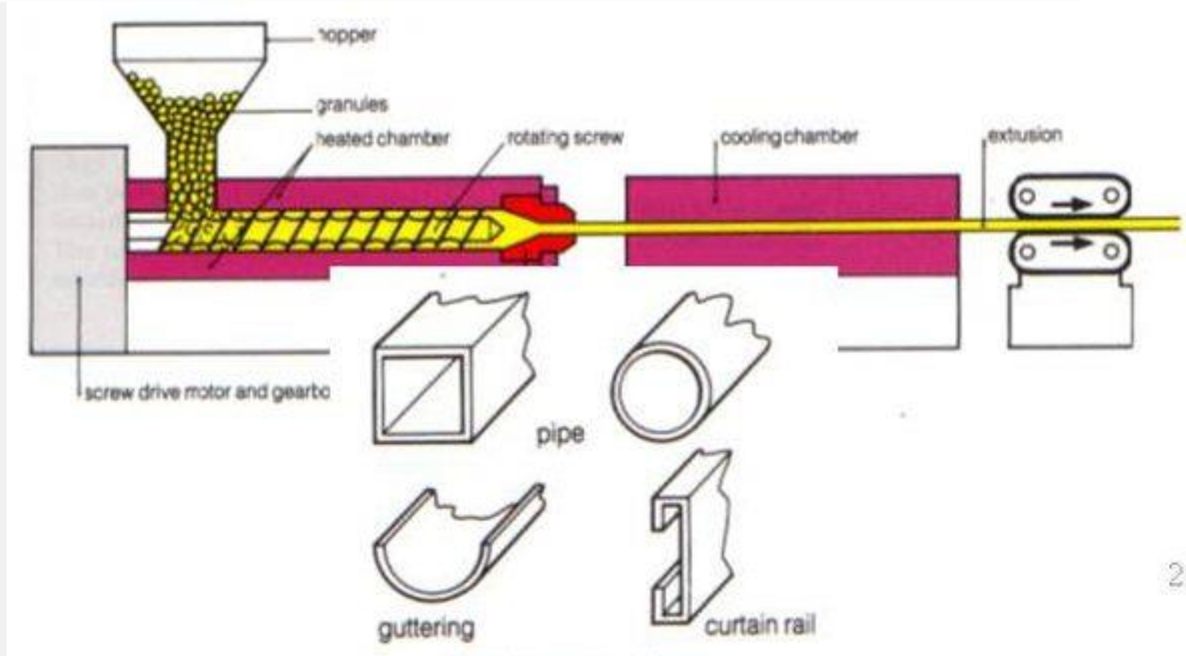
Types of Molding Processes

Plastic Injection Molding Process



Injection molding is one of the main methods by which parts are manufactured from plastic. The first step in the injection molding process is to feed plastic pellets into the hopper, which then feeds the pellets into the barrel. The barrel is heated and contains a reciprocating screw or a ram injector. A reciprocating screw is typically found in machines that produce smaller parts. The reciprocating screw crushes the pellets, making it easier for the plastic to be liquefied. Toward the front of the barrel, the reciprocating screw propels the liquefied plastic forward, thereby injecting the plastic through a nozzle and into the empty mold. Unlike the barrel, the mold is kept cool to harden the plastic into the correct shape. The mold plates are held closed by a large plate (referred to as a movable platen). The movable platen is attached to a hydraulic piston, which puts pressure on the mold. Clamping the mold shut prevents plastic from leaking out, which would create deformities in the finished pieces.

Plastic Extrusion Molding Process



Some common extrusions

Extrusion molding is another method of manufacturing plastic components. Extrusion molding is very similar to injection molding and is used to make pipes, tubes, straws, hoses and other hollow pieces. Plastic resin is fed into a barrel where it is liquefied. A rotating screw propels the liquefied plastic into a mold, which contains a tube-shaped orifice. The size and shape of the tube determines the size and shape of the plastic piece. The liquefied plastic then cools and is fed through an extruder, which flattens the plastic and forms the piece into its final shape.

Issues That Arise in the Plastic Manufacturing Process

A number of complications can arise during the plastic manufacturing process, including burned parts, deformities, surface imperfections and brittle parts. Parts become burned when the molds are not kept cool or if the melting temperature in the barrel is too high. Additionally, if the reciprocating screw becomes jammed or is not rotating fast enough, liquefied resin will remain in the barrel too long and become scorched. Surface imperfections and deformities occur when the surface temperature of the mold is uneven, if the molds are not clamped tightly enough or if the melting temperature is too high. Brittle pieces are formed when not enough liquefied resin is injected into the mold or if the plastic hardens before the mold can be filled. Regular testing and calibration of injection and extrusion molding machines is critical to ensure that the process runs smoothly.

WHAT IS THE BLOW MOLDING PROCESS IN THE PLASTIC INDUSTRY?

Blow molding is a type of manufacturing and production process that allows for the forming of hollow plastic parts. Air pressure is traditionally used to inflate a soft plastic into the mold cavity. While this technology originally derived from the glass industry, the blow molding process in the plastic sector competes in the recyclable and disposable market.

There are three main types of blow molding techniques: extrusion, injection stretch, and injection blow molding. The blow molding process can construct jars and containers such as PETE and PET containers and jars for packaging.
Blow molding is a critical industrial process for manufacturing any type of one-piece hollow plastic parts such as plastic piping, water cans, containers and bottles.

WHAT IS PET AND PETE?

PET is plastics that you come in contact with throughout your everyday life. PET or PETE, known as Polyethylene Terephthalate, is best known as the clear plastic used for soda bottle and water containers. As a raw material it is globally recognized as a flexible, lightweight, strong, non-toxic, and safe material that is 100% recyclable. In fact, PET is the most widely accepted recycled plastic available in the entire world. Almost all US municipal, recycling programs accept PET type packaging. Checking the backs or bottom of containers for the resin identification code can easily identify PET type plastics. This symbol can be recognized by the #1 surrounded with “chasing arrows”.

Recycled PET, along with virgin PET, can be used for soda and water bottles, cake packaging, cosmetic clam shell packaging for toys, razors, cosmetics and other retail items. It can also be found in containers for salad dressing, shampoo, peanut butter, sleeping bags, clothing, carpeting, and so much more. PET is so prevalent in our modern day society that it’s important to recycle it for reuse when and wherever possible. Under the recycle code 1, PET recycling rates are growing faster than ever.

PET is polyester product that is generally crafted with the injection blow molding process into clear containers. While it is possible to use the blow molding extrusion method in PET plastics, it is less common because the resin requires a drying period that is extensive.

HOW DOES THE BLOW MOLDING PROCESS WORK?

The plastic blow molding manufacturing process is made up of two parts. The first part of this process begins with the creation of Parisons, or starting tubes of molten plastic. These Parisons are the base for extrusion blowing, regardless of the type of container or plastic part that is being manufactured. When the Parisons have been fabricated they are ready for the second part of the process – blow molding into the desired shape.

Note: If we were talking about injection or injection stretch blow molding, the first step of the blow molding process would be called Preform instead of Parison.

1. EXTRUSION BLOW MOLDING (EBM)

- Parison Extrusion
- Blowing
- Cooling
- Ejection

As explained above, the extrusion blow molding manufacturing process begins with a parison. This process begins with a hollow tube (the parison) which hot air is blown into. This step inflates the tub into the hollow part, taking the shape of the mold cavity. Parts in the extrusion blow-molding sector can contain jars, containers, and plastic bottles. When the plastic has cooled, the mold is opened and the blow-molded piece is ejected. It is then replaced by a new parison for the process to be repeated.

2. INJECT BLOW MOLDING (IBM)

- Injection
- Blowing
- Ejection

The injection blow molding process begins with the molding of a polymer onto a core pin in a heated cavity. The cavity mold then forms the outer shape based off of the core rod, which shaped the inside of the preform. This preform is generally shaped as a bottle or jar neck with larger amounts of polymer attached to it. This polymer is what will eventually form into the jar body. When the preform mold is opened, the core rod brings the piece to the blow station. The core rod then opens up and compresses air into the preform. At the final equipment station, the part is blown, cooled, and ejected.

This manufacturing technique is generally used for smaller containers and hollow objects in larger quantities. However, this technique is the least commonly used by manufactures of the three techniques discussed here today.

3. INJECTION STRETCH BLOW MOLDING

- Injection
- Stretching
- Blowing
- Discharge

This final blow molding process is widely used by PET material throughout the manufacturing process of hollowed plastic containers.

Similar to the blow molding injection technique, molten polymer flows on a hot runner block into the injection cavity to make the Preform. As explained in the injection process, this core pin is what produces the inner diameter, while the injection cavity works to shape the outside of the preform. Following the injection molding process, the piece is held by its neck and rotated 90 degrees. When the preform reaches the right temperature, it is air infused (blown), and stretched into its final shape.

In the blow-mold area, the molds close and the stretch-rod works stretches the part using two different levels of air pressure. When the part is cool enough it gets discharged. This method produces containers for all different types of consumer related industries.

IBM AND EMB: WHAT'S THE DIFFERENCE?

The primary difference between injection blow molding and extrusion blow molding is that extrusion involves the squeezing of plastic through the mold. This mold is actually called a die (in blow molding terms). This can be thought of like pasta dough extruding from a machine. During this process, you can adjust the shape, length, and thickness of the pasta. In other words, extrusion molding involves squeezing plastic into a die in order to make the molded part, whereas injection blow molding pushes the plastic into a mold, then ejects the part and inflates it with air once it has cooled.

WHY USE PET PLASTICS

As a whole, plastics make up 13% of municipal waste. However, it is estimated by the EPA that only 1% of all municipal waste can be attributed to PET containers. This 1% may seem small, but it is in fact a lost opportunity, to recycle and reuse those PET plastics for new plastic packaging and clothes (that can further be recycled and reused again!). US households, which use approximately 45 lbs of PET containers and plastic bottle per year could make a serious impact by choosing to recycle over other waste methods.

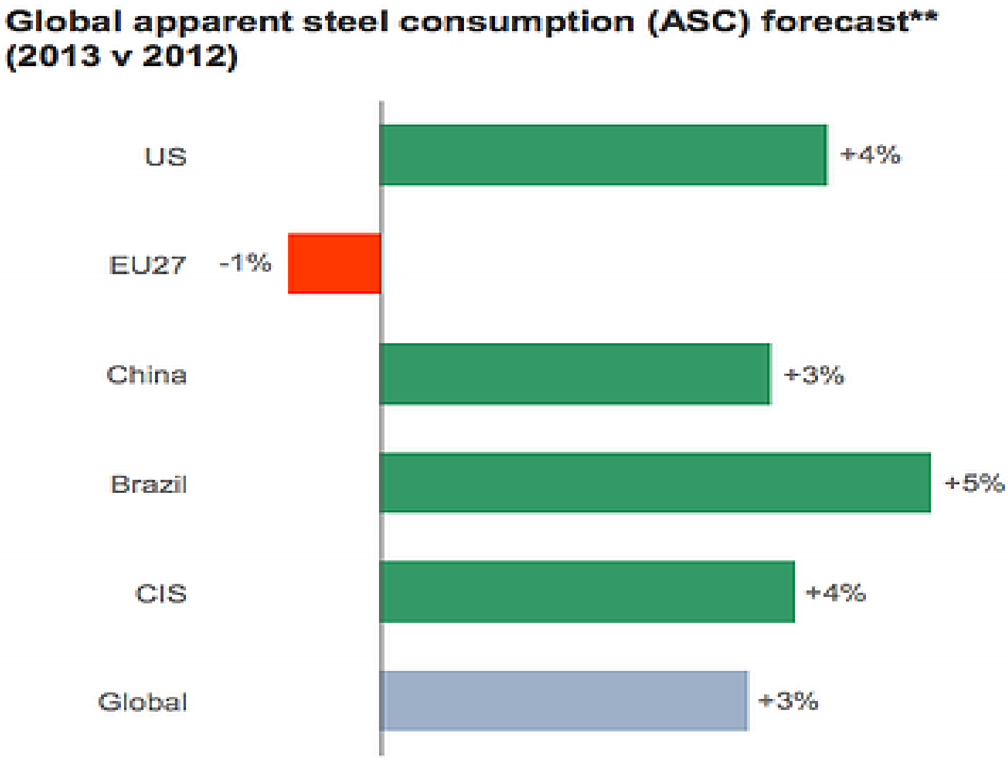
UNIT 3:

OCCUPATIONAL HEALTH AND SAFETY

- **Safety and Health in iron and Steel industry in India**

There has been a massive increase in the demand for steel since the turn of the millennium due to the economic boom of both China and India. World steel demand increased during the early 2000's; at the same time, many Indian and Chinese steel companies have risen to notability. Although China, as a whole, is both the largest steel producer and consumer, ArcelorMittal is, in fact, the world's largest steel producing company.

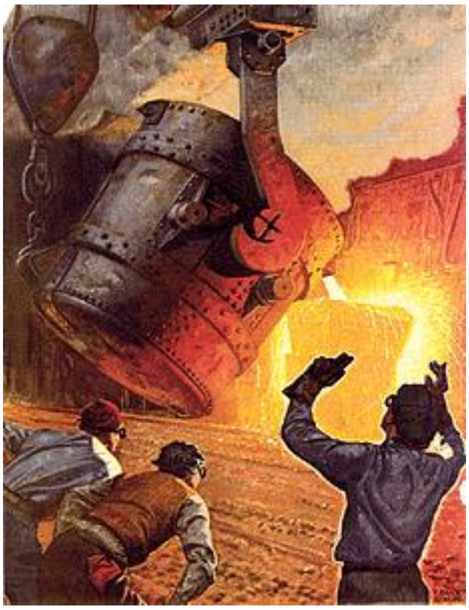
The world steel industry peaked in 2007, when the steel-using sectors plunged and the construction industry used 50% of steel produced (the next highest usage was mechanical machinery & metal products with about 15% each). Although it deserves to be said that the slowdown was occurring already before the worldwide great recession that started in 2008. Demand was weak in 3 of the 4 major steel countries (NA, JP, EU) and steel mills strongly reduced output. Heavy cutbacks in construction caused falling prices (down about 40%) due to a sharply lowered demand.



The industry witnessed a turnaround in late 2009 and continued to grow together with the global economic recovery. World crude steel production went up from 851 megatons (Mt) in 2001 to 1,548 Mt in 2012. This outperformed 2011 by almost 1.5%. Specifically, the U.S. steel sector will be dealing with excess capacity as its most significant issue due to the continued growth in new steelmaking facilities. However, on a good note, global steel demand is expected to improve gradually this year in comparison to 2012. In the United States, growth will be supported by attempts to sustain the economy's momentum, an improving labor market, strong momentum in the auto sector and recovery in construction markets. Increased demand should lead to improved profitability for 2014 and 2015, driven by better utilization rates. European steel demand is likely to fall further this year before a mild rebound takes hold in 2014. The big challenge for steelmakers in 2013 is to be cost competitive while maintaining enterprise value.

The original code of practice on safety and health in the iron and steel industry was adopted in 1981.

The International Labour Organization (ILO), founded in 1919, became the first specialized agency of the United Nations (UN) in 1946. The main aims of the ILO are to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialogue on work-related issues. The newest version of this code, updated 2005, reflects the many changes in the industry, its workforce, the roles of the competent authorities, employers, workers and their organizations, and on the development of new International Labour Organization instruments on occupational safety and health, focuses on the production of iron and steel and basic iron and steel products.



According to Part II, Section 5.1 of the Safety and Health in the Iron and Steel Industry Code, the choice and the implementation of specific measures for preventing workplace injury and ill health in the workforce of the iron and steel industry depend on the recognition of the principal hazards, and the anticipated injuries and diseases, ill health and incidents. Below are the most common causes of injury and illness in the iron and steel industry:

(i) slips, trips and falls on the same level;
(ii) falls from height;
(iii) unguarded machinery;
(iv) falling objects;
(v) engulfment;
(vi) working in confined spaces;
(vii) moving machinery, on-site transport, forklifts and cranes;
(viii) exposure to controlled and uncontrolled energy sources;
(ix) exposure to asbestos;
(x) exposure to mineral wools and fibres;
(xi) inhalable agents (gases, vapours, dusts and fumes);
(xii) skin contact with chemicals (irritants (acids, alkalis), solvents and sensitizers);
(xiii) contact with hot metal;
(xiv) fire and explosion;
(xv) extreme temperatures;

(xvi) radiation (non-ionizing, ionizing);
(xvii) noise and vibration;
(xviii) electrical burns and electric shock;

(ii) (xix) manual handling and repetitive work;
(xx) exposure to pathogens (e.g. legionella);
(xxi) failures due to automation;
(xxii) ergonomics;
(xxiii) lack of OSH training;
(xxiv) poor work organization;
(xxv) inadequate accident prevention and inspection;
(xxvi) inadequate emergency first-aid and rescue facilities;
(xxvii) lack of medical facilities and social protection.

As you can see quite well, the importance of safety and safety training in the steel and iron industry. With hazards ranging from noise to physical to chemical to ergonomics, it is an inherently dangerous industry to work in. Specific PPE should include, but not be limited to:

(a) molten metal resistant jackets and trousers;
(b) face shields or vented goggles;
(c) molten metal resistant gloves;
(d) safety footwear insulated against heat;
(e) respiratory protective equipment;
(f) protective helmets;
(g) hearing protection; and
(h) eye protection.

(Source: http://www.safetytrainingservices.net/sts-blog/bid/280743/safety-in-the-steel-industry-history-hazards-and-how-we-can-help)

- **Health and Safety PLASTIC MANUFACTURING INDUSTRY**

When manufacturing or processing plastics often chemicals are used as a part of the process. Chemicals can either be added to the product or be produced as a by-product as a result of the process e.g. in the form of plastic fume.

If you are using chemicals that can harm people's health or if chemicals are produced as a result of the process it is important to carryout assessments, commonly known as COSHH assessments.

COSHH assessments should look at how chemicals are being used, produced or stored in your workplace. They should consider how people could be exposed to the chemicals e.g. by inhaling them or absorbing them by the skin and what harmful effects any exposure would have on them. Finally, you should then review all of this information and work out the right control measures for your workplace. The following links give more help advice and help on chemical exposure in the plastics industry and measures that can be taken to protect peoples' health.

Plastic Fumes

Plastics are usually processed as pellets, granules or powders. These include additives such as fillers, pigments, fire retardants and stabilisers, depending upon requirements. Plastics fume, produced when the material is heated in processing, can include respiratory sensitisers, irritants and carcinogens. The exact composition of any fume varies. Immediate effects may include severe irritation to the eyes, nose and lungs. In some cases, the effects can be long-term and irreversible. Table 1 gives examples of commonly processed plastics and some of the constituents detected in fume when they were heated above their recommended upper process temperature.

Table 1 Examples of commonly processed plastics and constituents in fume Plastic Constituents in fume

1. PVC—Hydrogen Chloride
2. Fire-retarded ABS --Styrene, phenol, butadiene
3. Polypropylene--Formaldehyde, acrolein, acetone
4. Acetals Formaldehyde Polyethylene (low density) Butane, other alkanes, alkenes
5. Polystyrene – aldehydes, Styrene

Controlling exposure to plastics fume Fume production is influenced by:

1. material being processed, including recommended temperature ranges and residence/ dwell times;

2. operating procedures, including purging;
3. the reliability of temperature control; and
4. machine/screw maintenance.

Obtain the safety data sheet (SDS) from the supplier/distributor for the particular formulation. Make sure that it includes all the information needed on: – correct processing temperature; – degradation products; – any additives and their possible effects on fume production.

Safety measure -

1. Give training to operators about all the data and how to control fumes and temperatures.
2. Regular inspection and checking of machines should be carried out.
3. Material should be processed at the right temperature.
4. Machines should be kept clean and any spilt material should be wiped out regularly.
5. Barrel and screws should be regularly cleaned.
6. Ensure processes and units are well ventilated.
7. Ensure machine fault alarms are working.
8. Give emergency guidelines clearly to all workers and it should be rehearsed by all.
9. All virgin and regrin material should be marked so that it is not used by mistake.

Source: http://www.hse.gov.uk/pubns/ppis13.pdf

Health hazards of Styrene

Styrene vapour can cause irritation to the nose, throat and lungs with exposures at moderate levels. Neurological effects include difficulty in concentrating, drowsiness, headaches and nausea. The vapour and splashes are also irritating to the eyes and skin. At high exposure levels loss of consciousness and death can occur. Long-term exposure may also affect brain functions, including memory and colour vision.

The limit for Styrene vapour is designated by government regulatory bodies. The safety measures should limit it by various measures like size and area of working unit, the amount of resin used in a day, curing rate, wearing proper gloves.

The control measures should be regularly monitored to maintain a healthy environment. Proper ventilation system and exhaust fans are necessary. Ventilation may be supplemented by Respiratory Protective Equipment’s to ensure workers are not overexposed.

Occupational Asthma

The workers in plastic and wood industry may be inhaling particles leading to Asthma.
Regulations require employers to control exposures to hazardous substances to protect employees’ health.
Employers must assess the risk of exposure (exposure means taking in chemicals by breathing in, by skin contact or by swallowing).
Regulations require you to substitute of harmful products with less harmful ones; that all controls are kept in good working order, including:

- Mechanical controls eg local exhaust ventilation (LEV), protective gloves
- Administrative controls eg supervision
- Operator controls eg following instructions

Musculoskeletal disorder

The term musculoskeletal disorder covers any injury, damage or disorder of the joints or other tissues in the upper/lower limbs or the back.

- **UPPER LIMB DISORDER**
- **LOWER LIMB DISORDER**
- **BACK PAIN**

Moving items by lifting, lowering, carrying, pushing or pulling can cause injury to your workers' backs, necks and joints.

As precautionary measure, all employers must:

- Avoid hazardous manual handling operations so far as is reasonably practicable, by redesigning the task to avoid moving the load or by automating or mechanising the process.
- Make a suitable and sufficient assessment of the risk of injury from any hazardous manual handling operations that cannot be avoided.
- Reduce the risk of injury from those operations so far as is reasonably practicable. Where possible, provide mechanical assistance, for example, a sack trolley or hoist. Where this is not reasonably practicable then explores changes to the task, the load and the working environment.

Medical and scientific knowledge stress the importance of an ergonomic approach to look at manual handling as a whole, taking into account the nature of the task, the load and the working environment, and requiring worker participation.

Health surveillance

Health surveillance means regularly looking for early signs of work related ill health and putting procedures in place to achieve this.
The purpose of health surveillance is to monitor and protect the health of individual employees.
Collecting simple information may lead to early detection of ill health caused by work and identify the need for improved control measures.
All employees exposed or likely to be exposed to an asthmagen should receive suitable health surveillance.
The specific requirements are set out in COSHH and might involve examinations by a doctor or trained nurse.

Employers have to consult employees either directly or through appointed or elected representatives, on health and safety matters.

3. Health and Safety in Wood product Manufacturing industry

SAFETY AND HEALTH FOR WORKERS

wood workers in India are exposed to many health hazards.
1. Wood Dust – causes irritation to eyes, nose and throat
2. Formaldyhyde and resin in plyboards – may cause respiratory problems including Asthma

Both above contents are carcinogenic and workers should be informed properly about the health hazards. Safety training and drills should be conducted regularly.

http://www.hse.gov.uk/research/journals/mrn14.htm

Workers who breathe in wood particles generated by sanding and cutting may experience allergic respiratory symptoms, mucosal and non-allergic respiratory symptoms and cancer. Airborne dust can cause an explosion — any wood furniture manufacturing facility must install adequate dust extraction equipment and mandate cleaning procedures.

The United States' National Institute for Occupational Safety and Health (NIOSH) provides reports on controlling wood dust generated by the following machines:

- Automated routers
- Horizontal belt sanders
- Large diameter disc sanders
- Orbital hand sanders
- Shapers
- Table saws

Noise level safety

Some of the noisiest working environments can be found in the woodworking industry. Workers exposed to high noise levels, even for a short time, may experience temporary hearing loss. Continued exposure can result in permanent hearing loss.

- Health and safety for small and medium woodworking shops (PDF)
- Hearing loss
- Noise: What you need to know (UK)
- Noise control in the woodworking

This worker wears ear defenders and a dust mask while the circular saw has a guard

Health and safety can't be ignored in furniture production. When designers determine the form of each product's component, they specify production processes and materials. Management must then minimize the negative impacts of these technologies on workers' lungs, fingers, ears, eyes, etc., by providing adequate training, supervision and safety equipment.

Lack of thorough training on the specific system of safety and health signs and signals plays the pivotal role in furnishing the accidents in the woodworking sector. The established contacts with managers from SMEs and companies in Wood Industry also confirmed the current needs for this particular training. SMEs, in particular, have fewer resources to put complex systems of worker protection in place and tend to be more affected by the negative impact of health and safety problems.
Woodworking machines, wood dust, fire and explosion, noise, vibrations, manual handling operations in Wood Industry, hazardous and chemical substances, slips and trips are some of the biggest concerns.

Organic dust particles are highly flammable and under favourable conditions, highly explosive. In addition, some forms of wood release toxic materials when being cut; Western Red Cedar is one example. Another issue is rotating equipment. Guarding is a major issue with all rotating machinery.

Recent Health and Safety Executive (HSE) accident statistics shows that accidents involving contact with the dangerous parts of machinery or the material being machined accounted for approximately one quarter of all of the fatal injuries recorded in the woodworking industry, and approximately half of all major injury accidents.

The risks associated with the use of woodworking machinery are high since they rely on high-speed sharp cutters to do the job and in many cases, these are necessarily exposed to enable the machining process to take place. Additionally, many machines are still hand-fed; woodworking is probably the main industry where the hands of the operator are constantly exposed to danger.

Additional reading - https://en.wikipedia.org/wiki/Woodworking_safety

4. Occupational Health and Safety – Textile Industry

In 2014 to 2016, registered Surat textile units clocked 84 fatal accidents in which 114 fatalities and 375 serious injuries to workers were reported (RTI query to Directorate of Industrial Safety and Health, State of Gujarat).

The cause for the deaths included asphyxiation, fall from heights, mechanical injuries, injuries from material handlings and fiber and cotton dust inhalation.

According to the reports of Indian Brand Equity Foundation (IBEF), the size of India's textile market in November 2017 was around US$ 150 billion, and is expected to touch US$ 223 billion market by 2021, growing at a Compound Annual Growth Rate of 12.2% in 2009-21. The new textile policy aims to achieve US$ 300 billion worth of textile exports by 2024-25 and create an additional 35 million jobs.

Callous **attitude in following the safety measures can cause health hazards in the workers**

As the textile industry is a labor-oriented industry, unsafe practices can affect the well-being of workers and their families.

Health hazards associated with various units are:

- **Production and ginning unit:** Physical injuries in fingers, back, and eye, arm/shoulder, leg and head injuries include direct costs (medical compensation) and indirect costs (down time and loss of productivity).
- **Yarn manufacturing unit:** The manufacturing unit involves machineries having higher rotary and travelling speeds. These speeds can cause noise pollution resulting in headache and dizziness. Also, the workers and supervisors regularly engage themselves in processing and spinning of cotton with these machines. Continuous inhalation of cotton dust result in lung diseases and their symptoms involve tightening of chest, coughing and shortness of breath.

- **Synthetic** fiber **production unit:** A large amounts of solvent vapors are released when the filaments arise from the spinnerets by means of spinning. There is a high probability of cancer and heart diseases in such cases which can further result in fatalities.

  •**Dyeing and printing:** Dyeing is a physical affinity between the dye and the fiber of the fabric. Flammable solvents are used in the processes, leading to fire hazards. Workers deal with dangerous levels of chlorine on a daily basis and can cause lung edema. Usage of organic solvents result in **dermatitis** (skin disease).

  Printing results into formation of sludge that can have environmental issues with ground and groundwater contamination.

  Each factory should comply with the procedures scrupulously to prevent the potential hazards

  Staff members who regularly handle chemicals should have an easy access to **Material Safety Data Sheets** (MSDS) as they provide information such as physical data (meting or boiling points), toxicity, reactivity, disposable methods, storage conditions, and protective equipment and spill or leak procedures. Along with the training, an availability of MSDS **in local language** enables the workers to read the contents within without any issues.

  The storage area for the dyes and other chemicals should be cool and dry areas. One member in each shift of the staff should be **trained in first aid** to ensure outreach in case of an emergency.

  Other preventions include:

  • Regular cleaning of the floors with a Vacuum cleaner to cut down the dust spread.

  • Monitoring and repairing dust control equipment and ventilation systems.

  • Annual training programs for employees to create health hazard awareness.

  • Availability of Personal Protective Equipment (PPE) for safe work practices.

  • Proper ergonomic infrastructure to avoid musculoskeletal strain.

  • Well-maintained machinery to reduce noise pollution.

  • Ensure sanitary facilities for the workers to encourage personal hygiene.

  There is an increase in the technological advancements in this industry to enhance the range of fabrics and their production. Simultaneously, the progress should be backed by stringent safety policies to promote safety at the workplace.

- Source - https://www.ask-ehs.com/blog/health/occupational-health-safety-in-textile/

5. DEALING WITH EMERGENCY IN MANUFACTURING PLANTS

With their utilization of advanced and highly technical machinery on a shop floor full of workers, manufacturing plants are exposed to a significant amount of risks. There are a plethora of possibilities that could potentially lead to an accident or malfunction that warrant the implementation of an emergency response plan. When something unexpected arises that has the potential to injure workers, the most crucial aspect is to ensure the safety of everyone in the plant.

Risks of the Manufacturing Industry

The following is a non-exhaustive list of risks commonly faced by manufacturing company. The general approach remains the same for all types of risks.

It is not the role of the board or its designated committee to directly manage and specifically address each of the risks the company faces. The members of the board or the relevant committee should be aware of the risks. They should satisfy themselves that management:

- Designs and implements risk management policies and infrastructure that sufficiently address the relevant risk issues,
- Ensures the effectiveness of the risk policies and infrastructure,
- Reports on these issues to the board or the committee.

However, what happens to a manufacturing plant that does not have a policy in place for any kind of emergency response plan? This could lead to significant damages and losses, in addition to injured workers or guests at the plant at the time. According to Automation.com, the true cost of downtime is dependent upon the number of workers in a particular plant, the length of the production process and a host of other variables.

While the actual cost of downtime varies from one manufacturing plant to the next, the simple fact remains that any amount of downtime stemming from an emergency will ultimately cost a company a lot of money. Brokers and agents working with manufacturing companies should work with managers and safety officers to ensure these facilities have a robust emergency response plan in place that can potentially reduce problems that may lead to losses, damages or other injuries to the workers or business.

Assemble a planning team

Having a solid emergency response plan requires putting smart, efficient people in charge of drafting the policy. These individuals should be knowledgeable not only of the entire manufacturing process from start to finish, but they should also have a solid understanding of the different dynamics between all the departments in the company.

Further, having a thorough familiarity with the guidelines from the Occupational Safety & Health Administration will help this team develop a strong response strategy that can be tweaked for the specifics of the manufacturing plant.

This team must also establish authority. Often this requires upper management promoting an atmosphere of cooperation and authorizing the planning team to take the necessary steps to develop and implement the emergency response plan.

Analyze capabilities and weaknesses

It's important for the manufacturing plant to understand its full capabilities and potential weak spots. Having a thorough inventory of the company's emergency response capabilities will provide a list of what's available and accessible, and what is lacking and needed.
According to Safety Info, some of these capabilities include (but are not limited to):

Personnel:

- Medical response team
- Public information officer
- Fire brigade
- Hazardous materials team
- Security
- Evacuation team

Facilities:

- First-aid or medical stations
- Sanitation rooms
- Shelter areas
- Emergency operating area
- Media briefing area

Equipment:

- Fire extinguishing, protection or suppression gear
- First-aid supplies
- Warning systems
- Emergency power and/or generators
- Communication equipment
- Decontamination kits

In addition to gathering an inventory of the company's capabilities, it's also important for the emergency response team to put together a list of the manufacturing plant's potential hazards. It should be noted that no matter how extensive this will the team makes the list, by its nature, it will ultimately be incomplete. However, that doesn't mean the task of assembling the hazards should be taken light-heartedly.
Consider these factors when creating a comprehensive list of potential hazards:

- Historical – such as fires, past hazardous spills, severe weather or utility issues
- Geographic – such as proximity to other companies that deal with hazardous materials, or occurrence of earthquakes or floods
- Human error – poor training or maintenance, misconduct, substance abuse or carelessness
- Technological failure – safety, telecommunications, power, computer system, heating/cooling or emergency response

"*Employees must be trained on how to quickly implement an emergency response plan."*

Thoroughly train employees

Simply having an emergency response plan in place is not enough to suffice to adequately protect the company and its employees. Employees have to be properly trained to ensure they're able to thoroughly and rapidly put the emergency response plan into effect when something unexpected happens.

In addition, since an emergency response strategy involves a reaction to a potentially dangerous situation, any training should involve more than merely sitting in a conference room and reading through the official policy. The company should set up a time to walk employees and other staff members through the plan, having these individuals physically going through the steps – or at least miming the steps – involved in shutting down equipment, cleaning up any dangerous spills and evacuating the building if necessary. Much like a fire drill, the only way to truly train someone is to have them actively engaged in the process.

Having the right protections

While an emergency response plan will help a manufacturing plant handle an unexpected calamity in the plant and even potentially reduce the chances of an emergency happening in the first place, the sad fact is that no matter how diligently a company plans for the unexpected, nothing is fool proof. Unfortunately, emergencies will occur, and manufacturing plants must have the proper protections in place to help the company pick up the pieces after any catastrophe, whether major or minor.

Brokers and agents providing casualty or professional liability insurance for manufacturers should work hand in hand with these companies to ensure executives and managers are implementing the right emergency response strategies to mitigate exposure to risks. Further, brokers and agents who partner with Specialists gain access to a wide range of policy coverage's specially designed for manufacturers at risk for a wide variety of potential hazards and disruptions.

Source:http://mcgowanrisk.com/blog/implementing-emergency-response-plans-in-manufacturing-plants/

RISK ASSESSMENT

Much of safety risk management quality revolves around the ability to adequately assess various safety elements such as:

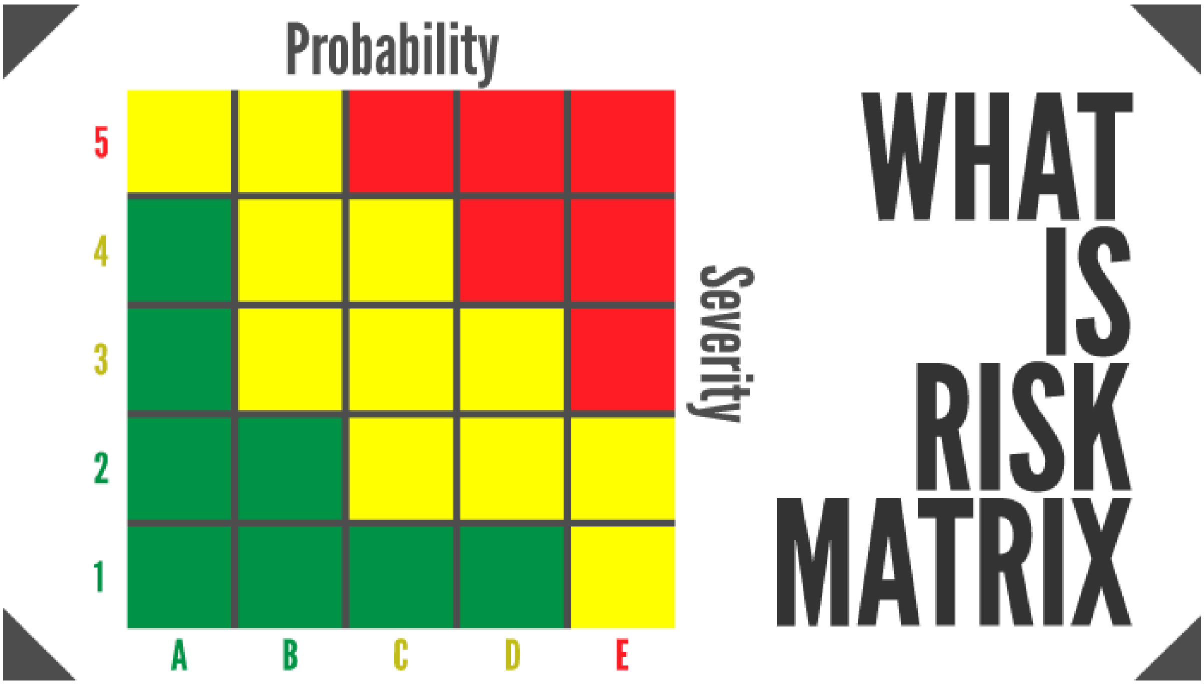
- Risk control adequacy;
- Likelihood of hazard or mishap occurring;
- Severity of mishap; and
- What kinds of measures are needed to reduce exposure.

The ability to control these elements will depend on the ability to assess them. Poor assessments lead to poor controls. Assessments include:

- Risk analysis; and

• A risk matrix.

What Is a Risk Matrix



Risk matrices are probably the inter-industry safety standard as the primary tool used in risk evaluation. In aviation safety management systems (SMS) they are ubiquitous.

Risk matrices are simplistic charts (though not necessarily "simple") that use "probability" and "severity" to quantify the risk priority of a real or hypothetical safety scenario. The quantification is generally broken into 3 categories:

- Acceptable risk (green);
- Unacceptable risk (red); and
- Acceptable with mitigation, meaning risk may not yet be as low as reasonably possible (ALARP) (yellow).

Some organizations use 1 or 2 additional colors, such as light green and/or orange, though these colours only provide further "aesthetic" and risk granularity rather than general quantification. Risk matrices are ultimately used as risk management tools to rank risks with the risk grid and the calculated risk indices.

The Risk Matrix Grid

The risk matrix is broken into a grid. The grid is usually 5x5, though it can be larger or smaller depending on company needs – we will use a 5x5 grid in this article, which happens to be the ICAO default risk matrix. The grid is used to assign a calculated "number" to the risk, which is combination of Probability x Severity, and represents the risk priority.

The risk matrix grid:

- Usually increases in severity from left (low) to right (high);
- Usually increases in probability from bottom (low) to top (high); but
- A risk matrix can move in any direction, so you may see risk matrices that move from right to left and top to bottom, right to left and bottom to top, or left to right and top to bottom.

As you can see, there is a lot of flexibility about how the risk matrix “appears" or is "laid out." What matters most is that it is:

- consistent and comfortable in your organization;
- easy to use;
- not changed frequently to preserve historical significance; and
- used in training organizational safety professionals as well as department heads and process owners.

Source - http://aviationsafetyblog.asms-pro.com/blog/what-is-a-risk-matrix-and-risk-assessment-in-aviation-sms-programs