LEAD PAPER

INTEGRATING ART, SCIENCE AND TECHNOLOGY IN EDUCATION

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Abstract
This article examines how art, science and technology can be effectively combined for industrial development. It focuses on making explicit connections within each subject area by combining one topic, one skill, one concept to the next. Efforts are made to relate ideas and concepts within the discipline, rather than assuming that planners, teachers and learners will automatically understand the connections. It views how the subjects can be effectively combined through inter-disciplinary topics rearranged around overlapping concepts, emergent patterns and designs which could be considered and lead to technological development. This paper could therefore become a working material for educational planners to use and combine the areas into an integrated study needed to achieve technology.

Key Words: Integration, Art, Science, Technology, Industrial Design, Education

Introduction

Education is the act or process of imparting or acquiring general knowledge, developing the process of reasoning and judgement, and generally of preparing oneself or others intellectually for mature life. It is a process of imparting or acquiring particular knowledge or skills as for a profession. It is a result produced by instruction. Education is the acquisition of knowledge, skill, values, beliefs and habits. Art is a product or process of deliberately arranging symbolic elements in a way that influences and affects the senses, emotions and intellect. It is the expression or application of human creative skill and imagination to produce works such as paintings, sculptures and drawings to be appreciated primarily for their beauty or emotional power. Such classes of objects are subject to aesthetic criteria or qualities. Technology is the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society and the environment. Technology draws upon such subjects as industrial arts, engineering, applied science and pure science. Science can be defined as a process or method of finding out or discovering our world. Scientists spend time trying to find out about things around us, things that have been living at some time and things that never have been alive by observing them properly and closely. They do this through the senses. They look at objects, touch them, smell them, listen to them and in some cases taste them. To pass on their discoveries to other people, scientists must write down or draw what they do in their experiments and what they observe. They also have to do this to remind them what they have done. In most experiments the scientist will be asked to write down what is done, what is seen and what is discovered or perhaps draw pictures showing these things. The definitions of the words show there are salient similarities between them, which form the basis for inter-disciplinary teaching and learning in this age.

The relationships between art, science and technology demand some clarifications. Science has continually fed the artist with accurate knowledge of the nature of objects that he represents and better materials and tools with which he executes his work. Scientific principles of receding objects are applied to drawing and painting and all forms of art. On the other hand, it is on record that it is through the drawings and paintings of Leonardo de Vinci that man discovered the human body. Innovators and keenest minds in science like Charles Darwin made full use of aesthetic modes of thought, visual images and imagination. All industrial products are first drawn on paper prior to the mechanical mass production. Just as scientific input goes into the working function of utilitarian objects so also does aesthetic input into what we call their design. In industrial process the artist indicates the possibilities of a new product through his creative skills or powers, the scientist creates the knowledge of its realization through the systematic study of natural phenomena and the engineer deals with organized skill to solve the problem of producing the object. It could be said that science is the "knowing" and art is the

"creative act" involved in making an object. Art evolves, science involves and technology brings into reality. The three areas work hand in hand and are all necessary in industrial development.
Science and technology have failed to practically show the symbiotic relationship between art, science and technology. Technology does not only require the knowledge of science and mathematics as portrayed by our educational planners. Art or design is required in technology to create images of what will be produced technically. It is only the artist who can create images which do not exist. Science can make different input in technology. Engineering can also make a separate input which science cannot make. If science and engineering are only used, the industrial products will not have beauty or aesthetic effect. In industrial production art, science and engineering are complementary.

Another relevant question is: Does technological innovation necessarily require only the knowledge of science and a mastery of mathematics? It is said that science owes more to the steam engine than the steam engine owes science. The famous inventor at times prefers trying hundreds of substances one by one than the more abstract approach of deducing the qualities required in the correct substance. People are apt to learn the hard way by trying out potentially successful responses not symbolically in their imaginations but physically. In some situations, such trial and error thinking is the only kind practicable.

Technology employs tools derived from science. Some of the advances made in pure science have emerged from industrial and technological research e.g. such discoveries as those concerned with the diffraction of electrons, radio, astronomy and information theory have formed the basis for technological innovations. Maxwell's physics paved the way for radio engineering. The works of engineer in building bridges is supported by theories of applied science. The methods peculiar to technology (trial and error, invention, experiment, intuition) have merged with those of applied science for the purpose of obtaining desirable practical consequences (Down, 1984). Industries are based on manufacturing processes which merely reproduces on a large scale effects first learned and practiced in a scientific laboratory. The manufacture of gasoline, penicillin, electricity and oxygen were never developed from technological procedures, but depended on works first done by pure scientists. Science plays a predominant role in industries like steel, aluminum and petroleum, pharmaceutical industry, biological industry, machine and husbandry.

The traditional practice of organizing subjects dictates separate and distinct disciplines with focus on a single discipline. Each is seen as a pure entity in and of itself. The disciplines are taught by different teachers in different locations. Each encounter has a distinct cellular organization, leaving students with a fragmented view of knowledge. In elementary schools the teacher says: "Now put away your mathematics books and take out your science". The daily schedule shows distinct time slot for each subject, but topics from two areas are only occasionally related intentionally. In the traditional system students know that mathematics is not science, science is not English and English is not history. The idea of integration focuses on making explicit connections within each subject area connecting one topic, one skill, one concept to the next. There is deliberate effort to relate ideas within the discipline, rather than assuming that learners will automatically understand the connections. Experts help learners make connections by explicitly making links between subject areas. Integration views the subjects through inter-disciplinary topics arranged around overlapping concepts, emergent patterns and designs. Using cross-disciplinary approach, the disciplines are blended by finding overlapping skills, concepts and attitudes in all. The integration sprouts from within the various disciplines, and teachers make matches among them as commonalities emerge. Shoemaker (1989) defines integration as:

> … Education that is organized in such a way that it cuts across subject matter lines bringing together various aspects of the subjects into meaningful association to focus upon broad areas of study. It views learning and teaching in a holistic way and reflects the real world which is interactive (p.5).

It provides a unified view of commonly held knowledge motivates and develops learner's power to perceive new relationships and thus create new models, systems and structures. It applies methodology and language from more than one discipline to examine a central theme, issue, problems, topics or experience (Jacob, 1989).

It is taken for granted apparently, that in time learners will see how things fit together. Unfortunately, the reality of the situation is that they tend to learn what we teach them. If we teach connectedness and integration, they learn that. If we teach separation and discontinuity, that is what they learn (Humphrey et al, 1981). Fragmented teaching lacks connections and relationships among disciplines. Schools are moving away from teaching isolated facts. This view finds its basis in the works of Piaget, Dewey, Brunner and others who hold a holistic view of learning. Each of these theorists is concerned with understanding of concepts and understanding structures. Advocates of the education movement of the 1930s advocated integrated subjects (Var, 1987). Integration is a move from memorization and recitation of isolated facts and figures to more meaningful concepts and connections between concepts. The 21st century requirement of a flexible use of knowledge goes beyond a superficial understanding of multiple isolated events to insights developed by learning that is connected or integrated. Concerns about national development have put the spotlight on any educational changes that can lead to increased success. In addition, there is a body of research related to how students learn that supports integration. The brain organizes new knowledge on the basis of previous experiences and meaning that has developed from these experiences. The human brain actively seeks patterns and searches for meaning through these patterns (Shoemaker, 1991). The brain may resist learning fragmented facts that are presented in isolation. Learning is believed to occur faster and more thoroughly when it is presented in meaningful contexts, with an experiential component. The brain searches towards inter-disciplinary learning, thematic teaching, experiential education, and teaching that is responsive to student learning styles. The movements towards a global economy and international connections, as well as the rapid changes in technology are pushing education towards integration. The ability to make connections to solve problems by looking at multiple perspectives and to incorporate information from different fields will be an essential ingredient for success in the future.

Bases and Interplay of Art, Science and Technology

From history art had influenced science and engineering. The Cubism movement exerted great influence on international architecture and industrial design in modern times. From adoptions of African traditional art, the style carried the ideas of the unity of the two dimensional picture surfaces by way of analysis of forms and their inter-relationships as ends in themselves. Structure and its position in space were combined from several view points and supper imposed to express an idea of an object rather than from one pictorial view point. The breakthrough allowed itself to be adapted to simplify endless variations in architecture and industrial design. Prior to the advent of Cubism, Art Noveau was an art movement that spread across western world. Based on the patterns of plant forms, the art exerted great influence on architecture, interior design and industrial design. The Bauhaus of Germany in 1930s, spearheaded by Walter Gorpius, was a deliberate attempt to combine art, architecture and engineering to upgrade product design. He invited top architects, artists and engineers for this purpose. Mohol-Nagy, a Russian artist in Chicago in the 1930s also set up a new Bauhaus. The high level of product design achieved by these two countries owes much to the pioneering efforts of these two schools. Nigeria can emulate the Bauhaus by involving in such inter-disciplinary interaction. Art is part of science and technology based institutions like the College of Art, Science and Technology.

Despite the significant strides in the teaching of science and engineering, there is little to show in terms of industrialization. We still rely on foreign technical experts and assistance for survival. People still patronize foreign goods more. Policy makers have failed to channel our education to achieve the desired technology because artistic creativity is not properly involved in the application of science and engineering. Just as mathematics is not exclusive domain of any subject, so is artistic creativity not limited to visual arts. Creativity is applicable to science and engineering. We have great brains in science, but woes in contemporary technological advancement partly due to the down play of an important aspect of technology (creative arts) in basic education. In order to catch up with the Asian tigers in technological development, a radical step has to be taken by educational planners. Art teachers must be produced in large number. Art, design, science and engineering must be taught concurrently (integration or inter-disciplinary approach).

Since the beginning of times mankind has been dependent on drawing and painting. The first alphabet was evolved from picture symbols and before the inception of writing, drawing was the only means of recording events, dates and forms. Until the invention of printing, hand written books were illustrated. Even the initial letters at the beginning of the chapters and paragraphs were ornamented with scenes or portraits, comic strip magazines and ornamental cartoons occupy screen (Delaquis, 2003). At the beginning of the 2nd world war, in order to cut down casualties in the fight against Russia, Hitler employed artists to design the camouflage uniform for the first time. It is still in use by all armies of the world. Since the 1st world war artists have been hired by Navy and Air force to apply their expertise in illusion of form and colour to camouflage ships and airplanes to confuse the enemy in a shootout. NASA still applies simple pictorial devices like frottage and others developed by the Surrealists painters to determine the mental makeup of astronauts and their susceptibility to hallucinations when confronted with unusual visual phenomena in outer space. Psychiatrists also use these Surrealist devices a lot in their practice. Accurate rendering of activities of court cases behind closed doors are carried by artists because camera is barred in courts. Artists have recreated the dinosaur; same applies to outer space even before man first walked on the moon. Without the medical illustrator, the study of medicine would not be envisaged. Just as a car designer must have both engineering and art competencies, so must the qualified medical illustrator have biology and art qualifications, rare combination for Nigerian education system (Delaquis, 2003). The design of stamps, coins, badges, trademarks are wholly dependent on the skill of artists and draughts men. Without publicity through commercial arts, mass production and the process of industry could be impossible. No matter how excellent a product might be, it would not compete in the industrial market if the packaging and the label are not aesthetically satisfying. Some products are even better than those imported but are not patronized because of lack of aesthetic input in the making, packaging and labeling. Buyers are naturally attracted to products which are presented beautifully, assuming that the inside products would be as good as the outside. In education, good teachers always seek to develop visual aids for the instruction of all age groups. Illustrated books have more interest for children and adults. A more successful teacher is one who can illustrate his geography or biology lesson with a sketch on the magic board. The engraving on money is executed by an artist. The coins we use are miniature sculpture piece created by hands of an artist. The belt buckle, the designer dress, the ear rings and the bangles, the designer shoes, eye glasses, car are all amalgamation of artistic skill and technical craftsmanship. Today designer product implies that someone sat down, took extra time, composed, formulated or manipulated form, texture, and colour till an aesthetically satisfying synthesis was achieved in the product. The product is in all cases extra-ordinarily beautiful of its kind.

A lot of investigations commence as mental images in the mind before transmission into mathematical formulae and into mechanical device. Often ideas pass through the medium of sketches. Great architects, from Renaissance to modern times, always initially formulate structural ideas in free hand drawing before putting them in scale. The sketches of the architects reveal that they cultivated imagination through drawing and this raised aesthetic considerations. Top car designers, interior decorators, industrial designers all initially pictorialize random ideas through quick sketches before crystallization into actuality. The interplay of technology and art is more apparent in car designing. The computing of outer body realization passes through the whole gamut of art. From preliminary freehand sketches to detailed, scaled drawing studies, to sculpture and ceramics in clay, to sheet metal adaptation, then through air tubes to streamline drag and further adjustments, then priming and pigment mixing that is not very different from the procedures that an artist goes through preparing canvas.

Newton first explained the dispersion of light in 1666 and the significance of his discovery to painting was later fully appreciated when it was realized that white light is made up of many colours and two colours may blend to form a third colour. Varying wave lengths of the rays of light are responsible for the sensation we perceive as colour and each colour has its own wave length. Objects have no colour in themselves. According to its nature an object absorbs part of the colour ray which composes white light. The colour which an object appears to be is the ray which is not absorbed (due to the nature of the object) and which therefore reflects and bounces off. Thus an object which appears to be orange has absorbed all the rays of the spectrum except orange ray which it reflects and you are given the sensation. The two extremes are black and white. An object which absorbs all the rays of the spectrum will appear black, because it does not reflect any ray of the spectrum. One which absorbs no ray will appear white, because the rays will recombine to make the white light again. The implication of the scientific discovery of colour to painters is that the colour of objects in a composition is subject to the circumstance in which you see them. Colour is never a constant thing. It is a phenomenon which changes with the variable circumstance in which it is seen. It is purely an arbitrary circumstance whether lemon is yellow or not.

The old masters were deeply involved in drawing of natural objects. The study of plant life in science involves the combination of nature study with drawing. It is possible for those who have no taste for art to gain from the art class by acquiring interest in nature study or in biology. By being engaged in drawing of leaves, flowers, skull, painting landscape or other natural forms, you will definitely acquire the knowledge of plants growth and its structure and thus develop interest in the world around you. The scientists who studied the evolution of man (e.g. Charles Darwin) and the early explorers (e.g. Leo Frobenius) relied very much on drawing of natural objects as forms of record. Observation, one of the basic steps used by science is also a major source of getting accurate drawing. Observational drawing and firsthand experience with objects as stimuli for art proliferated in the 1970s as forms of inquiry, means of awareness and fostering inquisitiveness. Objects for direct sensory experience stimulate the learner's vision and feed his imagination. Sensory experiences nourish mental, emotional and imaginative growth. They provide the brain with the material required for the maturation of perceptual, cognitive and sensory processes.

In industrial production, science is the knowledge and art is the creative act involved in the making of an object. Art evolves and science involves. While science deals with the principles by which ends are attained, art deals with the ends themselves and how to achieve them. Even during the early civilization art and science were not separated as they are today. The early man understood the world through unified study of artistic, logical and religious elements. Art, science and religion were combined or integrated. Art cannot develop without science; neither can science advance its investigations without the use of art. Art requires broad and scientific knowledge of the elements represented and scientific findings must be recorded through artistic images.

William Harvey (1578–1657), who had a degree in Fine Arts, discovered the circulation of blood in human body. The earliest known anemic drawing was Aristotle's drawing/diagram of the male urogenital system. It was through these art works that contemporary scientists gave serious attention to the study of human anatomy. The early sculptors and artists in general were better surface anatomists than men of science and the rise of naturalism in art during the Renaissance period led them to take an intense interest in human form. They took their art illustration into anatomy and thus laid the foundation of medical sciences and medical illustration technology. The use of animation graphics to illustrate the science of how the human body works had led to exposition of some physiological puzzles which is of immense interest to medical scholars and practitioners. What may begin as art activity could become a scientific investigation. The discovery of circulation of blood in human started as art exercise.

It has been discovered that mentally retarded and backward children learn more effectively through art opportunities. Music is used in physical exercise, work, military parade, traditional faming to enhance performance. Displaying art works in hospitals could help patients psychologically. Music, dance or drama provides a kind of satisfaction to patients who are restless. They enable them relax, rest and pay attention and send them into a state of composure and they forget that they are hospitalized. What many patients need is not drug, but opportunity to relax and re-channel their minds.

From the available literature on technology, we could develop some basic facts about it.

1. Technology is developed and not necessarily transferred as many people think.
2. People develop technology when they improve their knowledge, skills and procedures of making and doing things.

3. One of the conditions most favourable to invention is to accumulate knowledge and experience in art and creativity.
4. Art is the basis of all disciplines and the foundation of discovery.
5. There is need to provide integrated knowledge of art, science and engineering for industrial development.

Industrial products are first drawn or sketched on paper before their mechanical mass production. The artist indicates the possibility of a new product through his creative powers. Leonardo de Vinci was the first to suggest graphically the idea of a flying machine and it had taken science and engineering many years to catch up with him. All objects of our daily use show a recognizable style of art form. There are design elements in architecture, television sets, bridges, chairs, clothes, utensils, machineries, tables, chairs, cars, airplanes etc.

Industrial Design Process

I. Finding and investigating problems

Finding problems to tackle is the starting point for all design activities. Design problems exist everywhere you look, for they are concerned with how people live their lives and how products and systems help them do it. Imagine or think about what people are trying to do, how they are doing it, what systems or products they are making use of and how they might be improved. You will certainly find lots of design problems to tackle.

You spend a lot of time at home and at school, so these are good places to start when you want to look for design problems. Visitors are always coming to the school, but they can't find their way around. How could you help? You can design a corporate identity for different departments. At home think about your leisure, your transport, how to carry things by hand or on a bike, and how you leave messages. A great many design problems are concerned with containing things which are perishable like food, drink, people and livestock; dangerous like chemical and drugs; precious like money, documents and jewelry and numerous like marbles, pencils and stamps. Usually these items are being contained because they need to be stored safely until needed, quickly identified, easy to transport, protect and made accessible. Drink cartons, crisp packets, clothes and handbags are just a few examples of containers. The design of a container has to be carefully matched to the situation and environment in which it will be used, and visual clues are needed to help identify its contents and how to open and close it. Information design is concerned with developing two-dimensional graphic work to provide ideas or information. Record sleeves, magazines, sign systems, posters, timetable and instruction leaflets are typical products in this area. When the message is intended to sell or promote something, visual images are used to make a product seem extremely desirable and memorable. To make a message memorable:

a. make it strange or puzzling
b. distort its proportion,
c. make it dynamic (i.e. make it carry out an action),
d. exaggerate the number,
e. make it brilliantly coloured.

Brochures, record sleeves and book jackets show effective use of such devices. The corporate identity provides a quick and easily recognized way of labeling products and services, and helps to reinforce public awareness of them. Corporate identity systems might involve logo or symbol that can be used on a letter head or business card. Packaging, products, instruction leaflets, invoices, advertisements, uniforms, delivery vans, carrier bags and retail outlets can be unified under the banner of the corporation.

You only have to open your eyes to see a design problem, but seeing the problem is only the first step. The next important activity is to get as much information as possible about the problem. You need detailed information about the people involved, the activity they are involved in and the situation of the activity. Ask yourself various questions about each element of the problem.

1. The people: Who? How many? When? How often? How big? Why?
2. The activity: What? When? How? How often? What is the difficulty?
3. What is the cost? How long does it take?
4. The situation: Where? Why? Where else? What environment? What cost? What is the difficulty?

Think about how you can best get hold of and record the information that you need. Is it by talking to people, by watching people, by listening, or by writing to people? Collecting information under people, activity and situation, should enable you to summarize your particular design problem clearly and in detail.

II. Developing ideas of your own

Thinking for yourself is something you need to do through all the stages of your project.

Good ideas are very rarely completely new or original. They are usually existing ideas put together in different ways or applied to different situations. Brainstorming is a very useful activity, in which you try to come up with as many ideas about a problem as you possibly can. Let your mind wander freely around the problem. Put down as many ideas as you possibly can but do not judge them. No one is allowed to say whether an idea is silly or impossible or anything else. The point is to get ideas out of your head as fast as possible. Look for connections between things and ways in which usually unrelated things can be combined. Record all the ideas using words, sketches or both.

Everybody, without exception, has the capacity to think imaginatively. It is a basic human ability that we all possess. But like many other abilities, if we don't practice it, it won't develop very much. There is nothing worse than sitting starting at a blank sheet of paper waiting for ideas to suddenly happen. Your mind will generally go blank as the paper. You should begin by putting down whatever your first thoughts are however basic or unlikely they might seem. You could start by doodling and see what happens. No one expects you to come up with a brilliant idea in your first sketch and if you do they might be suspicious of where it came from. Some of the best things seem to happen by chance so try to encourage some happy accidents. Evaluate your ideas. Some will be too costly or too difficult to make or perhaps socially undesirable in other ways. Check back with the original specification and see which ideas best fit the problem.

Having your own idea is not easy. It often takes courage to begin with, but in the end you can look back and see that your project is different from other people. In some way it is individual and yours. Believe in your ideas even if they need a lot of developing before they can be used successfully. Always remember that having good idea involves trying things out, not worrying if things aren't always right first time, letting go of being a perfectionist, making the most of whatever happens, being patient, long hours of struggle and real sense of achievement.

III. Communicating ideas and information

However good your design ideas are they will be worthless if you cannot communicate them effectively to other people. Good communication will help you to retrieve and record important information about your design problem, discuss as they develop, convey the details of your solution to whoever will be involved in making or carrying out your ideas and convince your teacher and the examiner of the quality and quantity of your ideas.

In all types of messages the impact of visual communication is very important. A picture can tell a thousand words, but drawings by themselves are unlikely to be completely sufficient to convey your ideas. Effective communication usually involves a mixture of words, pictures, numbers and even physical gestures and actions. Both written and spoken words are probably the most commonly used form of communication. Visual images or pictures dominate our lives far more than we realize through signs, trademarks, drawings, photographs, film and television. Surprisingly though people are generally much less fluent in using these forms of communication than they are with words. It is easier to fudge issues with words, but designers can't afford to fudge things. Numbers are particularly efficient for communicating details of quality of such things as time, cost, weight, size, strength and location.

IV. Modelling ideas

You can represent your ideas by a means of a series of two- and three-dimensional models. Models are simplified versions of the intended real thing. They allow you to explore your ideas in detail. The sketches, drawings and numbers are all types of model as well. The most sophisticated modeling tool you have is your brain. In your mind's eye you can create and change ideas that combine 2D and 3D images, words and numbers. Choose the right types of model to test the particular ideas that you are interested in. Often models will have to use a combination of change of scale, material and form. Make real models to explore your thinking.

Getting your thoughts out of your head and onto paper and into modeling materials will help you to sharpen and clarify the ideas.

V. Making what you have designed (prototyping)

The stage at which you want to make the product is called realization stage. You need a working drawing which contains construction details, size, materials and finishes as well as cutting list or parts list. The realization can be divided into two stages: a) Preparation. Plan your approach to the manufacturing stage. Work out the procedures to be followed and indicate amount of time available for each part of the procedure. Keep your schedule as closely as you can. Another aspect of the preparation is the practicing of any techniques which you are unfamiliar. Select and collect together the materials which you require. Check the materials against your specification and choose materials of good quality b) Manufacture. Work carefully and methodically and work precisely. Use your design folio as a reference during the realization stage. It is quite usual and perfectly proper, for modifications to develop during realization.

VI. Weighing up the pros and cons (Evaluation)

Once your design has been realized you should make your evaluation of your project. Treat it as an initial prototype or provisional solution. There are four areas to evaluate:
performance against the original brief, appearance and aesthetics, the accuracy of the realization against the initial design, and personal feelings.
The first two evaluate the outcome or product of your design. The last two are evaluating your design as a process. The appearance of the realized idea is an important consideration and an evaluation of it is vital. Think of the best form of collecting information for your evaluation. This might be a test, questionnaire, a book, a tape recording, or photographs, or combination of all of these. Your evaluation should take the form of written report or it might form a part of a display, visual approach with drawings, photographs and charts. Kimbell (1987) provides evaluation questions. They are:
Have you tested your realization in its intended setting?
Does your realized idea work in the way that was intended?
Have any difficulties with the operation been noted?
How could you improve the function?
Is your realization well produced?
How could the standard of manufacturing be improved?
Have you used the best materials and construction for the object?
State the best features of your realization, such as finish, accuracy of construction, etc.
Is it possible to compare your project with a commercially produced item?
List the comments which other people have made about your work and who did you ask to comment and why?
Does the realization match the idea presented in your design folio?
State the reasons for any differences which have occurred.
Where did the idea for your design come from?
State the best features of your idea, such as novelty, values, simplicity, etc.
Have you presented your design folio?
Did you complete the realization in the time available? If not, why not?
With what did you need most help and where did the help come from?
Which aspects of the project did you most enjoy?

Conclusion

Science and engineering will be required to bring the designed product into reality.
Whenever there are moving parts in something, there is a mechanism. Mechanisms are designed to achieve any movements that are required. Industrial development requires the interplay of art, science and engineering. The formation of a product requires art skill. Products have to be designed by artist if they are to physically appeal to the public. The development of technology requires knowledge of art, science and engineering combined. Victor D. Amico (1960) said" … in the age of science, art may be the salvation of modern man, but only if children have the benefit of true aesthetic experience". The developed countries are aware that one of the conditions most favourable to invention is to accumulate knowledge, skill and experience in art and creativity.

Technology springs from a soil prepared by technical training, knowledge of physical science and symbols acquired through interaction and integration of art, science and engineering. Such training should start in primary and secondary schools. Subject areas can be connected through topics, skill and concepts. Ideas within the disciplines can be linked. The idea of teaching the subjects separately will not achieve our desired objective.

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