

2009

Propelling design evolution: using a scientifically driven design process to incrementally advance architecture

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Propelling design evolution: using a scientifically driven design process to incrementally advance architecture

By

Robert Thaddeus Gassman

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
MASTER OF ARCHITECTURE

Major: Architecture

Program of Study Committee:
Mikesch Muecke, Major Professor
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Iowa State University
Ames, Iowa
2009

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ACKNOWLEDGEMENTS

My gratitude is expressed towards the following individuals:

Alread, Jason- Thank you for establishing the primary foundation for my design philosophy and practice. You introduced me to the wonderful world of Ray and Charles Eames and their dogma, “Take your pleasure seriously.” Ride on!

Gassman Family- Thank you for being my family. We are certainly a fortunate bunch! May all of us siblings have the privilege of maintaining families with the loyalty, compassion, and dedication that our own has.

Horwitz, Jamie- Thank you for your friendship and generosity. The entirety of this thesis was composed in your very own dining room. Hopefully this work can provide the world with some food for thought. I will certainly reciprocate the kindness you have provided Shannon and I towards other young souls.

Jones, Shannon- Thank you for making this epic journey with me. It is now time for us to move on to bigger and better things. Congratulations on earning your honorary M.Arch II. You are my love.

Muecke, Mikesch- Thank you for serving as my mentor over the past six years of my existence. Your uplifting life philosophy and friendship has enriched my passion for education and just plain livin’. You have been my family away from home and I will always pass on the immense knowledge and energy that you have provided me.

ABSTRACT

This thesis explores the influence of design evolution within the professions of architecture, industrial design, and engineering. Design evolution is a process that can be accelerated through collaboration between various groups linked to the development and production of designed objects. Working as interdisciplinary professionals, I support the incremental advancement of contemporary products in order to encourage positive human progress.

As a case study, I investigate standard electrical systems used in architectural construction. It is apparent that for nearly 100 years the same basic electrical systems and components have been installed in buildings throughout the world. To promote design evolution in the field of architecture, I implement a scientific design approach to incrementally advance the designs of two century-old electrical components, the single-pole switch and the duplex outlet receptacle.

The goal of this thesis is to investigate how analytical design methods can reveal incremental advances that yield more appropriately designed products.

CHAPTER 1

DESIGN EVOLUTION PROPELS PROGRESS

This chapter offers a basic introduction to the process of evolution and reveals that the evolutionary process is notable in objects and artifacts created by humans. During the production of designed objects, I claim that design evolution can be accelerated through interdisciplinary collaboration. And, by working as a team towards a common goal, humans can rapidly produce innovative and positively progressive design solutions. This chapter concludes by posing a design case study in order to further explore the process of positive design evolution.

On evolution

Evolution is the “progress of change in a given direction”¹ and is a common theme throughout many scientific fields, particularly biology. Many biologists defend evolution as an explanation for changes made by living organisms over a given period of time and use this phenomenon to explain the development of human beings. The process of evolution can influence a specimen positively or negatively. When a specimen experiences negative change, it is affected non-advantageously. Negative evolution may diminish a specimen and bring it closer to obsolescence or extinction. Likewise, when evolutionary change causes a specimen to become superior and increase performance, the evolution can be considered positive. When a specimen gains superior abilities compared to other competitors, its longevity and chance of survival can increase.

Equally, the evolutionary process is not only conceivable in living organisms and humans, but in objects and artifacts created by them. “The oldest surviving things made by men are stone tools. A continuous series runs from them to the things of today.”² Humans have evolved primitive tools through their ability to adapt, manipulate, and change objects in order to solve problems. It is understandable how prehistoric people used problem-solving skills to

¹ Langenscheidt's Pocket Merriam-Webster English Dictionary. (Langenscheidt Publishers Incorporated, 1997); 262.

² Kubler, George. *The Shape of Time: Remarks on the History of Things*. (New Haven and London: Yale University Press, 1962); 2.

improve their stone tools. A sharp edged rock was a good object for cutting and scraping materials within close proximity of a user's hand. However, if there was a need to cut something from a further distance, a lengthening element needed to be attached. By attaching the sharp rock to the end of a sturdy stick, the user could cut from a further distance and satisfy their current need. If this modification improved the usefulness of the tool and increased the user's capabilities, then the tool experienced positive evolution (Fig. 1).

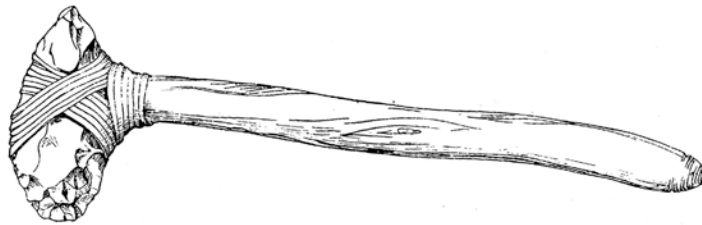


Figure 1: A primitive cutting tool composed of a sharp rock, wooden handle, and string.³

If we go back far enough, we find that the first acts of civilization were the use of tools... and the construction of dwellings. By means of all his tools, man makes his organs more perfect.... With spectacles he corrects the defects of the lens in his own eye; with telescopes he looks at far distances; with microscopes he overcomes the limitations in visibility due to the structure of his retina.⁴

It is apparent that humans have positively evolved many objects to enhance their lives. Throughout history products such as spectacles, telescopes, and microscopes have been developed to increase the physical abilities of the human body. These increased capabilities have often improved human longevity and allowed for societies to progress. Spectacles have made it possible for millions of visually impaired people to read finely typed text and observe distant sunsets. Scientists, such as Gregor Mendel have used microscopes to observe miniature cellular life, which has made it possible to study and develop cures for many diseases and health problems. And, the Hubbel telescope has propelled extraterrestrial

³ Reconstruction of an axe from Kostenki I in its handle; from Semenov, S.A. *Prehistoric Technology: an Experimental Study of the oldest Tools and Artefacts from traces of Manufacture and Wear*. (Bath: Adams and Dart, 1970); 126.

⁴ Freud, Sigmund. *Civilization and Its Discontents*. Edited and translated by James Strachey. (New York and London: W.W. Norton and Company, Inc., 1961); 37, 38.

progress by revealing information about distant galaxies and celestial bodies. These few examples demonstrate how positive evolution of objects has contributed to the advancement of humanity. These advancements have often increased human survival and have allowed our species to flourish.

Design evolution is enhanced through interdisciplinary collaboration

Over time, humans have used their problem-solving skills to evolve innumerable objects. However, many of these once simple assemblies have transformed into complicated, multi-part systems. Sharp edged rocks have turned into Swiss Army Knives (Fig. 2), sundials have developed into Swatches, and primitive huts are now skyscrapers. Many of these assemblies have become so complicated that expert knowledge is now needed in order to further advance certain assembled systems.



Figure 2: Image of a Classic SD, Victorinox Swiss Army Knife, multi-part assembly.⁵

Often the making of contemporary objects requires entire teams of professionals, solely dedicated to the design, development, and production of a specific product. Members of these teams typically possess specialty knowledge related to a particular aspect of the creation of an object. These product development teams regularly include professionals such as designers, engineers, draftsmen, and marketing experts. As a team, these professionals work in close collaboration with each other to achieve established goals. “The consequence is ‘social creativity’, which gives priority to joint problem solving.”⁶ Interaction between interdisciplinary group members can generate constructive criticism and encourage mutual help to rapidly generate thorough design solutions and accelerate the evolution of a product.

⁵ Image by author, 2009.

⁶ Heufler, Gerhard. *Design Basics: From Ideas to Products*. (Zurich: Niggli Verlag AG, 2004); 66.

Within an interdisciplinary team, the designer maintains a crucial role. The professional responsibilities of a designer are interpreted by the ICSID's (International Council of Societies of Industrial Design) definition of design:

AIM

Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles. Therefore, design is the central factor of innovative humanisation of technologies and the crucial factor of cultural and economic exchange.

TASK

Design seeks to discover and assess structural, organisational, functional, expressive and economic relationships, with the task of:

- Enhancing global sustainability and environmental protection (global ethics)
- Giving benefits and freedom to the entire human community, individual and collective
- Final users, producers and market protagonists (social ethics)
- Supporting cultural diversity despite the globalisation of the world (cultural ethics)
- Giving products, services and systems, those forms that are expressive of (semiology) and coherent with (aesthetics) their proper complexity

Design concerns products, services and systems conceived with tools, organisations and logic introduced by industrialisation - not just when produced by serial processes. The adjective "industrial" put to design must be related to the term industry or in its meaning of sector of production or in its ancient meaning of "industrious activity". Thus, design is an activity involving a wide spectrum of professions in which products, services, graphics, interiors and architecture all take part. Together, these activities should further enhance - in a choral way with other related professions - the value of life.

Therefore, the term designer refers to an individual who practices an intellectual profession, and not simply a trade or a service for enterprises.⁷

The ICSID definition of design makes it apparent that the role of designers is particularly crucial to the production of objects. Within interdisciplinary design teams, designers often act as the mediator between all other team members who maintain specialized knowledge related

⁷International Council of Societies of Industrial Design. "Definition of Design." International Council of Societies of Industrial Design . <http://www.icsid.org/about/about/articles31.htm> (accessed February 1, 2009).

to an object or product. Designers are typically not specialists, but generalists who simultaneously work in various production categories. This requires designers to find solutions to problems within many sectors of a design team.⁸ A successful designer can ensure cooperation between interdisciplinary team members to generate progressive and innovative design solutions. This can result in the development of products that are more useful, solve problems, and maintain positive evolution.

Evolution: Is it worth it?

Within the ICSID definition, it is emphasized that design is a cultural process, essential to the advancement of humanity. The act of designing occurs globally and has been prevalent since ancient human civilization. Throughout human existence, designers have created a countless number of objects. Many of these objects and inventions have gone extinct, potentially due to their lack of usefulness. However, throughout contemporary cultures many antique products still exist and maintain original use; for example, eyeglasses (Fig. 3).



Figure 3: A timeline of eyeglasses, ranging from the 16th century to 1990.⁹

For hundreds of years, eyeglasses have been used to solve people's sight problems and are still used for this purpose today. Overall, the design of eyeglasses has remained the same, consisting of two transparent lenses held by a frame. Subtle enhancements made to this basic design have generally improved the overall product. Positive design evolution has rendered eyeglasses that are comfortable, durable, aesthetic, and extremely useful.

⁸ Heufler, Gerhard. *Design Basics: From Ideas to Products*. (Zurich: Niggli Verlag AG, 2004); 66.

⁹ From left to right: Spectacles with flexible nosepieces, Germany, replica of 16th century example; Chinese spectacles with teastone lenses and brass frame, late 18th century; Model Rob, Robert la Roche, France, 1990s; from Eijk, Femke van. *Spectacles & Sunglasses*. (Amsterdam: The Peppin Press, 2005); 39, 49, 289; modified by author.

The longevity of an enduring product can be attributed to its ability to continually satisfy particular needs. In order to maintain usefulness and prolonged existence, many objects have experienced design evolution through a series of alterations made by designers. Sometimes the evolutionary change is slight; other times an entirely new product is developed.

...the “Rotato Potato Peeler,” [was] a mechanical marvel that applied high tech to the low art of removing a tuber’s skin. It worked – but it was cumbersome and ugly, and it removed an eighth of an inch of potato flesh. The seven-dollar OXO peeler, by contrast was just an incremental advance on the century-old mechanical standard. But that increment – a more comfortable handle, a curved blade, a cleaner look – was valuable. It turned the mundane into something enjoyable, even beautiful.¹⁰



Figure 4: The Rotato Potato Peeler¹¹ and the OXO Peeler.¹²

This example reveals two different products that have been developed to satisfy the same need, which is the removal of a potato skin (Fig. 4). The problem is as ancient as vegetables themselves and has been addressed through many different solutions. Over 100 years ago, a mechanical potato peeler was created and it became a standard tool. This product has been a successful device by satisfying the need for vegetable peeling. However, contemporary

¹⁰ Vogel, Craig M., Jonathan Cagan, and Peter Boatwright. *The Design of Things to Come*. (New Jersey: Wharton School Publishing, 2005); xiv.

¹¹ As Seen on TV Guys. “Rotato Express image.” As Seen on TV Guys.com.

<http://www.asseenontvguys.com/index.asp?PageAction=VIEWPROD&ProdID=164> (accessed March 1, 2009).

¹² Cooper –Hewitt National Design Awards. “OXO peeler image, Cooperate Achievement Finalist.” Cooper –Hewitt National Design Museum. <http://www.nationaldesignawards.org/2008/honoree/oxo-international> (accessed March 1, 2009).

society has still expressed a need for a solution to this age-old problem. To address this, both the Rotato Potato Peeler and the OXO peeler were designed and produced.

Compared to the century-old mechanical standard (Fig. 5), the Rotato Potato Peeler can be understood as a product that experienced negative evolution. This device is an example of a completely new product that has developed from the old mechanical solution. In terms of providing an improved solution to the problem (removing a potato skin), it is apparent that the Rotato Potato Peeler actually does an inferior job than the older, handheld peeler. Not only does the Rotato Potato Peeler perform worse, it seems to be substandard in many other design categories, such as aesthetics, ergonomics, usefulness, and economy. By not providing a superior solution to the problem, the Rotato Potato Peeler runs the risk of becoming obsolete and extinct.



Figure 5: An example of a century-old vegetable peeler design.¹³

The OXO peeler, on the other hand, has indeed provided a superior solution for peeling a potato. This peeler has evolved positively by advancing and adapting the solution provided by the century-old mechanical peeler. The OXO peeler is not an entirely “new” product, but merely an improved version of the old standard. Through incremental improvements, the OXO peeler offers an advanced solution for peeling a potato and reveals an enhanced design.

This method for deriving a superior solution to a problem is emphasized through the saying by Charles Eames, “Innovate as a last resort”.¹⁴ The Eames Office of Design practiced this dogma to derive legendary design solutions for architecture, furniture, graphics, exhibitions, and films. For example, the Eames molded-plywood chairs [LCW and DCW] were

¹³ Image by author, 2009.

¹⁴ Demetrios, Eames. *An Eames Primer*. (Universe Publishing: New York, 2001); 9.

developed through an experimental process that ultimately evolved technologies, materials, and forms associated with furniture production (Fig. 6). The result was still a chair, but one that provided a superior solution and established a seating standard that continues to serve as a precedent today.

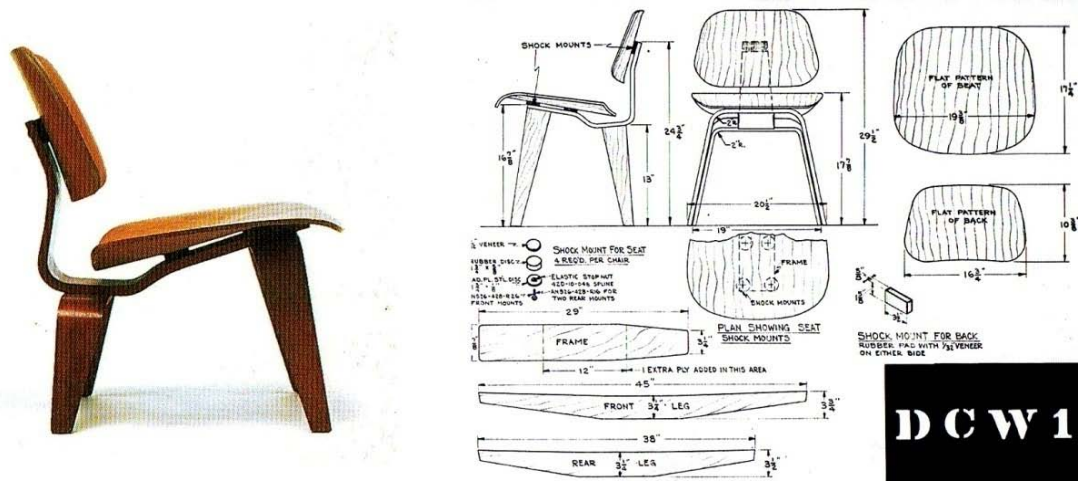


Figure 6: An image of the Eames LCW¹⁵ and design drawings for the Eames DCW.¹⁶

The previous examples demonstrate outcomes of product evolution. If an object evolves negatively, the result is often an inferior product that reveals inadequate usefulness. The making of substandard objects can adversely affect human progress by stagnating cultural advancement. However, when design evolution renders superior products, cultural advancement can be propelled. Positively evolved products can establish a higher platform for designers to make improvements and innovations. This offers a progressive product culture for future generations to build upon.

¹⁵ Lounge Chair Wood (1945); from Demetrios, Eames. *An Eames Primer*. (Universe Publishing: New York, 2001); 15.

¹⁶ Specifications for the DCW (Dining Chair Wood); from Koenig, Gloria. *Eames*. (Köln: Taschen GmbH, 2005); 30; modified by author.

Pre-problem solving: The X-PRIZE

It is evident that when products continue to positively evolve, they typically offer progressive and advanced solutions to problems. A successfully evolved object can reveal designs that thoroughly satisfy the needs of a user. However, positive product evolution does not have to occur only to solve problems as they arise. In fact, by maintaining the positive evolution of objects, the result can be products that provide solutions for future problems. This method of pre-problem solving can help advance a society and avoid what author Ronald Wright calls a “progress trap”.

A progress trap is a situation inadvertently caused by humans that may catastrophically affect evolving societies. Often, when these situations arise they are unable to be remedied due to a lack of resources. A progress trap often prevents a society from further progress, resulting in societal collapse. In his book, An Illustrated Short History of Progress, Wright traces world history by exposing a series of progress traps that have fatally affected societies and currently challenge present and future humanity. Ronald Wright provides the following example of a current progress trap:

Take weapons for example. Ever since the Chinese invented gunpowder, there has been great progress in the making of bangs: from the firecracker to the cannon, from the petard to the high explosive shell. And just when high explosives were reaching a state of perfection, progress found the infinitely bigger bang in the atom [(Fig.7)]. But when the bang we can make can blow up our world, we have made rather too much progress.¹⁷

¹⁷ Wright, Ronald. *An Illustrated Short History of Progress*. (Toronto: Anansi Press Inc., 2006); 4, 5.

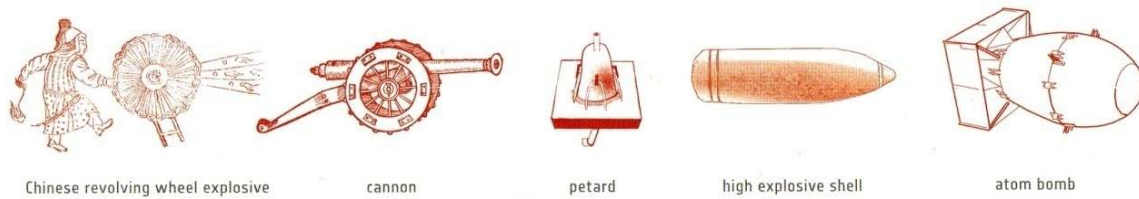


Figure 7: An illustrated timeline depicting an evolution of weapons that culminates with the development of the atomic bomb, which is a contemporary progress trap.¹⁸

Other examples of contemporary progress traps include climate change, overpopulation, and erosion. Humans have encountered many progress traps due to their development of products and objects that have rendered adverse affects on the earth and its inhabitants. For example, the recent abrupt increase of greenhouse gases can largely be attributed to the development of inefficient combustion engines. These engines have powered automobiles and other motorized equipment for the past century and a half and have spewed harmful exhaust into the air. The combustion engine has fostered progress in other arenas of human existence, but it has ultimately confronted society with a progress trap due to its polluting output, which has contributed towards global climate change.

The realization of progress traps makes it apparent that, in the pursuit of progress, humanity needs to constantly be aware of potential outcomes caused by the objects it creates. Societies need to adopt a dogma that critically assesses the ways in which they live and the objects and materials they produce. Ronald Wright believes that the world has currently reached a tipping point, and if humans don't change their ways of life, then human existence will face dire consequences. Wright comments, "The world has grown too small to forgive us any big mistakes."¹⁹ Through collaboration and partnership, humans can work collectively to strategically advance civilization. By carefully developing products that beneficially address future needs, a society can avoid certain progress traps and advance positively.

The X-PRIZE Foundation is a current example of an organization that promotes the advancement of humanity through pre-problem solving. This foundation was initially

¹⁸ There has been great "progress" in weaponry. But when the weapon can destroy our world, the progress has become a trap; from Wright, Ronald. *An Illustrated Short History of Progress*. (Toronto: Anansi Press Inc., 2006); 4, 5.

¹⁹ Wright, Ronald. *An Illustrated Short History of Progress*. (Toronto: Anansi Press Inc., 2006); back of recto.

established in 1994 by Dr. Peter Diamandis to sponsor a prize competition that would challenge teams to accomplish an established goal. Diamandis' initial inspiration came from the famous Orteig Prize of 1919, offered by the independent hotel magnet, Raymond Orteig. The Orteig Prize competition challenged competitive teams to complete the first non-stop flight between New York and Paris. "Where no government filled the need and no immediate profit could pay the bill, the Orteig Prize stimulated not one, but nine different attempts to cross the Atlantic. These nine teams cumulatively spent \$400,000 to win the \$25,000 purse - and spawned today's \$250 billion aviation industry."²⁰ Charles Lindberg and his small professional team ultimately achieved the goal of the Orteig Prize in 1927. The accomplishment of this challenge changed worldwide expectations for human advancement and inspired global progress. "The X-PRIZE Foundation was founded to create a similar change in the public's expectation of space flight, and now exists to create similar shifts in the public's perception in future X-PRIZE areas."²¹

An X-PRIZE is a \$10 million+ award given to the first team to achieve a specific goal, set by the X-PRIZE Foundation, which has the potential to benefit humanity. Rather than awarding money to honor past achievements or directly funding research, an X-PRIZE incites innovation by tapping into our competitive and entrepreneurial spirits.

...

X-PRIZE competitions capture the imagination of the public and speed radical breakthroughs that can ultimately change the way we see ourselves and how we live on this planet.²²

The X-PRIZE Foundation announced their first competition, the Ansari X-PRIZE, in 1996, which challenged interdisciplinary teams to design and develop a personal spacecraft capable of suborbital flight. This goal was achieved in late 2004 by the team Mojave Aerospace

²⁰ X- Prize Foundation. "The X Prize Heritage." X- Prize Foundation. <http://www.xprize.org/about/the-x-prize-heritage> (accessed March 15, 2009).

²¹ Ibid.

²² X- Prize Foundation. "What is an X Prize?" X- Prize Foundation. <http://www.xprize.org/about/x-prizes> (accessed March 15, 2009).

Ventures for their flight of SpaceShipOne (Fig. 8). The prize-winning spacecraft was developed by a multidisciplinary team lead by famous aircraft designer Burt Rutan and financed by Paul Allen, Microsoft co-founder. This achievement has set a precedent for advancing humanity through the development of positively evolved objects. Dr. Diamandis strongly believes that “focused and talented teams in pursuit of a prize and acclaim can change the world.”²³



Figure 8: Digital model of Ansari X-Prize winning spacecraft²⁴; and Ansari X-Prize magazine publicity.²⁵

Since the successful achievements of the first X-Prize competition, the X-Prize Foundation has gone on to establish many other challenges throughout various interdisciplinary fields, such as “exploration (space and underwater), life sciences, energy & environment, education and global development.”²⁶ These challenges have been established to foster solutions that can relieve future dilemmas through pre-problem solving. Many of the solutions developed to achieve X-Prize challenges often continue to accelerate the positive evolution of products and objects. Through interdisciplinary partnerships, teams can work together to accomplish established goals with the intent to provide positive global solutions. Ultimately, the X-Prize Foundation seeks to inspire an initiative that propels societies to strive for the betterment of humanity.

²³ X- Prize Foundation. “The X Prize Heritage.” X- Prize Foundation. <http://www.xprize.org/about/the-x-prize-heritage> (accessed March 15, 2009).

²⁴ Scaled Composites. “SpaceShipOne image, General Information.” Scaled Composites. <http://www.scaled.com/projects/tierone/info.htm> (accessed March 15, 2009).

²⁵ X- Prize Foundation. “What is an X Prize?” X- Prize Foundation. <http://www.xprize.org/about/x-prizes> (accessed March 15, 2009).

²⁶ Ibid.

The evolution of architecture

The previous sections make it apparent that evolution is not only plausible in the progression of living things, but also in objects created by them. Over time, innumerable products, such as eyeglasses and the OXO peeler, have evolved through the act of design. The vast collection of objects and artifacts created by humans includes the production of shelters and built structures. Since the beginning of our existence, humans have always required shelter. Initially, within our mother's womb, we were all provided with an enclosure that offered safety and protection.²⁷ However, on the day that each of us was born, we were all forced into the world and challenged to find new forms of shelter to ensure our survival. The need for shelter has led humanity to create a broad collection of architecture. And, like all manmade things, architecture has experienced a long and diverse evolution.

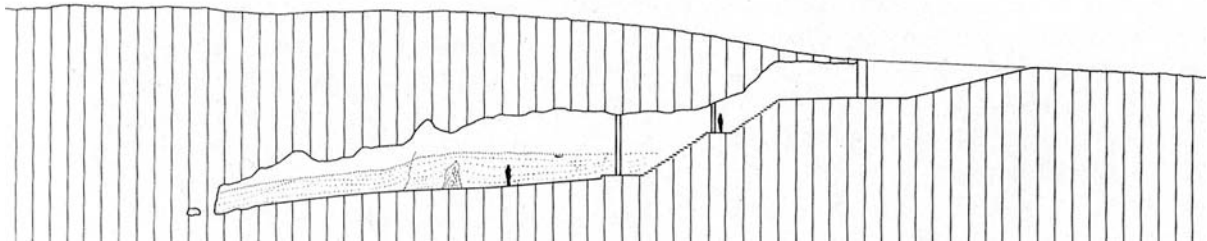


Figure 9: Section view of a prehistoric human dwelling within a cave in Lascaux France.²⁸

During prehistoric times, early humans occupied shelters provided by naturally developed geographies, such as caves, cliffs, and overhangs (Fig. 9). Prehistoric communities commonly inhabited these natural dwellings because they provided protection from predators, competitors, weather, and other earthly challenges. Gradually, many sedentary communities developed nomadic lifestyles and migrated throughout the world. It became essential for nomadic people to build their own shelters in order to satisfy their ever-present need for protection. Early shelters were created to provide basic enclosure and were typically constructed from elementary materials such as rocks, wooden poles, animal hides, and

²⁷ "...and the dwelling-house was a substitute for the mother's womb, the first lodging, for which in all likelihood man still longs, and in which he was safe and felt at ease."; from Freud, Sigmund. *Civilization and Its Discontents*. Edited and translated by James Strachey. (New York and London: W.W. Norton and Company, Inc., 1961); 38.

²⁸ Lascaux cave, section; from Kostof, Spiro. *A History of Architecture: Settings and Rituals*. (New York, Oxford: Oxford University Press, 1985); 24.

thatched reeds. Often the form of early shelters and dwellings were derived from naturally occurring precedents and maintained cave-like (womb-like) volumes (Fig. 10).

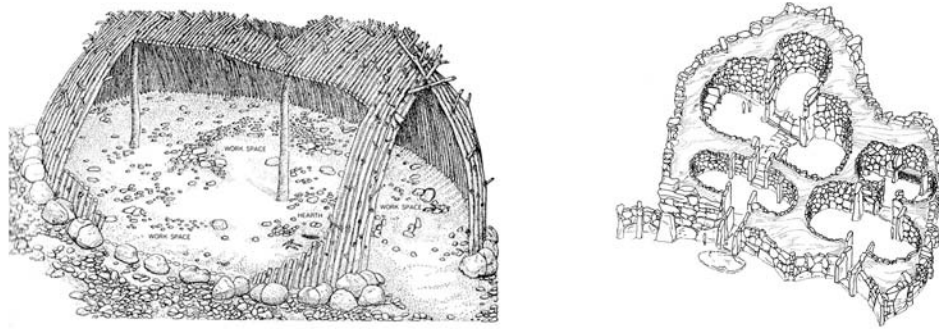


Figure 10: Left- reconstruction drawing of a prehistoric hut found in France, dating from approximately 400,000 B.C. This hut was constructed from branches braced by a ring of large stones.²⁹ Right- reconstruction drawing of Ggantija (a temple complex in Malta from the third millennium B.C.) constructed from earth, rubble, and stone.³⁰

Similar to the development of hand axe (Fig. 1), early buildings were habitually created through human acts of problem-solving. When a need was expressed, such as the need for shelter, humans were able to manipulate available earthly materials to create solutions. As early humans migrated throughout the world, they discovered new resources and landscapes. Access to new materials and building sites fostered innovative methods for producing objects and occasionally revealed progressive problem-solving opportunities. During the formation of early human civilizations, buildings began to fulfill a more diverse and sophisticated role. Early humans began to modify and evolve primitive dwellings to fit their increasing needs other than shelter. New specialized building types gradually emerged to accommodate specific uses and often developed particular architectural forms derived from the function of the building. The production of religious, civic, and infrastructural architecture became common among developing civilizations.

As early communities continued to grow, so did their need for architecture. Buildings and structures commonly grew larger in scale to meet the demands of increasing populations. As

²⁹ Terra Amata (France), prehistoric hut, ca. 400,000 B.C.; reconstruction drawing; from Kostof, Spiro. *A History of Architecture: Settings and Rituals*. (New York, Oxford: Oxford University Press, 1985); 23.

³⁰ Ggantija, interior, oblique view; reconstruction drawing; *Ibid*; 24.

the size of buildings continued to increase, urban architectural projects often became massive public works that required cooperative human efforts in order to progress forward. Typically, new architectural constructions were derived from historical precedents, traditions, and cumulative knowledge passed on from preceding generations. Advancing societies steadily improved upon previous methods for the fabrication and construction of buildings, which frequently resulted in architectural innovations. By working together and sharing knowledge, many early civilizations were able to accelerate architectural processes such as conception, design, and construction. The completion of many historic, large-scale works of architecture was often the result of team collaborators working towards an established goal.

An example of early architectural collaboration is exemplified through many works of Gothic architecture from the twelfth to the fourteenth centuries (Fig. 11). During this period, it is evident that workers and various professions involved with the building process began to establish a successful system of interdisciplinary partnership. Striving to satisfy spiritual and aesthetic needs, Gothic builders worked together to accomplish spectacular architectural feats. A chronological progression of Gothic structures reveals “a series of buildings one succeeding the other, and the last containing not only all the improvements before introduced into all the former examples, but contributing something new itself towards perfecting a style.”³¹ “The rude and heavy Norman pier was gradually lightened and refined into the clustered shaft of the later Gothic; ... the low rude wagon-vault expanded into the fairy roof of tracery, and the small timid opening in the wall, which was a window in earlier churches, became ‘a transparent wall of gorgeous hues.’”³² This evolution of Gothic architecture was certainly not accomplished, or possible, as a solo endeavor but required the contributions from many generations of interdisciplinary workers. In the book *The Evolution of Design*, Philip Steadman writes about Gothic architecture and notes that, “These buildings occupied the attention of not just a series of individual architects, but a whole mass of people, clergy, as well as masons and mechanics, who worked together in a common effort.”³³

³¹ Fergusson, James. *An Historical Inquiry into the True Principles of Beauty in Art, more especially with reference to Architecture*. (London: Longman, Brown, Green, and Longmans, 1849); 156.

³² *Ibid.*, 156.

³³ Steadman, Philip. *The evolution of designs: Biological analogy in architecture and the applied arts*. (Cambridge: Cambridge University Press, 1979); 83.

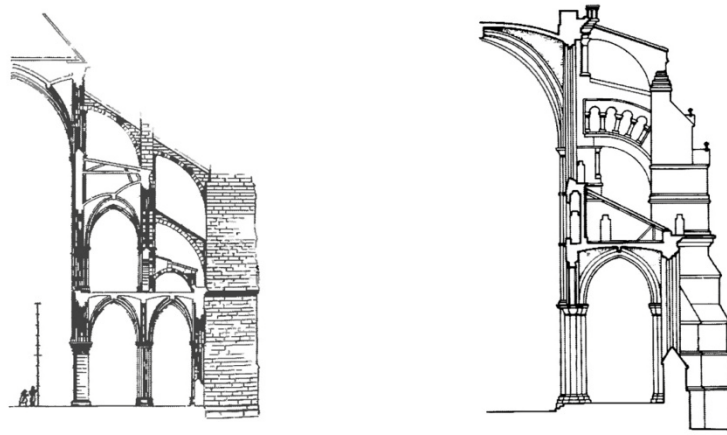


Figure 11: An incremental evolutionary progression between Gothic cathedrals in section view.³⁴

From the beginning of primitive cave-like dwellings, humans have continued to manipulate buildings to satisfy their needs and solve problems. In a building, when a user needs more daylight or ventilation, additional windows are installed; when there is a need for better temperature control, heating/cooling systems are integrated; when the neighbors are too loud, acoustic paneling is applied; and when running to the outhouse is too inconvenient, indoor plumbing becomes commonplace. As mentioned previously in the section *Design Evolution is Enhanced through Interdisciplinary Collaboration*, over time humans have used their problem solving skills to evolve innumerable objects. Sharp edged rocks have turned into Swiss Army Knives and primitive huts are now skyscrapers. Many architectural assemblies are no longer simple enclosures, but complex structures composed from multiple unique systems. Each of these systems often requires specialized knowledge to design, install, and operate. Similar to the production of many current products, the making of contemporary buildings frequently involves entire teams of professionals who possess expert knowledge related to a specific aspect of the architectural process.

³⁴ Cross section of nave, Chartres Cathedral (After R. Mark); and Cross section of nave, Notre-Dame. Paris (After Villet-le-Duc); from Trachtenberg, Marvin and Isabelle Hyman. *Architecture, from Prehistory to Postmodernity*. (New Jersey and New York: Prentice-Hall Inc. and Harry N. Abrams Inc., 2002); 234. Modified by author.

As civilizations have continued to progress and buildings have grown more sophisticated, collaboration between individuals has become integral within the field of architecture. The contemporary practice of architecture often involves an extensive range of specialized professionals such as plumbers, electricians, engineers, construction workers, building inspectors, and planners. These professionals are each responsible for a particular system or process that contributes towards a larger architectural assembly and work simultaneously with each other throughout the architectural process. In order to produce a functional and successful work of architecture, these specialized professionals must coordinate with each other and work towards an established goal. Ultimately, the goals to be achieved throughout the architectural process are formulated by an architect. It is the responsibility of a professional architect to ensure that all other professions involved in the making of buildings work in close collaboration with each other to achieve the established goals. Architects are designers who are responsible for the planning of buildings and oversee their construction.³⁵ Within the team of professionals involved in the architectural process, architects function as generalists who maintain broad knowledge about the many processes and parts required for the fabrication of a building.

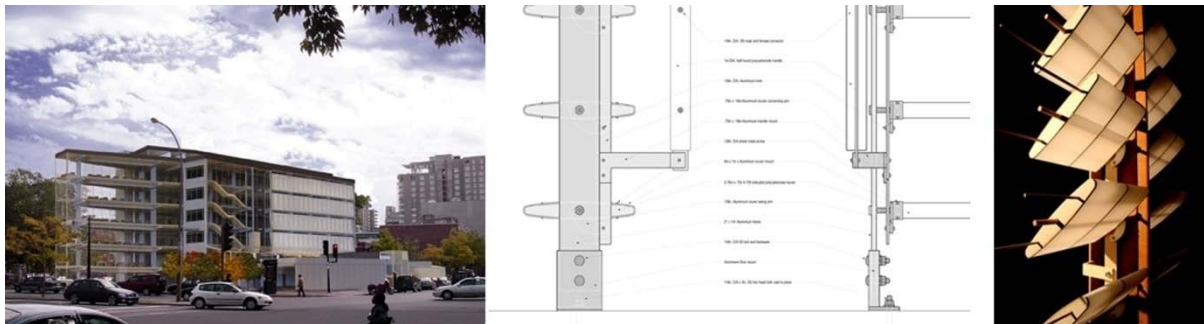


Figure 12: Three images from a collaborative architectural project presenting one particular component (a window louver system) of the overall architectural assembly.³⁶

Often the scale and intricacy of contemporary buildings causes the evolution of architecture to progress slowly in comparison to smaller scaled objects and products. Complex contemporary buildings and architectural systems require many individuals to work in unison

³⁵ Langenscheidt's Pocket Merriam-Webster English Dictionary. (Langenscheidt Publishers Incorporated, 1997); 54.

³⁶ Images by author; 2006.

with each other towards the completion of an architectural project (Fig. 12). Since buildings are composed from a number of smaller integrated systems, it is difficult for an entire architectural assembly to advance as a whole. To foster positive evolution in the field of architecture, the smaller systems within a larger architectural body need to advance incrementally. Serving as a mediator, a successful architect can ensure that interdisciplinary professionals collaborate with each other to generate progressive and innovative architectural solutions within their specific professions.

Without partnership between building related professions, the production of architecture often takes too long, becomes unaffordable, and can result in an unsafe, nonfunctional product. Lack of professional cooperation often causes dissatisfaction between all parties involved and may lead to extenuating negative situations such as litigation and negatively evolved architecture. Maintaining positive collaboration between all professions involved in the architectural process encourages mutual partnership and joint problem-solving towards the final architectural goal. By working as teammates, specialized professionals can generate advanced and innovative solutions that may deviate from their traditional modes of practice. This can result in the advancement of architectural products and systems that are more useful, solve problems, and propel positive architectural evolution.

However, when the systems installed in contemporary architectural projects are critically examined, it becomes apparent that many of these building systems have maintained relatively slow design evolution compared to similar systems used in other design fields. For example, in the automobile industry, interdisciplinary teams work together to continuously evolve automotive technologies and develop new automobile designs annually. Specialized professionals regularly collaborate during the manufacture of automobiles to incrementally advance the many systems that make up final automotive assemblies. This has resulted in a constantly progressive transportation design industry. Since the invention of the automobile, a little more than a century ago, automobiles have evolved from boxy, inefficient carriages into sleek and comfortable speed machines (Fig. 13).

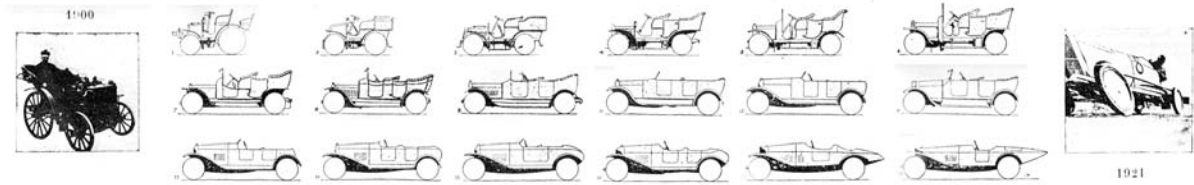


Figure 13: An evolution of motor cars from 1900 to 1921. A drastically apparent design evolution has occurred over the relatively short time span of 20 years.³⁷

When analyzing architecture since 1900, it is evident that many of the systems found in architectural projects have evolved slowly and some systems and components have even remained essentially unchanged for over a century. For example, the electrical systems that are installed in contemporary architectural projects often retain the same fundamental designs that were used during the early 20th century (Fig. 14). The two-prong electrical plug and outlet was patented in 1904³⁸ and the three-prong plug system was patented in 1928.³⁹ These electrical systems are still common, if not standard, in contemporary architectural constructions worldwide.

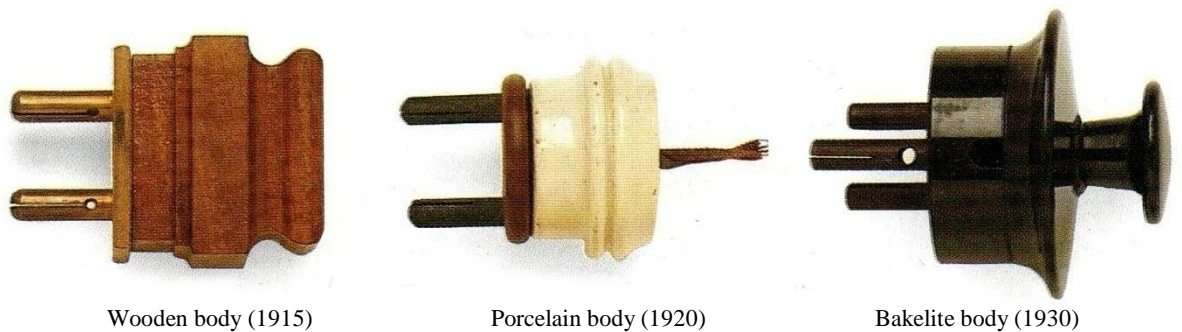


Figure 14: Electrical plugs from the early 20th century. Note the similarities between these plugs and plugs of the 21st century.⁴⁰

Many complicated building systems used in architectural projects have evolved slowly because their original designs are still able to satisfy the needs of current users. However, when these building systems reveal new problems or no longer satisfy contemporary needs, it

³⁷ A progression of automobiles; from Steadman, Philip. *The evolution of designs: Biological analogy in architecture and the applied arts*. (Cambridge: Cambridge University Press, 1979); 142, 143.

³⁸ Hubbell Incorporated. "Hubbell History." Hubbell Incorporated. <http://www.hubbell.com/Investor/History.aspx> (accessed March 17, 2009).

³⁹ Free Patents Online. "Grounding Receptacle and Plug." Free Patents Online. <http://www.freepatentsonline.com/1672067.html> (accessed March 17, 2009).

⁴⁰ Electrical plugs; from Parker, Steve. *Electricity: Eyewitness Science*. (New York: Dorling Kindersley, Inc., 1992); 21.

is often difficult for an average user to personally modify or improve the system due to its complexity. Instead, users are often forced to live with dated technology and required to adapt to the shortcomings of these systems. This leads to the stagnation of positive evolution in the field of architecture.

A design evolution case study

As previously stated, since buildings are composed from a number of smaller integrated systems, it is often difficult to advance an entire architectural assembly as a whole. To foster positive evolution in the field of architecture, the smaller systems within a larger architectural body need to advance incrementally. As a case study, I present two basic components used in electrical systems throughout North America: the duplex outlet receptacle and the single-pole switch (Fig 15). Both of these electrical components are found in nearly every new architectural construction in North America, no matter the scale or budget, and these same electrical component designs can be discovered in a broad range of building projects throughout the last century.

In contemporary buildings, the duplex outlet receptacle and single-pole switch often work in close relation with each other. These two devices are the most tactile electrical components in a buildings electrical system and may be interacted with many times daily. Both of these components are fabricated from similar materials and employ related modes of production. These electrical devices are commonly accepted in contemporary architectural design, often selected and installed without scrutiny. This has resulted in the steady use of these components for the past century.

To encourage and cultivate positive architectural evolution, I critically examine and experiment with duplex outlet receptacles and the single-pole electrical switches. The goal is to work collaboratively with specialized professionals to accelerate the design evolution of these components and reveal designed objects that contribute towards positive architectural evolution. I believe that by starting small and working together, humans can achieve common goals that will benefit human progress. The duplex outlet receptacle and single-pole

switch are two integral architectural components that have maintained slow design evolution. By challenging the designs of these commonly accepted electrical devices, I strive to reveal more appropriately designed architectural solutions that progressively address present and future needs.

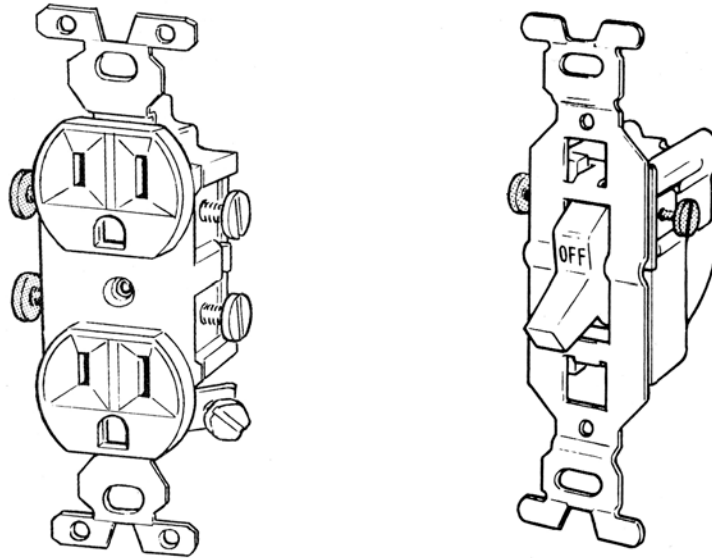


Figure 15: A three-pronged duplex outlet receptacle and a single-pole switch.⁴¹

⁴¹ Duplex outlet receptacle and single-pole switch; from Mix, Floyd M. *House Wiring Simplified*. (Illinois, The Goodhearted-Willcox Co., Inc., 1981); 29, 35.

CHAPTER 2

A HISTORY OF ELECTRICITY

Chapter 2 traces a history of electricity in order to reveal the inventions of the duplex electrical outlet and the single-pole electrical switch. With an architectural focus, various electrical inventions and advancements are highlighted chronologically. Through a graphic comparison of electrical advancements from 1750 A.D. to present day (Fig. 16), it becomes apparent that a relative stagnation of design evolution has occurred in the architectural/electrical profession over the past century. This chapter helps reveal the significance of the duplex outlet receptacle and the single-pole switch related to architectural progress, and highlights the slow design evolution that these components have maintained.

“The history of the electrical and electronic technologies is a fascinating study which starts in the remote past and leads us step by step to the present development of devices too complicated for the average brain to conceive of or comprehend.”⁴²

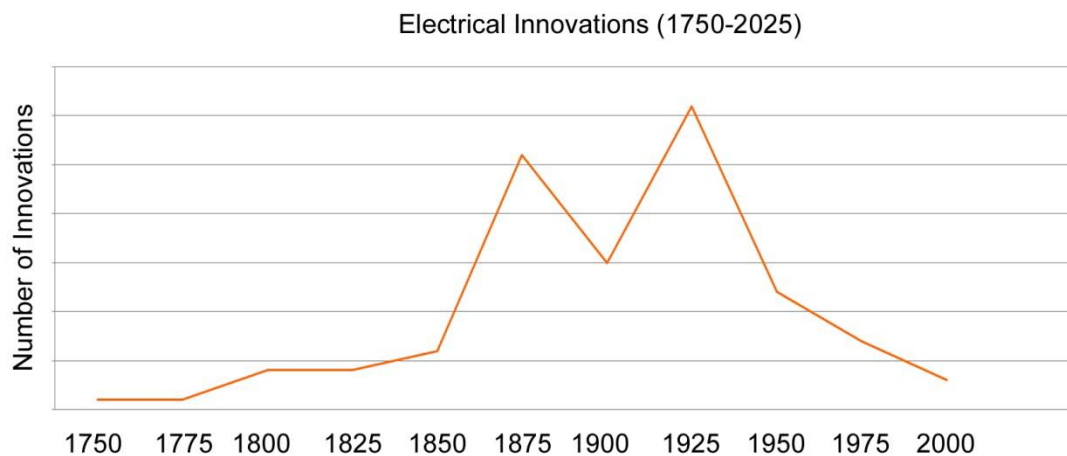


Figure 16: A graph charting the number of architectural/ electrical innovations from 1750 (invention of the voltaic pile) through 2000 (present day). Notice the spikes of innovation during years that occurred during the American industrial revolution and WW2.⁴³

⁴² Davis, Henry B.D. *Electrical and Electronic Technologies: A Chronology of Events and Inventors to 1900*. (New Jersey: The Scarecrow Press, 1981); Preface, vii.

⁴³ Graph by author, 2009.

An electrical chronology

- 600 B.C. - Thales, Greek physical philosopher of Miletus discovers that if amber is rubbed with a cloth, it has the power to attract light bodies such as feathers, leaves, straw, and small bits of wood. This is the origin of static electricity.
- 1000 A.D. - Europeans use the compass, possibly introduced from China, in navigation.
- 1570- Dr. William Gilbert of England, court physician to Queen Elizabeth, discovers that many substances other than the already known amber and jet possess electrical properties. He makes the distinction between electric and magnetic bodies in that while all magnetic bodies come together by their joint forces, electric bodies attract the electric only.
- 1650- Otto Von Guericke, German physicist, makes the first electrical machine. His crude apparatus was the means by which the first electric light was produced, or first recognized. Von Guericke's name is most closely associated with the discovery of producing light from electricity.
- 1752- Benjamin Franklin is credited with inventing the first lightning rod.
- 1779- Alessandro Volta announces his construction of the voltaic pile, the first electric battery, which transforms chemical energy into electrical energy.
- 1820- Professor Andre-Marie Ampere, French physicist, develops a terminology for electricity, explains the nature of the electric current and its relation to magnetism, and develops his famous solenoid.
- 1820- De La Rue, in France makes a lamp with a coil of platinum wire for a burner, enclosed in a glass tube with brass caps at the ends. This was the earliest record of any attempt to make an incandescent lamp.
- 1821- Michael Faraday, English chemist and physicist, working with Sir Humphry Davy in London, discovers magnetoelectricity and produces rotation of a wire carrying a current around a pole (a crude electric motor). This proved that electrical energy could be converted to mechanical motion.
- 1831- Joseph Henry and Michael Faraday are both credited with developing the first experimental dynamo electric machines (electric motors). These machines could produce electricity by changing magnetic fields within a conductor.
- 1837- Samuel Morse completed his first operable telegraph system.
- 1837- Thomas Davenport, inventor, of Brandon, Vermont, develops several types of electric motors for industrial work and is generally credited with being the first to produce commercially successful electric motors.
- 1840- Samuel Morse is granted Patent No. 1647 for "Telegraph Signs." This telegraph makes possible instantaneous communication between distant corners of the land.
- 1841- F. De Moleyns was the first to obtain a patent (British) for an incandescent lamp.
- 1851- Boston, Massachusetts is the first city to adopt an electric fire alarm system.

- 1859- Professor Moses G. Farmer of the Naval Training Station, Newport, Rhode Island, is probably the first person to use electric light to illuminate a house. He arranges a series of lamps in his parlor with current supplied by a wet cell battery. He also invents an incandescent lamp, which consists of a strip of sheet platinum operating in air.
- 1859- George B. Simpson of Washington, D. C., is granted a patent for the first electric hotplate. This date may be considered as the beginning of electrical heating principle using resistance wires.
- 1860- Hoppen, an Englishman, originates vulcanized rubber insulation for wires and cables.
- 1861- Antonio Oacinotti, of Pisa, Italy, is considered by some people to have made one of the most important inventions of the century – the discovery that the same machine could be used as a motor or a generator.
- 1870- Zenobe Theophile Gramme, Belgian electrician, introduces his first lighting generator and initiates the use of electric motors for industrial motors. The efficiency of the Gramme dynamo now made arc lights practical.
- 1875- Alexander Graham Bell, Scottish educator, verifies the principle of the electric speaking telephone. This date is commonly accepted as that of the invention of the telephone and has been said that this is the most valuable patent ever issued.
- 1877- Up to this date wire for transmitting electricity was generally made of iron. It is during this year that hard drawn copper wire is invented and cable development also begins at this time.
- 1878- The first electric arc lights in a store are installed in the John Wanamaker store in Philadelphia and many other installations soon followed. This had become possible because the development of the dynamo had progressed to the point where electric lights had become economically feasible for some applications.
- 1879- Sir Joseph William Swan, English electrician, develops an all glass, hermetically sealed electric light bulb. Later this design became universally accepted.
- 1879- The first company in the United States, if not in the world, to enter the business of producing and selling electric service to the public is organized in San Francisco, California.
- 1880- Edison begins the first large-scale manufacture of generators and electric lamps and produces and patents the first successful commercial incandescent lamp.
- 1881- Marcel Deprez exhibits at the Paris Exhibition five motor-driven sewing machines, four woodcutting lathes, a drilling machine, two watchmaker's lathes, a chain maker, and a printing press.
- 1882- Thomas Edison opens the first electric lighting plant in the United States – the Pearl Street Station of the Edison Electric Illuminating Company, New York. Edison invents a chemical meter to measure the electricity used by customers.
- 1884- Edwards and Co. is assigned a patent covering door openers operated by electricity.
- 1886- The Westinghouse Electric Company builds the first commercially successful alternating-current generating station in Buffalo, New York. This is the first city to receive alternating current and electric light and power on a large scale.
- 1886- The first kitchen appliance (the electric hotplate) is marketed.

- 1887- Nikola Tesla works out the theory of the modern alternating-current induction motor and applies for patents.
- 1887- Philip Diehl invents and places in public operation the first electric ceiling fan.
- 1888- This year the screw base lamps became the standard for Edison Lamps. The original lamps had a wood base with two binding posts for connections.
- 1889- Otis Bros. & Co. installs the first two successful electrically operated passenger elevators in the Demarest Bldg., New York.
- 1889- Berlin, Safety Fair: the first household appliances (iron, hair-curler, egg-boiler, electric hotplate, tea maker, cigar lighter).
- 1891- The electric cooker is commercially available in England.
- 1893- The first code covering the installation of electrical equipment is printed under the title "Rules & Requirements for the Installation of Electric Light & Power," as revised and codified by the Underwriters International Electric Association. This is the beginning of the National Electric Code.
- 1893- The World's Columbian Exposition is held in Chicago and gives the electrical industry an opportunity to show the progress it has made in electrical generation and lighting up to this time. The entire exposition is lit by 92,622 lamps. On display is a model electric kitchen featuring an array of electrical appliances, including an electrically heated saucepan, chafing dish, coffeepot, and grill.
- 1894- The first motion pictures are shown in a former shoe store on Broadway, New York.
- 1896- Edison files a patent for the first florescent lamp.
- 1896- Harvey Hubbell receives a patent for the pull-chain electric light switch.
- 1897- Guglielmo Marconi, Italian electrician, receives a patent for wireless telegraphy. Marconi transmits signal in Morse code through space without wires.
- 1899- In June the A.I.E.E. makes its first report on standardization. Recommended for trial by both manufactures and users of electrical equipment, it is the groundwork for all future electrical standardization.
- 1904- Hotpoint is the first to produce an electric iron on a commercial scale.
- 1904- Harvey Hubbell receives a patent for the two prong electrical plug and receptacle.
- 1905- Christmas tree lights are available for the first time.
- 1907- The tower of the Singer Building in New York is floodlighted, the first instance of lighting the exterior of a large building in this manner.
- 1907- Hoover successfully markets the first vertical electric vacuum cleaner.
- 1907- A motor-driven phonograph is developed.
- 1909- Leo Hendrick Baekeland of Belgium, receives a patent for "Bakelite." Its first application was in the electrical manufacturing industry. This is the beginning of the modern plastics industry.

- 1910- George A. Hughes, a former electric utility operator, begins the manufacture of the first practical electric range.
- 1910- The first electrically driven washing machine is introduced.
- 1910- Compressor refrigerators are commercially available.
- 1919- The automatic toaster is invented by Charles Strite.
- 1923- Phonograph Adapters. By moving the reproducer of a phonograph and substituting a "phonograph adapter," the phonograph horn could be used as a loudspeaker for radio. The adapter was a speaker unit without the horn.
- 1923- The first neon tube advertising sign is installed on the marquee at the Cosmopolitan Theater, New York.
- 1924- Vladimir K. Zworkin develops a complete television system while working for the Westinghouse Electric and Manufacturing Company.
- 1924- Electric blenders are now available.
- 1925- Electric mixers are now available.
- 1925- The first automatic electric coffee percolator is developed.
- 1926- Facsimile- a picturegram of a check was sent by RCA radio-photo from London and cashed in New York.
- 1926- The National Electric Manufacturing Association (NEMA) is organized.
- 1926- The first automatic (pop-up) toasters for use in the home are produced.
- 1927- Radio receiving sets and tubes designed for complete alternating-current operation are introduced by R.C.A., for home use.
- 1927- Electric saws are now available.
- 1928- Electric welding came into use about this time as a substitute for riveting on building frames and bridges.
- 1928- Underfloor raceways and electrical metallic tubing as a wiring method is recognized in the National Electric Code.
- 1928- Philip F. Labre receives the patent for the grounded three-pronged plug and receptacle.
- 1929- The first sunlamps for generating ultraviolet rays for sun tanning were introduced by General Electric this year.
- 1929- Bell Telephone Laboratories develops the coaxial cable for the transmission of broadband radio waves for multiplex telephony and national television networks.
- 1929- The first automatic waffle iron is developed.
- 1930- The first commercial electric shaver is placed on the market by Shick Incorporated.

- 1930- "Vinyl resin" plastics are introduced and used extensively in the electricity industry for insulating purposes.
- 1930- Heat lamps are commercially available.
- 1931- "Neoprene," the first widely used rubber-like synthetic which, because of its non-flammability and resistance to oils and chemicals, soon finds many uses in the electrical manufacturing industry, especially on wires and cables.
- 1932- The first edition of the National Electric Code Handbook was published this year, authored by Arthur L. Abbott. The National Electrical Safety Code was necessary because of the many disastrous fires resulting from improper wiring when electric lighting first came into general use.
- 1935- This year marks the beginning of all electronic television in the United States.
- 1935- The first successful electric typewriter was brought out by IBM.
- 1935- Electric fans are now commercially available.
- 1936- The AEG Co. in Germany developed a magnetic tape suitable for recording and developed a recorder for using it. This year, at the annual Radio Fair, it was introduced as the "Magnetophone," the first commercially available tape recorder.
- 1936- It was about this time that the automatic door opener by photocell control came in general use.
- 1937- The first automatic electrically operated washing machine is produced.
- 1938- In the United States, RCA announced that television for the home was now feasible.
- 1938- The garbage disposer is invented.
- 1938- Fluorescent lamps are introduced, more than doubling the efficiencies obtained from corresponding wattages of filament lamps. Fluorescent lamps in some colors give more than one hundred times as much light per watt consumed as do colored filament type lamps.
- 1943- "Polyethylene," a plastic material well adapted for insulation of high frequency wires and cables, is introduced.
- 1947- Microwave ovens are available on sale in the USA.
- 1947- The new plastic, Teflon, was being applied to capacitors and other components requiring high insulating properties at high frequencies and temperatures. It could withstand all known solvents and temperatures to 575 degrees C. and had essentially zero water absorption.
- 1947- It was around the end of this year that table radios came out containing alarm clocks.
- 1951- Hand-held hair dryers are commercially available.
- 1953- Air conditioning units having the capability of reverse-cycle heating became commercially available about this time. These so-called heat pumps became especially popular for new construction projects.
- 1955- Food freezers for domestic use are available.
- 1956- Electric can opener is commercially available.

- 1965- Microwave ovens designed for domestic use are commercially available.
- 1965- Ground-fault circuit-interrupters (GFCI) are developed by Professor Charles Dalziel at the University of California at Berkeley.
- 1966- Early in the year, video recorders were perfected for home use for recording and playback of TV programs.
- 1968- The first commercially available light-emitting diodes (LEDs) were revealed.
- 1969- RCA introduced a remotely controlled TV color set, tuned by small ultrasonic transmitters.
- 1972- Drip-type coffeemaker is commercially available.
- 1973- The electric garage door opener is invented.
- 1974- The electronic toy industry had grown to the point that by the end of the year more than 20 companies had electronic video games on the market.
- 1975- The Singer pre-programmed sewing machine was introduced. It was programmed to perform up to 25 different stitches as well as button holes as set by a selector dial.
- 1978- A system of video recording called Laser Vision was developed in the Netherlands. Recording was on a plastic disc. By means of a turntable it was played back over a conventional television set.
- 1978- Personal computers are commercially available.
- 1982- CD players are commercially available.
- 1984- Phone answering machine is invented.
- 1997- DVD players are available and start replacing VHS technologies.
- 1999- Plasma TV's are available and begin replacing televisions that use space consuming vacuum tube technology.
- 2002- Wireless internet routers are commercially available.
- 2005- Smart Switches are on the market.
- 2007- Batteryless, wireless switches are commercially available.⁴⁴

⁴⁴ Electrical chronology compiled from the following sources; National Electrical Manufacturers Association. *A Chronological History of Electrical Development*. (New York: National Electrical Manufactures Association, 1946).; Davis, Henry B.D. *Electrical and Electronic Technologies: A Chronology of Events and Inventors to 1900*. (New Jersey: The Scarecrow Press, Inc., 1981).; Davis, Henry B.D. *Electrical and Electronic Technologies: A Chronology of Events and Inventors from 1900 to 1940*. (New Jersey: The Scarecrow Press, Inc., 1983).; Davis, Henry B.D. *Electrical and Electronic Technologies: A Chronology of Events and Inventors from 1940 to 1980*. (New Jersey: The Scarecrow Press, Inc., 1981).;

Zap... a brief history of electricity

Energy is defined as the capacity to perform work, and work is performed whenever an object is moved against an opposing force.⁴⁵ Since the beginning of the universe there was energy and it is what makes the world go round. Humans use energy to breathe, think, walk, eat, drive, heat homes, and power appliances. Energy is all around us and the principle known as *conservation of energy* states that energy cannot be created or destroyed, only converted from one form to another. Electricity is a form of energy that occurs in nature and can be produced by friction, chemical reaction, or mechanical effort. Humans have been aware of electrical energy for thousands of years and observed early electrical phenomenon in lightning, static shock, shock from electric fish, magnetic metals, and other various materials such as amber. The word ‘electricity’ comes from *electron*, the Greek term for amber due to the material’s electrical properties.⁴⁶ In Ancient Greece, early scientific experiments were performed with amber by rubbing it with fur, which created static charge and allowed it to attract lightweight objects such as feathers and leaves.

It was not until the 17th and 18th centuries that substantially significant electrical advancements became prevalent. During this timeframe, scientists produced many contraptions to create and capture an array of sparks and low voltage energy. One of the first electricity capturing devices, known as a Leyden jar, was developed in 1745. The Leyden jar was capable of building up and storing charges of static electricity. When the Leyden jar’s exposed conductor came into contact with a grounding source, it produced a spark. For the first time in history this apparatus allowed experimenters to harness electricity and conduct further research on electrical phenomenon. These “machine[s] not only offered a means of generating electricity at such potentials that long sparks could be seen, heard, and experimented with, but also provided a stimulus for inducing other men to take up the study”⁴⁷ of electricity.

⁴⁵ Campbell, Neil A., Jane B. Reece, and Eric J. Simon. *Essential Biology*. (San Francisco: Pearson Benjamin Cummings, 2007); 73.

⁴⁶ Parker, Steve. *Electricity: Eyewitness Science*. (New York: Dorling Kindersley, Inc., 1992); 6.

⁴⁷ Davis, Henry B.D. *Electrical and Electronic Technologies: A Chronology of Events and Inventors to 1900*. (New Jersey: The Scarecrow Press, 1981); 20.



Figure 17: Early electricity producing devices: Lid and chain from a late 19th century Leyden jar, Wilmshurst machine (1882) for making electric charge, Voltaic pile (1800).⁴⁸

Perhaps the next most significant development in the history of electrical science occurred over half a century later (1800) when Alessandro Volta created the first true battery, known as the voltaic pile (Fig. 17). This device was constructed of stacked zinc and silver disks that were separated by damp cardboard disks, which had been soaked in salt water. This unique combination resulted in a chemical reaction between the two dissimilar metals, causing the silver to lose electrons and the zinc to gain them; this is the basic principle of an electric current. When wires were connected to the top and bottom of the voltaic pile, a steady current flowed through the conducting wires and provided electricity. “To this invention, whose greatest significance lies in the accompanying discovery of current electricity, we owe the development of modern electrical science and industry.”⁴⁹

The development of the chemical battery provided many new opportunities for experimentation in electrical science and fostered numerous electrical advancements throughout the 19th century. During that century, the communication industry prospered and telegraphs and telephone lines spread throughout many countries. Even wireless communication became a reality and allowed for the transmission of messages and images without the use and restriction of a connecting wire. The availability of rapid, long-distance communication resulted in an accelerated exchange of ideas that began to swiftly propel human progress.

⁴⁸ Electrical devices; from Parker, Steve. *Electricity: Eyewitness Science*. (New York: Dorling Kindersley, Inc., 1992); 2.

⁴⁹ National Electrical Manufacturers Association. *A Chronological History of Electrical Development*. (New York: National Electrical Manufactures Association, 1946); 15.



Figure 18: Images depicting different mediums and methods for electrical distribution; Telegraph cable (1837), Porcelain insulator for telegraph wires (20th century), Power Cable (20th century).⁵⁰

By the end of the 19th century, mass power distribution was spreading throughout many countries. In America, power stations were being constructed in nearly every major city and providing electricity throughout the nation. With innovations by Joseph Swan and Thomas Edison, the field of electric illumination significantly progressed, and the spark provided by batteries developed into the practical application of arc lights and incandescent lamps. During this era, electric lighting was making its way into every new architectural construction and many older buildings were retrofitted with electrical systems. The architectural wiring was not initially standardized and was integrated throughout buildings in many different ways. Throughout the late 19th century and early 20th century, it was not uncommon for electrical power to be distributed through bare wires within buildings. Eventually safer and more efficient electrical power distribution systems were developed, such as cloth covered wire, pitch covered wire, wire encased in wooden or metal moldings, ceramic supported and encased wires, and eventually a large array of plastic and rubber covered wires that are frequently used today (Fig 18).

⁵⁰ Electrical devices; from Parker, Steve. *Electricity: Eyewitness Science*. (New York: Dorling Kindersley, Inc., 1992); 2, 23.



Figure 19: Advertisement for AEG household appliances (1905), image from the Ideal Home Exhibition in London (1934), advertisement for the McGraw Electric Co. (1946).⁵¹

With the discovery of electric rotation, also during the 19th century, electric motors were developed and implemented in machines that performed many arduous and tedious tasks. Within the home, the electric motor was integrated into countless appliances that added convenience and efficiency to the domestic lifestyle (Fig. 19). The electrical systems that were initially installed within homes to power electric lighting also provided opportunity to power appliances, such as electric fry pans, toasters, and mixers. However, the earliest electrical appliances did not simply plug into wall sockets, but instead screwed into light bulb sockets; initially the only specifically designed access points for electricity. The constant development of new electric appliances resulted in a need for a standardized system to access domestic electricity. In North America, the basic standardized plug/ outlet system used today was developed in 1904 by Harvey Hubbell and has remained essentially unchanged for nearly a century. This system provided a “male” two-prong plug, and a “female” two-prong outlet receptacle. Also developed by Hubbell was one of the first practical domestic electric switches. This early light switch is explained on the Hubbell Incorporated website:

Fixtures for electric light were slowly replacing gas lamps, and were usually installed where the gas fixture had been in the center of the ceiling or mounted high on a wall. In many cases, the electric lights burned continuously since, with no existing wiring in the building, the installation of a separate circuit

⁵¹ Historic electricity related advertisements; from Poletti, Raffaella. *La Cucina Electrica: Small kitchen appliances from their invention to the seventies*. (Milan: Electra, 1994); 18, 38, 62; images modified by author.

and switch to control each fixture was costly. Hubbell's idea was to provide convenience, safety, and control to an electric light with his new "pull socket" which was patented in August of 1896. The same familiar device with its on/off pull chain is still in use today.⁵²



Figure 20: An early ceramic electrical switch. “This early electric switch has the metal components in a ceramic body. Two metal arms are sprung so they flick quickly from one position to another. When the switch is turned on, the arms slot into U-shaped springy contacts, so completing the electric circuit. This must happen fast, and the contacts must be good, or the electricity could spark across any gaps and cause damage.”⁵³

The concept behind Hubbell’s original switch was a device that could connect and disconnect a current flow rapidly without producing a spark (Fig. 20). This design was developed to improve upon various shortcomings of earlier electrical switch designs. Since the invention of Hubbell’s switch, numerous other electrical switching mechanisms have been devised based on its design. Almost all contemporary electrical switches are adaptations of this initial switching concept. Many electrical switch designs have remained essentially unchanged since the early 20th century and have maintained a slow, 100 year design evolution.

Once basic outlet/ plug and switching systems were adopted by the National Electric Code during the early 20th century, they became standard throughout all architectural constructions in North America and many other countries. Throughout the rest of that century, significant electrical innovations primarily took place within radio, television, and computer fields, with little progress being made towards advancing architectural electrical systems. Instead, in the

⁵² Hubbell Incorporated. “Hubbell History.” Hubbell Incorporated. <http://www.hubbell.com/Investor/History.aspx> (accessed March 17, 2009).

⁵³ Switch image and accompanying text; from Parker, Steve. *Electricity: Eyewitness Science*. (New York: Dorling Kindersley, Inc., 1992); 47.

architectural field, creative efforts were put towards the development of household machines and appliances that could easily interface within the national electrical system standard.

Throughout the remainder of the 20th century, Alexander Graham Bell's telephone has evolved into a global cellular telephone network, Marconi's simple radio has transformed into plasma televisions and entertainment centers, and the slide rule has been replaced by laptop computers.

Yet, the technology that we probably take most for granted, the reliable and safe use of electricity in our home, has for the most part remained relatively unchanged in that same time. Except for that one word, "plastic," much of the history and technology of residential wiring practices has not changed all that much since the days of Edison. Armored and nonmetallic cables, fuses and circuit breakers, wall switches and receptacle outlets have all withstood the test of time. Many people would think nothing of spending the night in an old house wired 90 years ago, but how many of those same people would fly in an airplane built during that same vintage?⁵⁴

Smart Switches: contemporary architectural electrical innovations

In his 1991 book, *The Walls Around Us*, author David Owen comments, "The last big technological news was grounded outlets, which were introduced in the 1950s and 1960s. People use vastly more power now than they did in the 1920s, and they use it for more purposes, but the power they use is delivered around the house in pretty much the same old way. This may now be on the verge of changing."⁵⁵ For the most part, David Owen's excerpt is accurate and now in the year 2009, a few recent innovations are occurring in the architectural/ electrical field, known as "smart switching" devices (Fig. 21). These electrical technologies have been in development since the early 1990s and have recently become publicly available.

⁵⁴ Dini, David A., P.E., *Some History of Residential Wiring Practices in the U.S.* (Underwriters Laboratories Inc., 2006)

⁵⁵ Owen, David. *The Walls Around Us*. (New York: Vintage Books, 1991); 172.



Figure 21: Three contemporary (2009) electrical switching devices: A multibutton networked dimmer⁵⁶; a Hubbell LX series networked lighting control⁵⁷; and a Liviton, *viza+* lighting control.⁵⁸

Many smart switching devices are assembled as a networked electrical system. A conventional residential electrical system requires a switch to be directly connected within the same circuit as the desired device to be powered on/off, such as a lighting fixture or an outlet receptacle. A conventional residential electrical system incorporates multiple separate electrical circuits, typically one for each room in a house. Smart switches eliminate the need for integrating switches, light fixtures, and outlet receptacles into the same circuit. Instead, each switching device can communicate with each other via either radio frequency or through your homes power lines. Also, these switching devices are each programmable and can be assigned particular functions. This means that in a home wired with smart switching devices, each component in the electrical system (switches, outlets, and fixtures) can be uniquely controlled and adjusted without having to physically reconfigure a home's electrical circuitry network.

Like most new technology, a negative aspect of smart switching devices is their cost. Currently most of these switching devices cost \$40- \$50 for each switch. This is considerably more expensive than the cost of a standard single-pole switch, which can commonly be purchased for less than one dollar. Another negative aspect is that many smart switching devices constantly draw electrical power because they are small electrical devices

⁵⁶Smart switch image; from Derene, Glenn. "Smarter Switching." *Popular Mechanics* 186. (2009); 97.

⁵⁷Smart switch image; from Hubbell Building Automation Inc. product brochure (2009).

⁵⁸Smart switch image; from Leviton product brochure (2009).

themselves. “Each one is a tiny computer that draws about 7 watts.”⁵⁹ If a home is wired with many of these switches, over time quite a bit of energy will be consumed just to power the constant signal-searching minicomputers. A single-pole switch and standard outlet receptacle consume no energy. Compared to a single-pole switch, a “smart” switching device can expend considerable amounts of energy over a given period of time.

However, there are a few companies that are beginning to eliminate the energy consuming computers within smart switching devices, such as the company Echoflex Solutions. In 2007 they released a batteryless, wireless switch that is “powered by energy harvesting technology where the act of clicking the switch creates the energy necessary to control devices.”⁶⁰ Since these switches are wireless, they can be placed virtually anywhere within a home and eliminate large amounts of conventional residential electrical infrastructure that is traditionally required to install electrical switches.

Along with smart switching devices that are available for residential electrical systems, currently there is a standard array of basic switches and outlet receptacles that are available for installation in contemporary buildings. Many of these switches and outlet receptacles are basic electrical technologies that have changed very little since their initial development. The standard switching systems that are available are as follows: single-pole switch, double-pole switch, three-way switch, four-way switch, dimmer switches, and interchangeable device switches. Each of these switches is available with a few different operating designs as follows: snap (toggle), push, slider, rotary, electronic, and with or without pilot lights. These switches also require faceplates to protect the final switch installation, and are available in a breadth of choices. However, the limited evolutionary change that these switches have undergone is apparent when comparing a single-pole toggle switch with a single-pole decorator switch. Many early single-pole switch designs were essentially toggle-like switches. With a slight adaptation of the toggle switch mechanism, the decorator switch

⁵⁹ Derene, Glenn. “Smarter Switching.” *Popular Mechanics* 186. (2009); 97.

⁶⁰ Peterson, Shawn. “*Revolutionary Light Switch does not require wires or batteries.*” Global Press Release Distribution. (January 18, 2007). <<http://www.PRLog.org>>.

provides a minimally different method of operation to the standard switching mechanism (Fig 22).

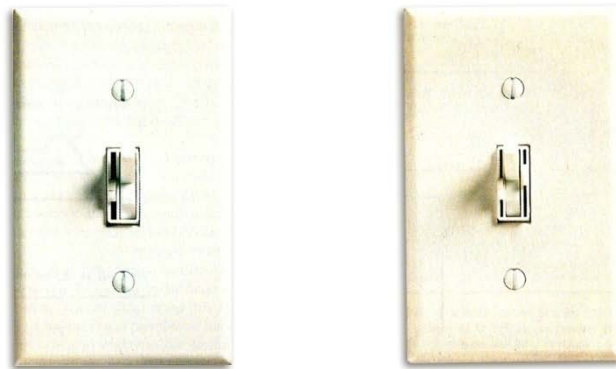


Figure 22: Two types of fan/ light controls. One has a toggle switch for turning a ceiling fan on off and on, plus a “slider” that provides 3-speed control of the fan. The other has a toggle switch for turning a light off and on, plus two “sliders,” one for ON/ OFF and 3-speed control of a ceiling fan, the other for full range dimming of lighting.⁶¹

Similarly, residential outlet receptacles are commonly available in the following designs: single outlet, duplex outlet, triplex outlet, weatherproof outlet receptacle, and ground fault circuit interrupter outlet receptacle. Each of these outlet types is a slight variation of a basic design. For example, a weatherproof receptacle outlet is essentially a standard receptacle outlet that is covered with a special protective faceplate designed to keep weather and precipitation out of the device. Many other outlet receptacle types are commonly installed in residential electrical systems that have specific functions, such as range outlets and clothes drier outlets. However, with residential architecture these particular components are not as frequent as duplex outlet receptacles, which are designed to power a wide array of common small domestic appliances throughout a building.

When observed as a chronology, it is apparent that many designs have evolved throughout the history of electricity. Some designs, such as television technology have experienced dramatic positive design evolution. Televisions have evolved from mechanical, black and white picture tubes, into high-definition flat screen monitors. However, other developments such as Morse code telegraphy have not been as prosperous. This system for electrical

⁶¹Switch images; from Mullin, Ray C. *Electrical Wiring: Residential*. (New York: Delmar Publishers, 1999); 212.

communication is now nearly obsolete and has been replaced by various wireless communication methods. Other technologies have evolved little to none, such as electrical switches and receptacle outlets, but still manage to function as important electrical technologies for contemporary society. However, in order to encourage positive human progress, I believe we should always question and challenge designs that have become standard and commonplace. Throughout this history of electricity it is now apparent that the single-pole switch and three-pronged duplex outlet receptacle are old-fashioned designs that have become commonplace throughout contemporary architecture. For this reason, these designs deserve to be re-examined and redeveloped.

CHAPTER 3

AN ARMATURE FOR EVOLUTION

As a starting point for working towards the incremental advancement of two architectural components, the duplex outlet receptacle and the single-pole switch, Chapter 3 establishes the current modes of residential electrical installation. By understanding the acceptable standards of contemporary residential electrical installation, solutions can be derived to challenge and improve upon current modes of practice and the components used in electrical systems. The second section of this chapter introduces a “blank palate” that has been constructed based on the contemporary standard for electrical wiring in a residential building. This blank palate armature provides a template for future design tests and experiments.

The basics of residential electrical installation

The installation of a basic residential electrical system typically begins with the work of an architect. Through a design process, an architect initially develops plans and specifications used for the construction of a building (Fig. 23). These plans and specifications are then presented to a wide array of skilled craftspeople to interpret and materialize the design. Like most professional architectural work, the design of a building is largely influenced by various code requirements. In the United States, all electrical installations must comply with the National Electric Code (NEC). The first NEC was initially revealed in 1897 and is now published by the National Fire Protection Agency. “The purpose of the Code is to provide information considered necessary for the safeguarding of people and property against electrical hazards. It states that the installation must be essentially hazard-free, but that such an installation is not necessarily efficient, convenient, or adequate.”⁶² The installation of a buildings electrical system must comply with this code and is ultimately the responsibility of an electrician to ensure that the installed system meets the specified criteria.

⁶² Mullin, Ray C. *Electrical Wiring: Residential*. (New York: Delmar Publishers, 1999); 4.

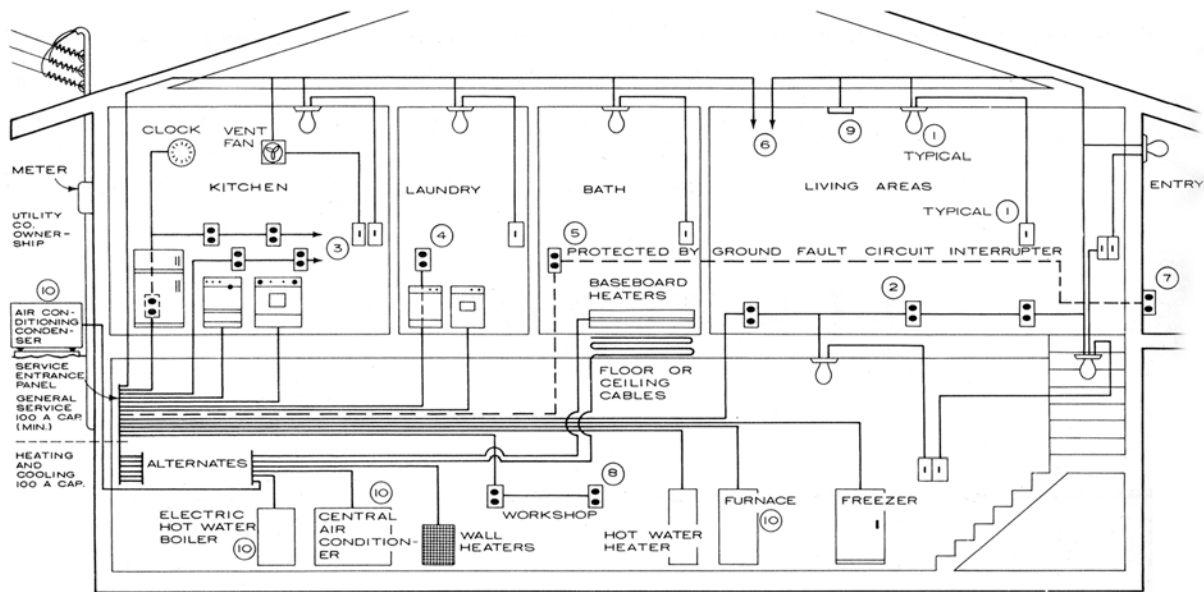


Figure 23: Schematic diagram of a typical residential electrical layout.⁶³

In a residential situation, the installation of switches and outlets must be installed according to these general requirements:

1. A minimum of one wall switch controlled lighting outlet is required in every habitable room, in hallways, stairways, and attached garages, and at outdoor entrances. Exception: in habitable rooms other than kitchens and bathrooms one or more receptacles controlled by a wall switch are permitted in lieu of lighting outlets.
2. In every kitchen, family room, dining room, den, breakfast room, living room, parlor, sun room, bed room, recreation room, and similar rooms, receptacle outlets are required such that no point along the floor line in any space is greater than 12 ft, measured horizontally, from an outlet in that space, including any wall space 2 ft or more wide and the wall space occupied by sliding panels in exterior walls.
3. A minimum of two #12 wire 20 A small appliance circuits are required to serve only small appliance outlets, including refrigeration equipment, in

⁶³ Residential electrical diagram; from Hoke, John Ray, editor, Bruce Bassler, student edition editor. *Architectural Graphic Standards: Student Edition*. (New York: John Wiley & Sons, Inc., 2000); 374.

- kitchen, pantry, dining room, breakfast room, and family room. Both circuits must extend to kitchen; the other rooms may be served by either one or both of them. No other outlets may be connected to these circuits, other than a receptacle installed solely for the supply to and support of an electric clock. In kitchen and dining areas receptacle outlets must be installed at each and every counter space wider than 12 in.
4. A minimum of one #12 wire 20 A circuit must be provided to supply the laundry receptacle(s), and it may have no other outlets.
 5. A minimum of one receptacle outlet must be installed in the bathroom near the basin and must be provided with ground fault circuit interrupter protection.
 6. The code requires sufficient 15 and 20 A circuits to supply 3 W of power for every square foot of floor space, not including garage and open porch areas. Minimum code suggestion is one circuit per 600 sq ft; one circuit per 500 sq ft is desirable.
 7. A minimum of one exterior receptacle outlet is required (two are desirable) and must be provided with ground fault circuit interrupter protection.
 8. A minimum of one receptacle outlet is required in basement and garage, in addition to that in the laundry. In attached garages it must be provided with ground fault circuit interrupter protection.
 9. Many building codes require a smoke detector in the hallway outside bedrooms or above the stairway leading to upper floor bedrooms.
 10. Disconnect switches required.⁶⁴

⁶⁴ Electrical installation guidelines, 1-10; from Hoke, John Ray, editor, Bruce Bassler, student edition editor. *Architectural Graphic Standards: Student Edition*. (New York: John Wiley & Sons, Inc., 2000); 374.

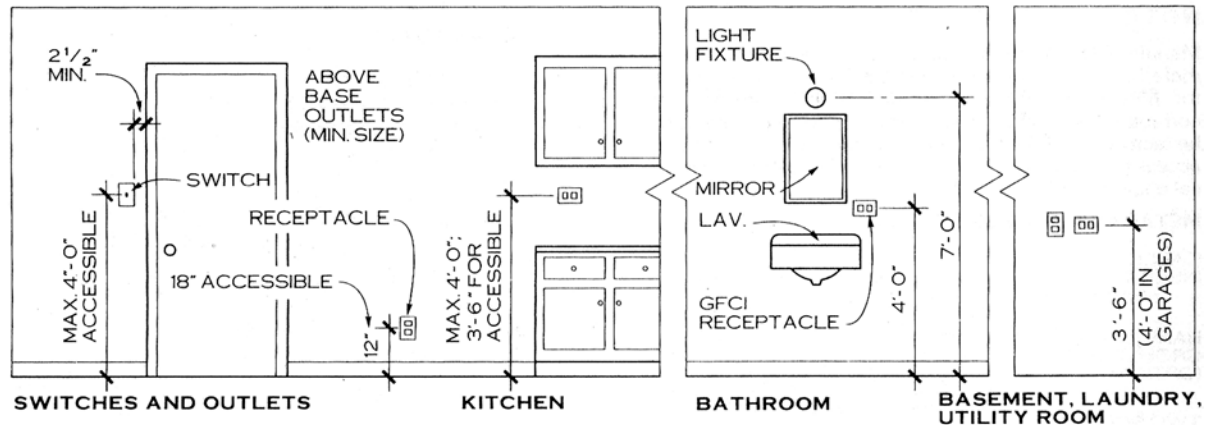


Figure 24: Schematic diagram of common accessible switch and outlet receptacle locations.⁶⁵

Additionally, electrical switches and outlet receptacles should be installed in locations that are accessible for all people. The Americans with Disabilities Act (ADA) provides recommended locations for these electrical components (Fig. 24):

1. Switches should be located at a maximum height of 4 ft from floor level.
2. Standard wall outlet receptacles should be located no closer than 18 in from floor level.
3. Countertop wall outlet receptacles should be located at a maximum height of 3.5 ft from ground level.

A blank palate

There are numerous materials and methods available for constructing a building, such as masonry, concrete, metal, and many other synthetic and natural materials. However, one of the most commonly used materials for architectural applications is wood. “Approximately nine of every ten buildings constructed in the United States each year are framed with wood, including most single-family and multifamily residences and a large percentage of commercial, institutional, and public buildings.”⁶⁶ Wood construction is often favored due to the structural abilities of the material, economy, and architectural flexibility.

⁶⁵ Switch/ outlet location diagram; from Hoke, John Ray, editor, Bruce Bassler, student edition editor. *Architectural Graphic Standards: Student Edition*. (New York: John Wiley & Sons, Inc., 2000); 375.

⁶⁶ *Ibid.*, 175.

To develop a design template for testing and experimenting with new electrical switch and outlet receptacle designs, I constructed a framework based on the wall section of a typical residential home built with light wood-frame construction. This armature represents the wall cavity located between two wooden 2x4 studs. The stud wall is secured to a wooden floor joist assembly that is supported by a concrete block foundation. The three panels attached to the 2x4 studs represent gypsum board sheathing that commonly covers partitions of this nature. These panels provide a blank mounting surface to attach and test various interchangeable electrical component designs. This armature (Fig. 25) is used in the remaining chapters to provide a basic structure for developing positively evolved switches and outlet receptacle designs.

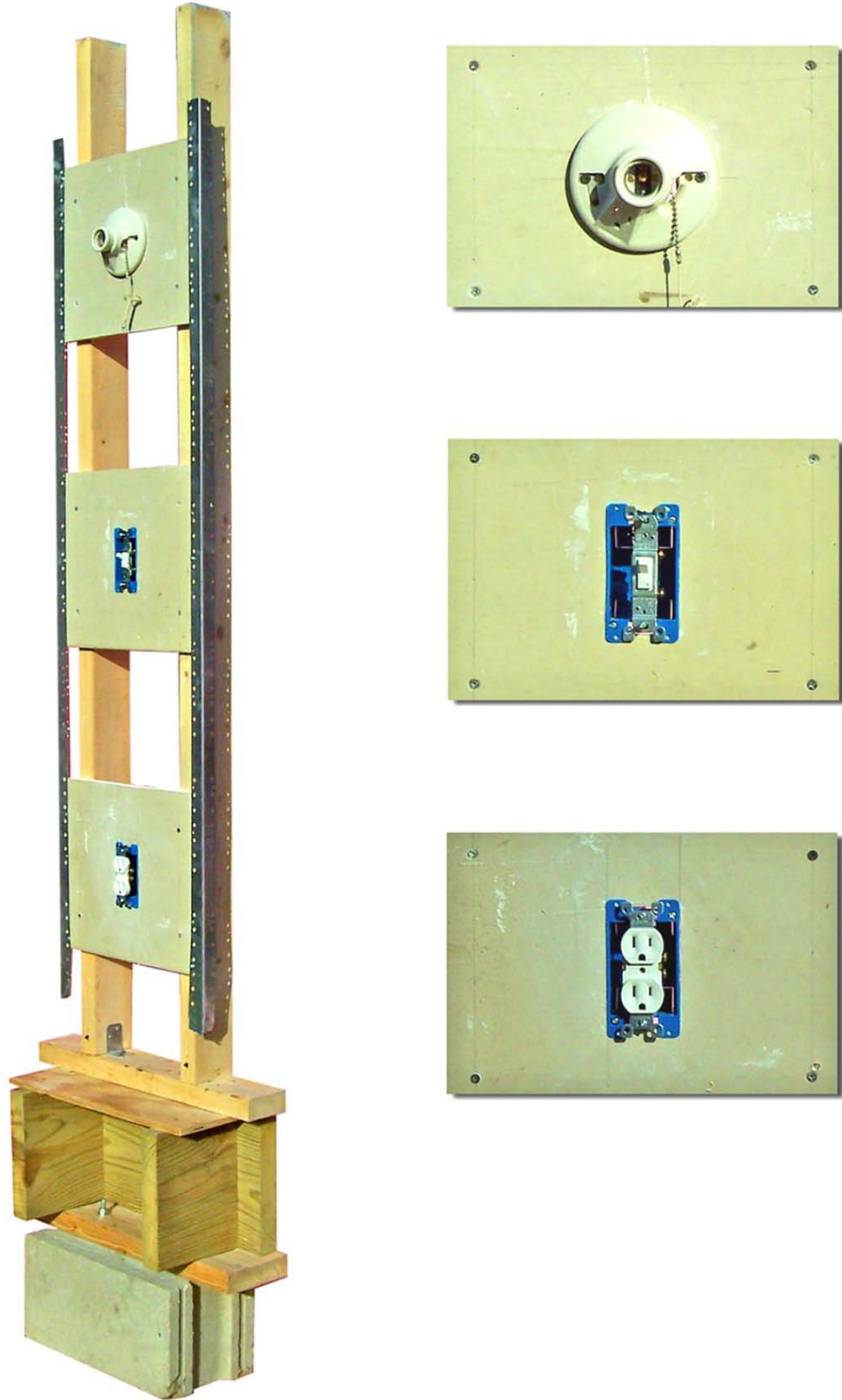


Figure 25: An armature for evolution.⁶⁷

⁶⁷ Armature constructed by author, 2008; Images by author, 2009.

CHAPTER 4

A FASHIONABLE SOLUTION

Chapter 4 offers three different design approaches that could be used for the development of new electrical switch and outlet receptacle designs, and are as follows: Swatchization, Chindogu, and Second Aid. Throughout recent years, some aspects of these design approaches have been successfully utilized by numerous companies to design and develop their products. I believe that these methods often yield products that are fashionable and trendy and provide solutions that are current. However, products that only aid current problems may also end up only providing temporary solutions. This chapter reviews these three design methods in order to formulate potential electrical switch and outlet receptacle designs that can provide a temporary, fashionable solution. Although some of the products developed using these design methods may seem kitsch, the final results can be interpreted as genuine attempts to develop products that offer designs which cater to unique problems and a broad spectrum of specific tastes... for now.

Swatchization

During the 1970's the Swiss watch industry faced a pressing technological crisis. Propelled by Japan, digital watches offering accurate timekeeping, inexpensive production, and unique designs were being produced. To confront this technological shift, SMH, the Swiss Corporation for Microelectronics and Watchmaking Industries was formed and they ultimately developed the Swatch watch. The first Swatch watch went on sale in 1983; "a slim plastic watch with only 51 components (instead of the usual 91 parts or more) that combined top quality with a highly affordable price."⁶⁸ Since then, the Swatch watch has become one of the most successful wristwatches of all time and their parent company, The Swatch Group, has become the largest watch company in the world.

⁶⁸Swatch. "The Swatch History" Swatch AG. http://www.swatch.com/zz_en/about/history.html (accessed June 1, 2009).



Figure 26: Three different Swatch watch models that utilize the same overall engineering module. These three watches offer variation by changing color, material, and/ or graphic.⁶⁹

The success of the Swatch watch can be attributed to the company's ability to offer hundreds of unique and versatile watches that cater to a multitude of individual tastes, while keeping down the cost of production (Fig. 26). Designer, Gerhard Heufler comments on The Swatch Group's flourishing operation:

Swatch opted for a highly successful approach in commercial terms in response to the demand for individualization. The company keeps the tool-intensive and therefore expensive engineering modules in use for a relatively long time, but changes the cheap colors, patterns and surface finishes at frequent intervals. Several collections are presented each year, often even in limited editions. This successful marketing strategy has often been imitated in the interim and has even been given the name: "swatchization".⁷⁰

Utilizing the Swatch watch as a design model, the swatchization technique can be used to develop new electrical switch and outlet receptacle designs. In fact, the vast array of switch/ outlet receptacle faceplates currently available are often produced through a similar

⁶⁹ Images by author, 2009.

⁷⁰ Heufler, Gerhard. *Design Basics: From Ideas to Products*. (Zurich: Niggli Verlag AG, 2004); 55.

swatchization method. Similar to the Swatch watch, switch/ outlet faceplates often maintain the engineering module for the electrical component and only change the cheap faceplate colors, patterns, and surface finishes. This allows for a breadth of faceplate options to slightly individualize electrical components within a building. Currently, the faceplate choices that are available often maintain neutral designs, yielding subtle integration of these components into the finished wall surface of a building.

By using the swatchization method to further progress the designs of electrical switches and outlet receptacles, electrical faceplates could become designer objects instead of secondary wall coverings. Not only could this design method render the electrical faceplate as a sought-after object, but certain finishes may even improve the usability of electrical fixtures and components. Textured faceplates could enhance the surface tactility of a switch and brightly colored faceplates could improve a user's ability to locate switches and outlet receptacles. Also, Swatch has notably partnered with famous artists, such as Keith Haring, to provide watches that offer high-artistic designs. This same concept could be applied to electrical faceplate designs to offer miniature wall art that might even add to the function of electrical components (Fig. 26)

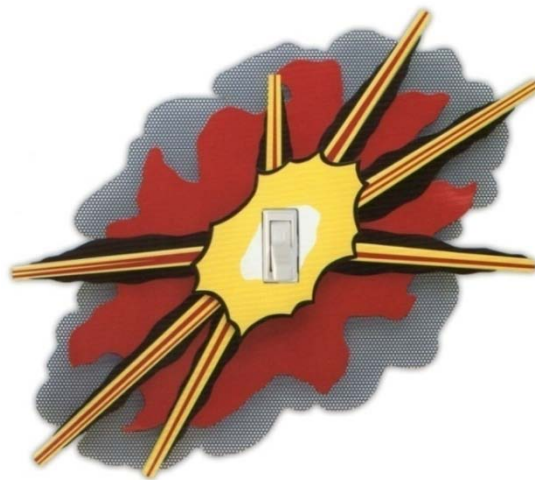


Figure 26: A theoretical artist-designed faceplate using Roy Lichtenstein's, *Wall Explosion II*. The "wall explosion" may add to the physical act of hitting of the lights through the use of this graphic sculpture.⁷¹

⁷¹ Digital model rendered by author, 2009; using an image of Roy Lichtenstein's, *Wall Explosion II*; from Tate Modern. "Wall Explosion II." Roy Lichtenstein. <http://www.tate.org.uk/modern/explore/work.do?id=8785&action=3> (accessed July 1, 2009).

A problem that many users have with electrical lighting systems is figuring out which switch controls a particular electrical function. Because light switches only come in a limited number of designs, when there are many similar switches in close proximity, it is often difficult to immediately know which device a particular switch will operate. When confronted with many standard switches, a user often requires numerous trials and errors to locate the correct switch. In his book, *The Design of Everyday Things*, Donald Norman provides a solution to this problem by offering a light switch that is overlaid with a floor plan and lighting scheme of a room; each switch corresponds to a light fixture located on the floor plan. Ultimately, this system would be difficult to implement because it disregards contemporary standards for wall construction. Donald Norman's system would require a wall redesign in order for his solution to be integrated. Instead, by using the swatchization method to design inexpensive faceplates that intuitively and aesthetically reveal the mapping of a switches function, an improved switch/ outlet receptacle design could be discovered. For example, the mapping of an electrical system could be improved by implementing coordinating faceplates that visually link a particular light switch with the fixture it operates (Fig. 27).

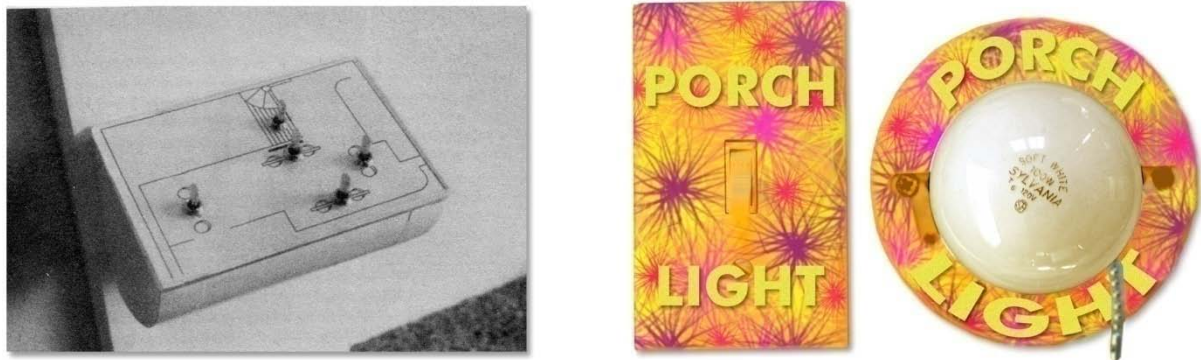


Figure 27: Left- An image of Donald Norman's specialized floor plan switching device compared to a theoretical matching switch and fixture;⁷² Right- Outfitting switches and light fixtures with inexpensive coordinating faceplates and fixture covers can make it blatantly apparent for a user to identify which function a particular switch controls.⁷³

⁷² Image of a wall switch; from Norman, Donald A. *The Design of Everyday Things*. (New York: Doubleday Currency, 1988).

⁷³ Digital switch/ fixture model rendered by author, 2009.

Chindogu

Unofficially, Chindogu is an “art form” of inventing that was developed in Japan by Kenji Kawakami. The book, 101 Unuseless Japanese Inventions, by Kawakami reveals that Chindogu creations are “inventions that seem like they’re going to make life a lot easier, but don’t.”⁷⁴ Featured in this book are inventions such as *Training High Heels*, *The Up/ Down Toothbrush*, and *Duster Slippers for Cats* (Fig. 30). All of these inventions are undeniably humorous. Chindogu “are funny because they are paradoxical and they are funny because they fail, but Chindogu are not designed to be stupid for the mere sake of stupidity.”⁷⁵ It should be understood that Chindogu inventions are designed with genuine intent to produce products that solve various problems encountered by people throughout their daily lives. “A Chindogu, or unuseless invention, is a gadget that has been conceived, designed, built, tested and verified to make our lives more convenient in some way. The only problem is that a Chindogu also makes our lives more inconvenient in another way.”⁷⁶

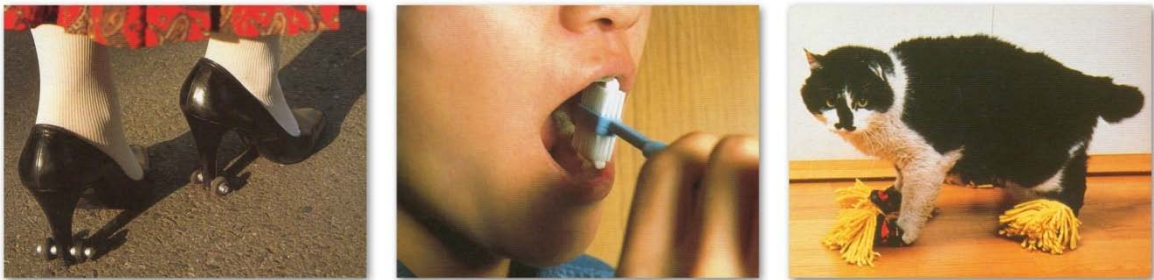


Figure 30: Images of three “Unuseless” Japanese inventions: *Training High Heels*, *The Up/ Down Toothbrush*, and *Duster Slippers for Cats*.⁷⁷

⁷⁴ Kawakami, Kenji. *101 Unuseless Japanese Inventions: The Art of Chindogu*. (New York: Norton & Company, Inc., 1995); 6.

⁷⁵ Ibid.; 7.

⁷⁶ Kawakami, Kenji. *99 More Unuseless Japanese Inventions: The Art of Chindogu*. (New York: W.W. Norton & Company, Inc., 1995); 7.

⁷⁷ Chindogu images; from Kawakami, Kenji. *101 Unuseless Japanese Inventions: The Art of Chindogu*. (New York: W.W. Norton & Company, Inc., 1995); 144, 73, 13.

How to practice Chindogu:

The successful Chindoguisit approaches his subject in much the same way that a serious inventor would: searching for an aspect of life that could somehow be rendered more convenient and concocting a method for making it so. Like an inventor, he discards those notions that clearly miss the mark, but unlike the inventor, he also abandons those ideas that will obviously work. The Chindoguisit latches onto and builds a prototype of the best idea he can come up with that looks good at the onset but on closer examination isn't. Having tested and verified that it indeed wasn't worth the effort, the creator of the Chindogu will then congratulate himself on having successfully produced an almost useful implement.⁷⁸

One of the Chindogu inventions created by the author Kenji Kawakami is known as a *Chin Switch* (Fig. 31). Kawakami writes that the Chin Switch allows for the "hands-free turning off and on" of a switch. The promotion for this invention is as follows:

There are numerous occasions when the fingers may not be the best part of the body with which to turn on a switch. Perhaps they are unavailable (for example when you are carrying a precious work of art). Or they may be wet, or covered in sticky rice or tempura. The Chin Switch is specifically designed to be activated by one part of you that is almost certainly not to be engaged in another task: your chin. Men who happen to be shaving will find that it is also easily activated by the elbow or forehead. Or finger.⁷⁹

⁷⁸ Kawakami, Kenji. *101 Unuseless Japanese Inventions: The Art of Chindogu*. (New York: W.W. Norton & Company, Inc., 1995); 7.

⁷⁹ Ibid.; 58.

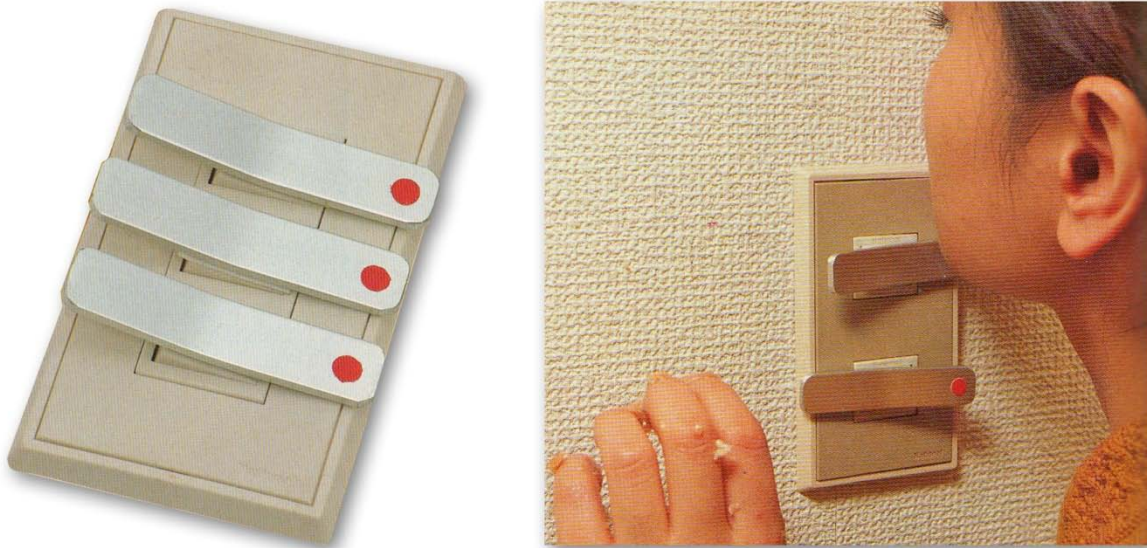


Figure 31: The *Chin Switch*.⁸⁰

As seemingly ridiculous as the “chin switch” may be, it is in the spirit of creating Chindogu that can serve as a useful design method for creating better electrical switches and outlet receptacles designs. Even though Chindogu takes pride in the creation of failed inventions, much can be learned from these failed attempts. If at first you don’t succeed, then try, try again. By using Chindogu as a design method, you can learn from mistakes and failed attempts to work towards a truly useful design.

Second Aid

The term “*second aid*” was first popularized by designers Jörg Adam and Dominik Harborth through their 2003 exhibition and book Second Aid: Doorstops, drip-catchers and other symbiotic gadgets. This book roughly defines a second aid as a device or product that maintains the sole purpose of aiding and making up for the shortcomings of an existing product. For example, the act of propping a door open often requires a doorstopper to secure the door in a desired position (Fig. 28). A doorstopper is necessary to make up for the inherent shortcomings that many doors maintain; often doors are not initially designed with an ability to be secured in an array of open positions. Because many doors exemplify this

⁸⁰ Chin switch images; from Kawakami, Kenji. *101 Unuseless Japanese Inventions: The Art of Chindogu*. (New York: W.W. Norton & Company, Inc., 1995); 58.

problem, there exists a vast collection of door stopping devices. Another characteristic of a second aid is that, without an initial host object, the second aid is essentially a useless object. A doorstopper is useless without a door, a chinrest is useless without a violin, a drip-catcher is useless without a teapot, etc.



Figure 28: Five different types of door stopping devices. Each of these products are second aids that assist in the securing of a door. Without a door, these products are useless.⁸¹

The second aid design approach can serve as a useful method for developing superior electrical switches and outlet receptacle designs. For many users, the contemporary electrical switches and outlet receptacles maintain various shortcomings and some second aid products are already commercially available for various residential electrical devices (Fig. 29). Self-timers have been popular aids for switching on and off outlet receptacles because the designs of standard outlet receptacles do not offer programmable timer functions. Instead, a “wall wart” self timer may be attached to an existing outlet to provide this function. Without an existing outlet receptacle this self timer device is a useless product.

Another ‘second aid’ device that is currently produced to assist residential electrical systems is known as a light switch extender/ extension. Due to the standard height that most residential light switches are located, some users are unable to reach and operate switches. The light switch extender is an implement that attaches to an existing switch to provide a wider range of operation, primarily from lower height levels. Without an existing light switch, a light switch extender/ extension is essentially a useless product (Fig. 29).

⁸¹ Images of door stoppers; from Adam, Jörg, Dominik Harborth, and Andrea Vilter. *Second Aid: Doorstops, drip-catchers and other symbolic gadgets*. (Ludwigsburg: avedition GmbH, 2003).



Figure 29: Three commercially available 'second aids' for residential electrical systems: Outlet receptacle self-timer⁸², light switch extender⁸³, and outlet receptacle safety plug.⁸⁴

Categorical examples of a second aid for electrical outlet receptacles are the vast array of safety plugs available to help prevent the insertion of foreign objects into an outlet. Perhaps the lucrative market for these plastic plug-like devices has led to the development of recently available tamper resistant outlets. Through the invention of additional second aid devices to serve various shortcomings of residential electrical systems, additional superior electrical component designs may be derived.

⁸² Outlet receptacle self-timer; image of author, 2009.

⁸³ Light Switch Extender/ Extension. "Image of Light Switch Extender/ Extension." Light Switch Extender/ Extension. <http://www.lightswitchextender.com/> (accessed July 1, 2009).

⁸⁴ Ace Hardware. "Image of Prime-Line® Child Safety Security Outlet." Ace Hardware. <http://www.acehardware.com> (accessed July 1, 2009).

CHAPTER 5

A SCIENTIFIC SOLUTION

The previous chapter, *A Fashionable Solution*, reveals three different design approaches that could be used for the development of new electrical switch and outlet receptacle designs. However, it is noted that the implementation of these methods typically renders products that are trendy and only offer temporary solutions. Chapter 5 offers an alternative design approach based on the scientific method. I believe that a scientific design approach can derive superior products that will provide enduring solutions. Through a step-by-step process of inquiry, I analyze existing electrical switches and outlet receptacles to formulate, through research and experimentation, incrementally superior products.

The Scientific Method

The scientific method is a formula for discovery that has been developed over the past few centuries. The current structure of this process encourages asking questions and seeking explanations in the pursuit of knowledge. “As a formal process of inquiry, the scientific method consists of a series of steps”⁸⁵ and typically includes “the finding and stating of a problem, the collection of facts through observation and experiment, and the making and testing of ideas that need to be proven right or wrong.”⁸⁶

A commonly accepted formula for the scientific method (Fig. 30) operates in the following order: observation, question, hypothesis, prediction, and experiment. This method is commonly driven by the hypothesis, which is a tentative answer to a question. “We all use hypotheses for solving everyday problems.”⁸⁷ For example, imagine you flip a light switch and *observe* that the corresponding light bulb does not illuminate. This leads to the formation of a *question*: Why is the light not working? Based on previous knowledge, a logical *hypothesis* is: The light bulb is burnt out. Once the hypothesis is formed, you can proceed to

⁸⁵ Campbell, Neil A., Jane B. Reece, and Eric J. Simon. *Essential Biology*. (San Francisco: Pearson Benjamin Cummings, 2007); 14.

⁸⁶ Langenscheidt's Pocket Merriam-Webster English Dictionary. (Langenscheidt Publishers Incorporated, 1997); 652.

⁸⁷ Campbell, Neil A., Jane B. Reece, and Eric J. Simon. *Essential Biology*. (San Francisco: Pearson Benjamin Cummings, 2007); 14.

test it through a series of predictions and experiments. *Prediction*: If the light bulb is replaced, the light switch will illuminate the new bulb. *Experiment*: Replace the light bulb. If the light bulb now illuminates when you operate the switch, then your initial hypothesis was correct. However, if the light bulb still does not illuminate you can form and test alternative hypotheses such as: there is a bad electrical connection in the light switch, or a fuse has burnt out in the lighting circuit, etc.

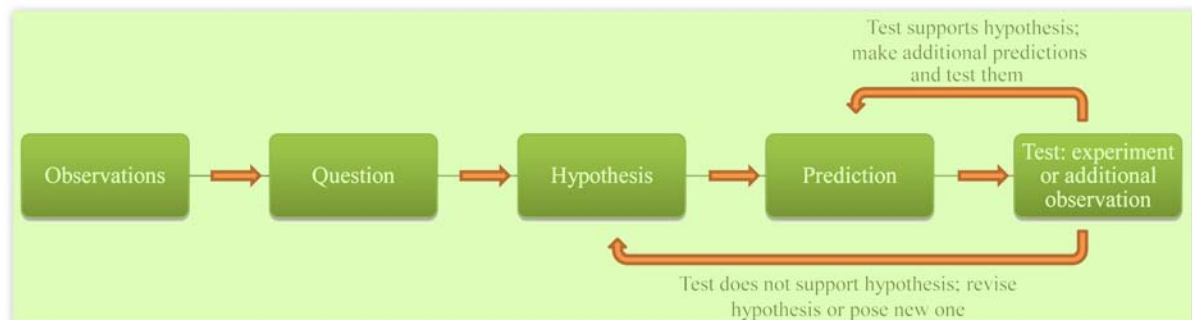


Figure 30: The scientific method.⁸⁸

The Scientific Method of Design

By applying a design approach inspired by the scientific method to the development of electrical switches and outlet receptacles, new scientifically-derived designs for these electrical components can be created to provide superior design solutions. Implementing a scientific design method encourages the gathering of empirical observations and opinions related to these electrical components in order to reengineer improved product designs that solve specific problems.

Observations

As a starting point, I gather a breadth of observations related to electrical switches and outlet receptacles:

Observation 1- *When exploring buildings that have been constructed within the past 100 years, it is apparent that the designs of electrical switches and outlet receptacles have*

⁸⁸ Image by author, 2009.

maintained slow design evolution. Since the installation of the first residential electrical systems, similar electrical component designs can be found in most buildings, whether they were constructed in the early 1900's or the early 2000's (Fig. 31).

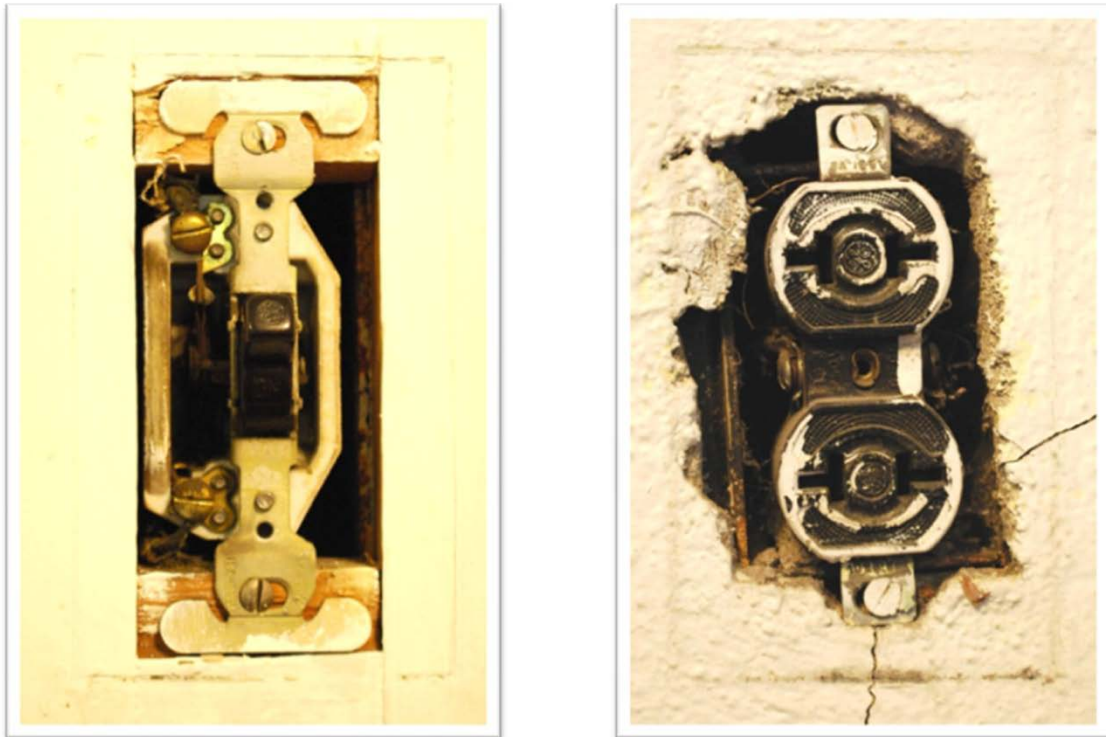


Figure 31: An electrical switch and outlet receptacle from a home built in 1931. Both of these electrical components embody designs that are similar to electrical switches and outlet receptacles currently produced.⁸⁹

Observation 2- A recent incremental advance that has occurred in standard single-pole electrical switch designs has been the replacement of the age-old toggle switching mechanism with a larger “rocker” switch (Fig. 32). This new switch design, known as the decorator switch, provides a larger switching surface that offers increased accessibility and ergonomic function. Also, this design offers a more seamless design aesthetic by applying a more balanced switch-to-wallplate ratio. Throughout the past decade, the decorator switch has become a common electrical component in residential buildings.

⁸⁹ Images by author, 2009.

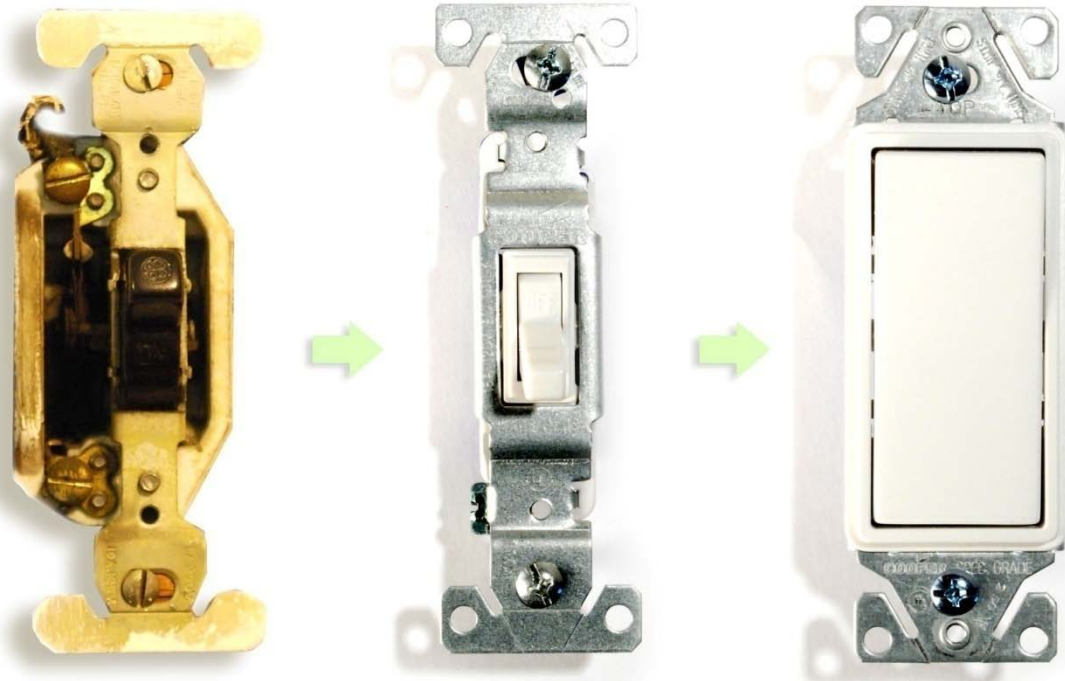


Figure 32: Left- single-pole toggle switch, 1930's; Center- single-pole toggle switch, 2000's; Right- single-pole decorator switch, 2000's. Notice the similarities between the two toggle switch designs. Over the 70 years between the productions of these two electrical components little change has occurred to this basic design. However, recently an incremental design advance has been integrated, resulting in the single-pole decorator switch; the toggle switch mechanism has been replaced by a rocker switch mechanism.⁹⁰



Figure 33: Left- toggle switch and oval shaped duplex outlet receptacle; Right- decorator switch and decorator duplex outlet receptacle.⁹¹

Observation 3- *Toggle electrical switches and oval-shaped outlet receptacles require two different faceplates. Electrical switches and outlet receptacles of the decorator style design use the same faceplate (Fig. 33). Decorator style electrical components provide an improved*

⁹⁰ Images by author, 2009.

⁹¹ Images by author, 2009.

design by using a single interchangeable faceplate. The decorator faceplate provides increased production economy by eliminating the need to produce two specific faceplates for electrical switches and outlet receptacles (Fig. 34). Also, the decorator faceplate requires less material to produce compared to toggle switch faceplates and oval shaped outlet faceplates. A single interchangeable faceplate can also increase worksite productivity. One less component on a building worksite decreases the potential for error during the construction process.

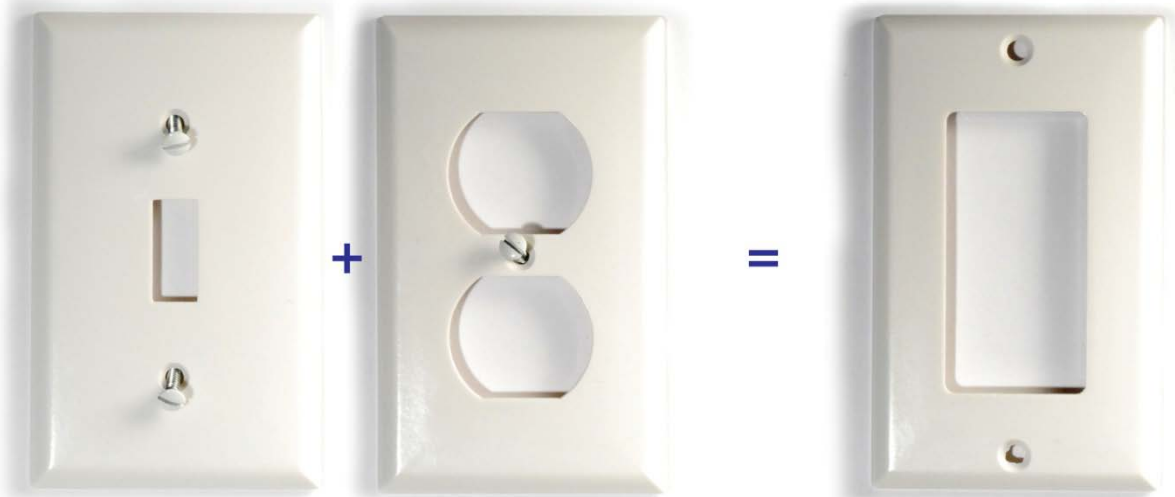


Figure 34: A decorator faceplate can be used to cover either a decorator switch or a decorator outlet receptacle.⁹²



Figure 35: Left- standard decorator faceplate; Right- screwless decorator faceplate.⁹³

⁹² Images by author, 2009.

Observation 4- *Recently, screwless faceplates have become available (Fig. 35). A negative aspect of the screwless faceplate is that it uses a two part system, instead of the standard single piece faceplate. Because the screwless faceplate implements a two part design, it requires twice as much material to produce, increasing production costs.*

However, screwless faceplates also offer several superior design improvements compared to standard single piece faceplates. Screwless faceplates provide improved safety by including a primary removable faceplate and a secondary permanent faceplate. This is particularly beneficial when painting walls that include electrical components. For many people it is often tedious and difficult to paint around electrical components and many users opt to either paint over the entire electrical device or completely remove the faceplate before painting (Fig. 31). Painting over electrical components typically yields unsightly results and removing electrical faceplates presents safety hazards such as electrical shock. When painting around an electrical component that uses a screwless faceplate, a user can temporarily remove the primary faceplate and paint directly over the secondary permanent faceplate (Fig. 36). This system keeps electrical components clean and safe. When the primary faceplate is snapped in place over the electrical component, the final result is a minimal design, free of screws.



Figure 36: Left- screwless faceplate, secondary permanent faceplate component; Right- screwless faceplate, primary removable faceplate component.⁹⁴

⁹³ Images by author, 2009.

⁹⁴ Images by author, 2009.

Observation 5- According to the 2008 National Electric Code, tamper-resistant outlet receptacles are now required in certain locations within residential buildings. Tamper-resistant outlet receptacles offer an incrementally advanced design compared to standard outlet receptacles. With the addition of two internal spring-loaded plastic shutters, tamper-resistant outlets help prevent the insertion of foreign objects into a plug outlet. Tamper-resistant outlets are designed to only accept standard plugs. The outlets will not open unless the blades of a plug simultaneously depress each internal shutter. This incremental advance greatly improves the safety of these electrical devices and only requires a minute increase in production cost (Fig. 37).



Figure 37: Left- standard decorator duplex outlet receptacle; Center- tamper-resistant decorator outlet receptacle; Left- side profile for both the standard decorator duplex outlet receptacle and the tamper-resistant decorator outlet receptacle. The incremental advance of the tamper-resistant outlet only occurs internally. The exterior of this component still works within existing electrical standards.⁹⁵

⁹⁵ Images by author, 2009.

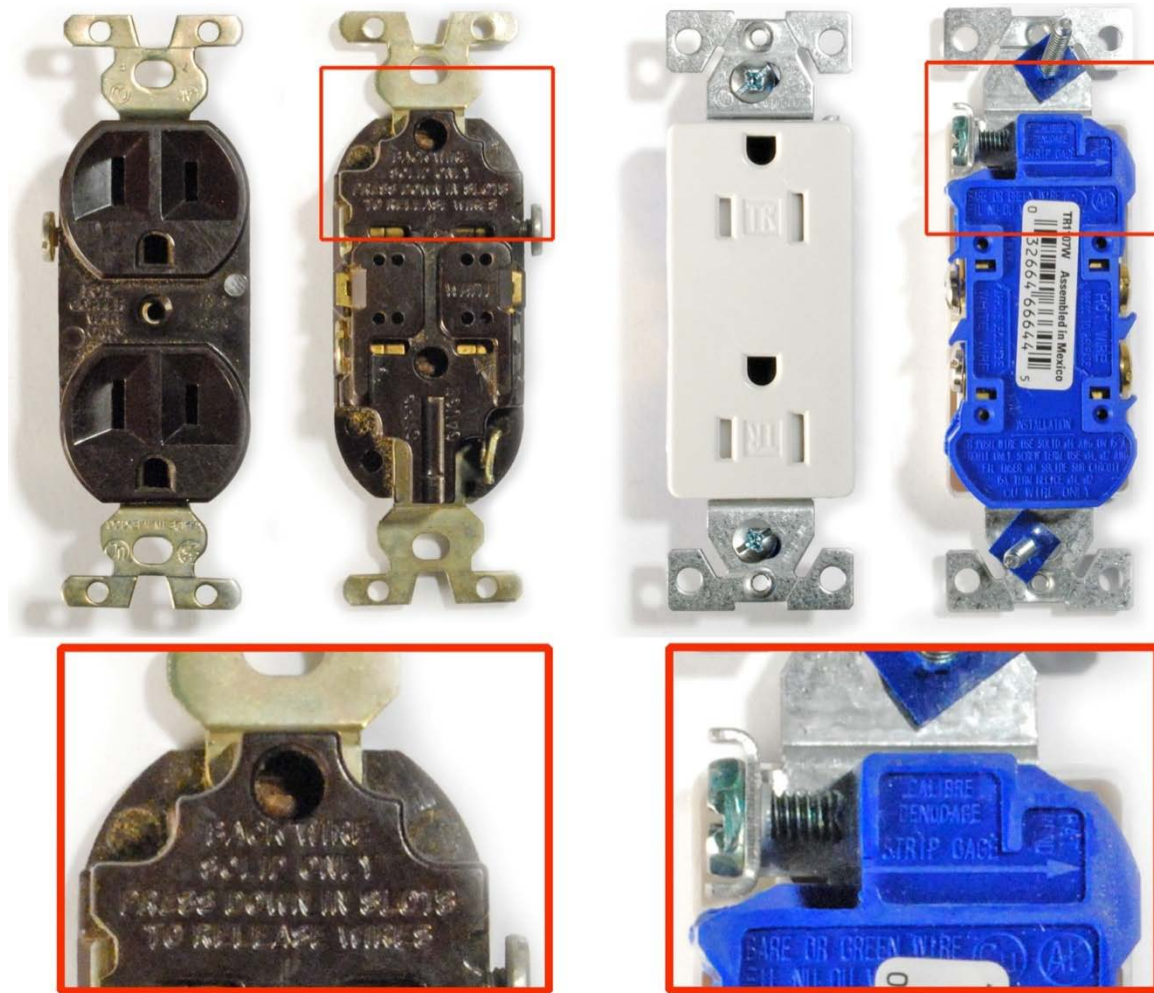


Figure 38: Images revealing electrical component text orientation. Left- This older duplex outlet receptacle is shown face-up. The text on the back of this device is also face-up, which encourages face-up installation of this outlet receptacle; Right- This more recent duplex outlet receptacle is shown face-down. The text on the back of this device is also face-down, which encourages face-down installation of this outlet receptacle.⁹⁶

Observation 6- A subtle, yet incremental improvement that has recently been applied to many electrical components has been a change in the orientation of text located on certain devices (Fig. 38). Typically, the text orientation on electrical components infers the recommended orientation for a device to be installed. This is particularly applicable for outlet receptacles. Historically, outlet receptacles have been installed in a face-up position. Correspondingly, the product text on older outlet receptacles is written in a face-up position. However, recent National Electric Codes have increasingly designated outlet receptacles to be installed with a face-down orientation in certain locations within residential buildings. It is believed that

⁹⁶ Images by author, 2009.

outlet receptacle safety is improved by installing these devices with the grounded prongs of electrified plugs located at the topmost part of an outlet. If an object falls onto an electrified plug, which is inserted into an outlet receptacle that was installed in a face-down position, and comes into contact with a prong of the plug, it has an increased likelihood to become grounded and will be safe to handle, rather than becoming electrified. When an outlet is in a face-up position there is greater likelihood that a fallen object may come into contact with a “hot” prong of a plug and become a safety hazard. Applying text that corresponds with recommended electrical device orientation can help improve electrical safety.



Figure 39: The back of an electrical component that includes numerous mapping devices and built-in tools to aid in the installation of the device.⁹⁷

Observation 7- When examined closely, it is apparent that certain electrical components include various useful mapping devices to provide information related to a particular component (Fig. 39). Also, various tools are often built into certain electrical devices to aid in installation. Mapping elements commonly found on electrical components include the following information: type of wire material to be used; offered in written and symbol form (CU WIRE ONLY, AL), written instructions designating where each wire should be connected (HOT WIRE→, WHITE WIRE→, BARE OR GREEN WIRE→), color coordinated device parts that correspond with designated wires, written instructions explaining how to operate particular device elements (FOR PUSH WIRE USE SOLID #14 AWG. SCREW TERMINAL USE #14, #12 AWG), and device ratings (15 amp circuit only). Some of the built-in tools that are commonly found on electrical devices are as follows: wire

⁹⁷ Images by author, 2009.

strippers for various sized wires, strip gauges to designate stripped wire length, and wire bending cleats to aid in bending wires around screw terminals. Each of these mapping devices and built-in tools aid in the efficient and safe installation of electrical components.

Observation 8- When examining any contemporary residential building it is common to find a vast collection of power adapters, accessory outlets, multi-outlet assemblies, and surge protectors being implemented (Fig. 40). This observation infers that standard duplex outlet receptacles are not enough for the electrical demands of 21st century society. At many locations within residential buildings there is often a need to plug in more than two electrical devices. For example a standard entertainment system may include a television, DVD player, VCR, stereo receiver, surround sound system, etc. Each of these devices requires an outlet and electrical supply, which is more than a standard duplex outlet receptacle can provide. Often these auxiliary devices that are required within a residence to provide sufficient outlets are big, clumsy, and ugly.



Figure 40: Four auxiliary outlet devices. Many of these devices are bulky, boxy, difficult to fit behind furniture, dangerous along floors, and obtrusive.⁹⁸

⁹⁸ Images by author, 2009.

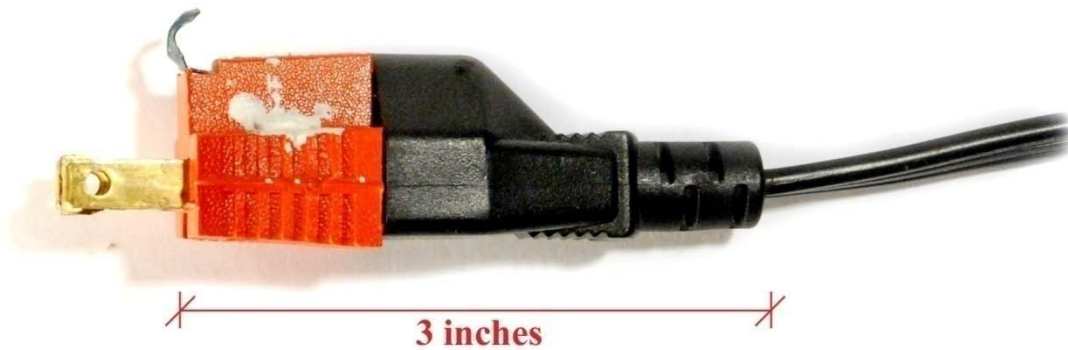


Figure 41: A common three prong plug with a two prong outlet adapter. The length of this plug system can easily exceed a length of 3 inches, not including bent cord length.⁹⁹

Observation 9- *Historically, standard outlet receptacles have been installed flush with residential walls and are designed to have plugs inserted at a direction perpendicular to the wall surface. Also, in most residential situations, outlet receptacles are installed between 12 to 18 inches from the surface of a floor to potentially increase their accessibility. When various devices are plugged into outlet receptacles, it is not uncommon for their plugs to protrude 2 to 4 inches from the surface of a wall (Fig. 41).*



Figure 42: Three commercially available devices that allow for plugs to be attached to an outlet parallel to a wall instead of perpendicular.¹⁰⁰

⁹⁹ Image by author, 2009.

¹⁰⁰ Images by author, 2009.

This current design and method can be extremely problematic whenever furniture and various appliances are placed within a residential space. In many situations it is desirable to situate these residential objects directly along the perimeter walls of a room. However, common furniture often occupies space approximately 12 to 18 inches from floor level (such as desks, beds, sofas, etc.); the same height that most outlet receptacles are located. This results in interference between furniture and electrical plugs. Pushing furniture directly against outlet receptacles can cause attached plugs and cords to become bent and frayed, creating a safety hazard. To aid this spatial discrepancy, various supplementary devices are commercially available to allow for plugs to be inserted parallel to an outlet instead of perpendicular (Fig. 42). Often these supplementary devices protrude a maximum of 2 inches from a wall surface and can reduce the risk of bending and fraying electrical plugs and cords.



Figure 43: Images from a Pass & Seymour advertisement for Plug Tail devices¹⁰¹

Observation 10: *The electrical supply company, Pass & Seymour, offers many components that use their “Plug Tail” installation system (Fig. 43). They advertise this product as follows:*

“Plug Tail. The fastest, most consistent and reliable wiring devices – ever! Factory-terminated devices and connectors mean that device installation is the same regardless of skill level of the installer. The UL-Listed connectors are keyed to ensure proper wiring installation into each receptacle. The connector simply snaps into the back of the device – no preparing, stripping or looping conductors, no exposed terminals to tighten or tape, and no mistakes mean no costly callbacks! Now device installation is a snap!”

¹⁰¹Pass & Seymour. “Plug tail device images, Product Literature.” Pass & Seymour. <http://www.passandseymour.com/> (accessed July 1, 2009).

This system may help improve current codes and practices for the installation of electrical systems. Using a system similar to the Pass & Seymour Plug Tail could result in increased accuracy, economy, and safety for the installation of electrical components and devices.

Observation 12- *When examining the dimensions of faceplates and switching devices, it is apparent that faceplates maintain vastly greater surface areas compared to switches. Faceplate surface area for a standard toggle switch is typically a minimum of 30 times larger than the actual switch. Faceplate surface area for a standard decorator switch is typically a minimum of 4 times larger than the actual switch. The primary function of an electrical faceplate is to cover the wall opening and device box within a wall. Comparing these proportions, it requires much more material to produce faceplates as opposed to the material used to create the components they conceal.*

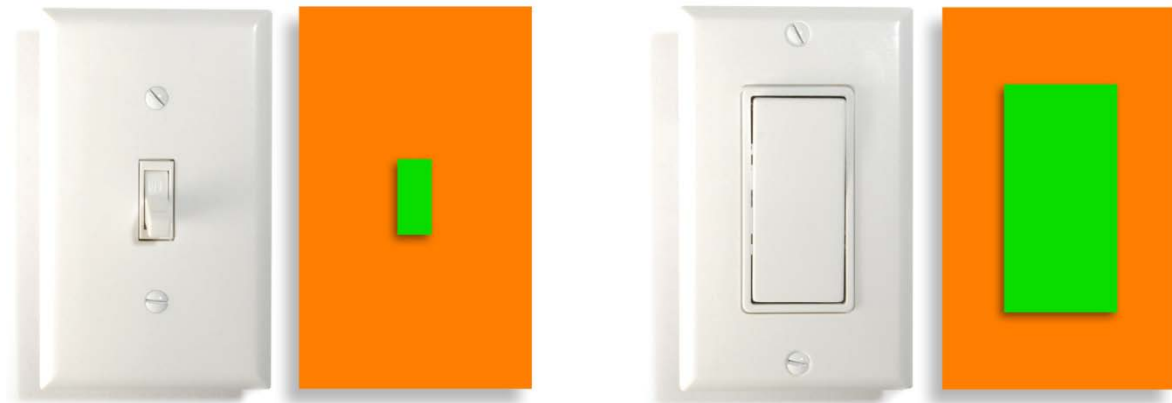


Figure 43: Left- This standard toggle switch system has a 30:1 faceplate to switch ratio; Right- This standard decorator switch system has a 4:1 faceplate to switch ratio.

Questions

Following the scientific method, the summation of these observations leads to many questions:

Question 1- *Why do electrical faceplates not provide any extra functions besides the covering of a wall opening? Compared to the total material in a final electrical device assembly, faceplates require a significant amount of material to produce. Could this material be*

applied towards adding extra function to an electrical device; perhaps making a larger switch that also covers a wall opening?

Question 2- Why does every electrical device not use the Pass & Seymour Plug Tail system? If this system truly does offer improved installation accuracy, economy, and safety, should it not become a new electrical standard?

Question 3- Why do contemporary outlet receptacles not provide a means for inserting plugs parallel to an outlet instead of perpendicular? If pushing furniture against electrical plugs is a safety hazard, should there not be a way to avoid this notorious residential problem?

Question 4- If contemporary society has to rely on auxiliary devices such as power strips, surge protectors, and adapter, to provide enough outlets, could standard outlet receptacles be redesigned to provide more than two outlets?

Question 5- The mapping devices and built-in tools that some electrical components include are generally useful and can improve a components installation and safety. Why are these useful product elements not included on every electrical device and why are they not made more legible and accessible?

Question 6- If it is safer to install outlet receptacles in a facedown orientation, then why does the current electrical code not require all outlet receptacles to be installed facedown?

Question 7- Incrementally advanced tamper resistant outlet receptacles have greatly improved the safety of outlet devices through the addition of two small plastic, spring-loaded shutters. These two small pieces of plastic have been able to greatly improve the historic standard outlet receptacle. What other incremental improvements can be made to this design?

Question 8- *Screwless faceplates provide a more seamless design aesthetic, protect electrical devices from being painted over, and maintain a secondary faceplate to help improve device safety. What other electrical safety devices could be developed for electrical components that also improve the overall design aesthetic of the device?*

Question 9- *Decorator switches and decorator outlet receptacles use the same faceplate, unlike historic standard switches and outlet receptacles that require unique faceplates for each electrical device. By eliminating the need for multiple unique faceplates, decorator style electrical components provide increased production economy. What other interchangeable components could be developed for electrical switches and outlet receptacles to provide advanced designs that reveal improved production economy, safety, and aesthetics?*

Question 10- *Decorator light switches provide a physical switching surface that is approximately 15 times the size of a standard toggle switch. The decorator switch design with its added “rocker” switching mechanism provides improved accessibility, ergonomics, and aesthetics. This incremental addition has improved electrical switch design. What other incremental advances could be applied to standard switches to reveal an overall superior product?*

Question 11- *When comparing electrical switches and outlet receptacles that were produced during the early 1900's with contemporarily produced light switches and outlet receptacles, it is apparent that the same basic designs for these electrical components have endured for nearly 100 years. Why have these electrical components maintained such a slow design evolution?*

Hypothesis

Succeeding these observations and questions I propose the following hypothesis:

In order to encourage positive design evolution in the field of architecture, I can develop electrical switch and outlet receptacle designs that are incrementally advanced compared to century-old standard electrical switch and outlet receptacle designs.

Prediction

Based on my hypothesis, I make the following prediction:

If I develop new designs for electrical switches and outlet receptacles, that hybridize the positive aspects of these components that I discovered through my observations as well as provide solutions for the problems which were revealed, then a superior product will be realized.

Experiments

The following experimentations attempt to prove the above hypothesis correct.

Experiment 1- *This design demonstrates an electrical plug that magnetically attaches itself to an electrical outlet receptacle (Fig. 44). This plug has conductor blades recessed within its plastic body. When the plug is dangled in close proximity to a corresponding outlet, it magnetically orients and attaches itself to the outlet receptacle, drawing the conductor blades from the plug body and establishing a flow of electrical current. Using an outlet receptacle at floor level with outlets running perpendicular to a wall, this design would eliminate the need to bend over in order to plug in and unplug electrical cords.*

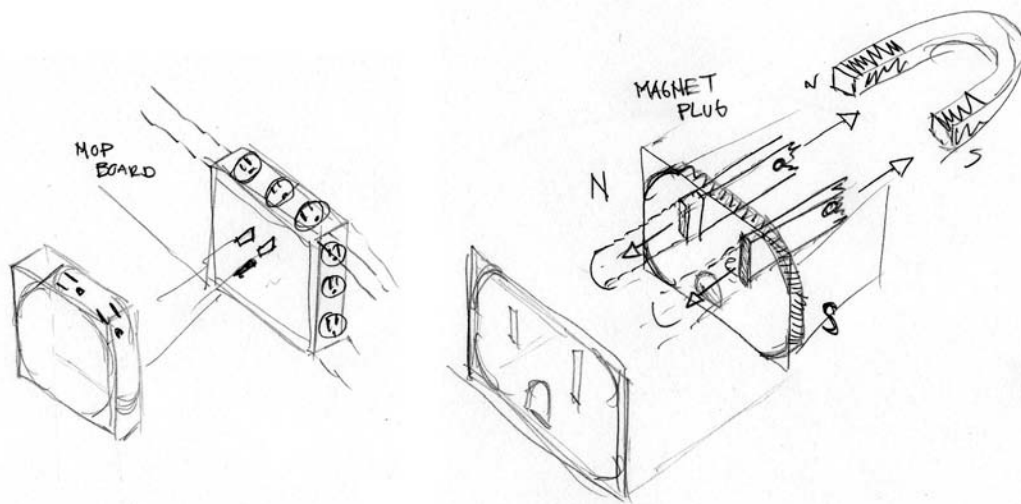


Figure 44: Magnetic plug design.¹⁰²

Experiment 2: *This design features a new electrical device box that accepts various snap-in electrical components, such as electrical switches and outlet receptacles. These electrical device boxes are directly connected to conductors upon installation instead of connecting the conductors directly to specific electrical components after the assembly of a wall. When switches and outlet receptacles are ready to install, they are simply snapped directly into the prewired device box and ready to function (Fig. 45). This design uses miniaturized electrical components that do not require direct wiring into a circuit.*

¹⁰² Sketches and ideas by author, 2009.

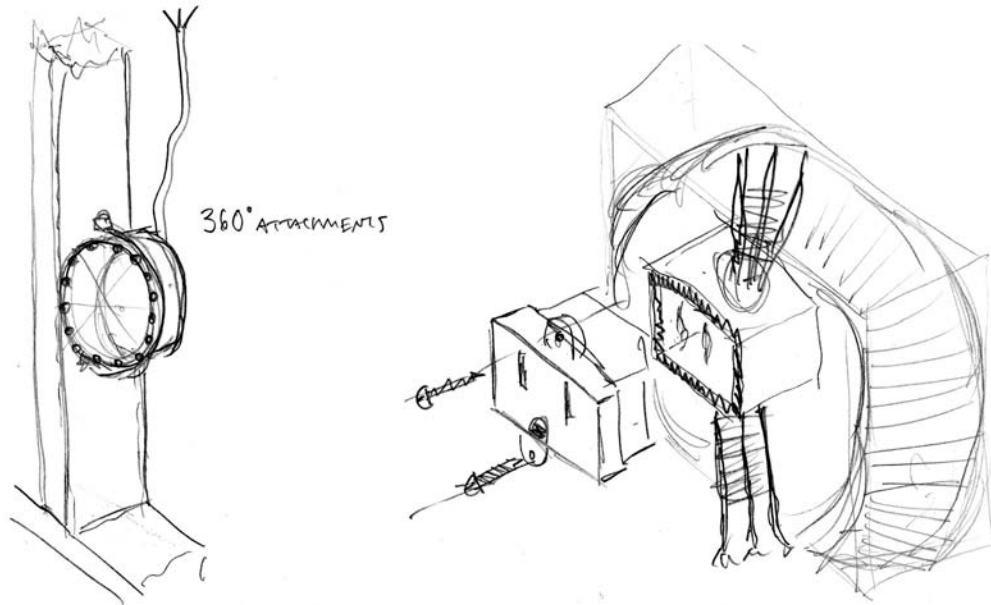


Figure 45: Snap-in electrical device box with corresponding snap-in electrical outlet receptacle.¹⁰³

Experiment 3- *This invention is a two piece faceplate system that renders the entire faceplate as a useable switch. The design consists of a secondary permanent safety faceplate that is attached directly to a standard decorator switch of any make. A primary switch plate is then attached to the secondary safety faceplate. The primary switch plate entirely covers a standard faceplate dimension, including the decorator switch. The primary switch plate concisely fits the contours of the decorator switch below, which acts as the principal switching mechanism (Fig. 46). This design eliminates the nonfunctional material used by traditional faceplates and reallocates it as a functional electrical component. By utilizing the entire surface area of the finished electrical installation, this switching system provides maximum accessibility. Primary switch plates come in any finish to complement a multitude of aesthetics. The finished installation of this switching assembly can have no noticeable reveals in its surface. It can essentially offer a totally seamless design aesthetic. By maintaining decorator-style proportions, this invention works within the existing residential*

¹⁰³ Sketches and ideas by author, 2009.

electrical standard and could be directly integrated into new and existing electrical systems.¹⁰⁴

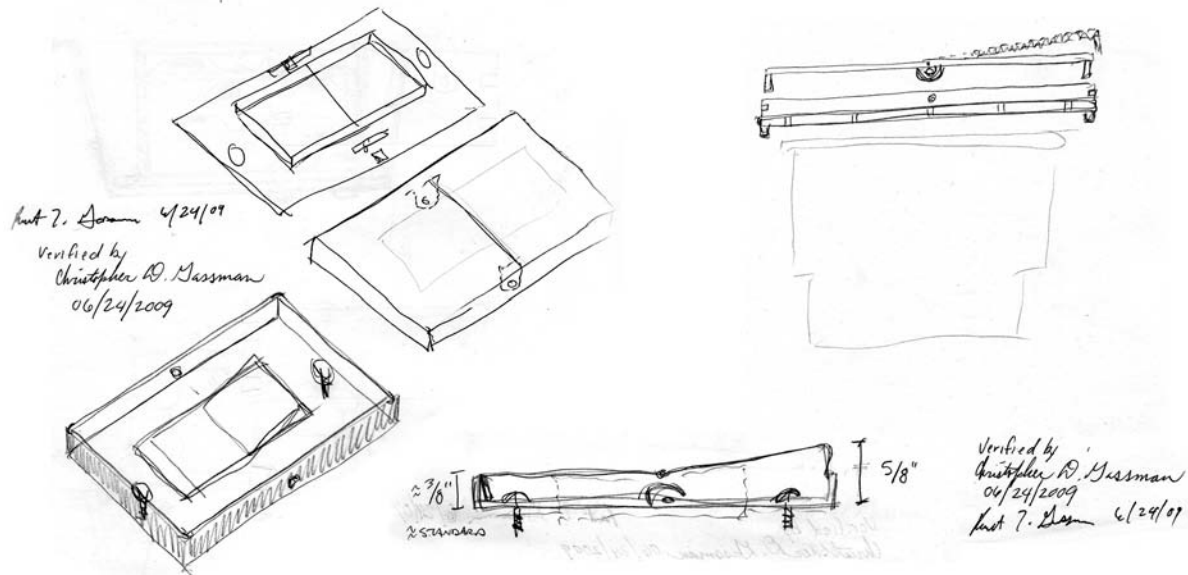


Figure 46: Switching faceplate design.¹⁰⁵

Experiment 4- *This invention is a design for a new outlet receptacle. The design implements a spring-loaded outlet box that maintains decorator-style proportions. This outlet box provides 4 to 6 outlets (two on each side and one on top and bottom) that are accessed parallel to the wall that the device is installed. When not in use, the spring-loaded outlet box is housed within a standard electrical device box, flush with the faceplate surface. To use the outlet, the front rectangle surface of the outlet box is pressed with a finger to engage the spring-loaded action within the system. This causes the outlet box to be extruded from the electrical device box, locking it into a useable position and supplying power to the outlets (Fig. 47). Once situated in the operable position, 4 to 6 plugs can be attached to the outlet box, parallel to the wall surface. This design provides two to three times as many outlets compared to historical standard outlet receptacles. Also, by providing outlets that are accessed parallel to a wall, the entire device including plugged-in cords only protrudes*

¹⁰⁴ This product and all iterations thereof are the original ideas and sole property of the owner and inventor, Robert Gassman.

¹⁰⁵ Sketches and ideas by author, 2009.

approximately 2 inches from the surface of wall. This helps prevent cords from being bent and frayed by furniture and other interferences. By maintaining decorator-style proportions, this invention works within the existing residential electrical standard and can be directly integrated into new and existing electrical systems.¹⁰⁶

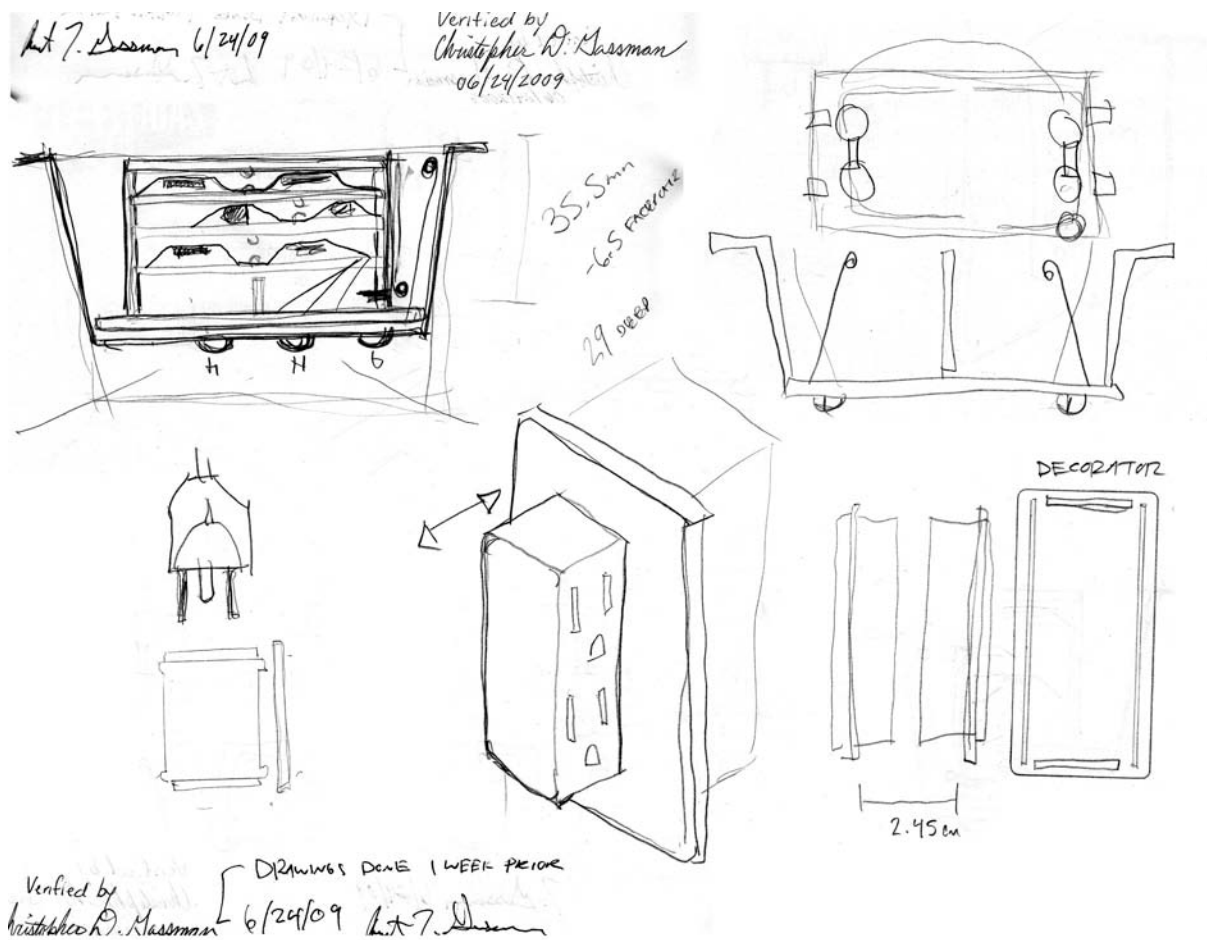


Figure 47: Spring-loaded decorator-shaped multi-outlet receptacle.¹⁰⁷

Experiment 5: This exploration demonstrates a further developed iteration of the invention described in experiment three, which is a two piece faceplate system that renders an entire faceplate as a useable switch. Using physical models, I experiment with the fabrication of this device by testing various functions, proportions, materials, finishes, ergonomics, installation methods, productions costs, and aesthetics (Fig. 48). This device provides a

¹⁰⁶ This product and all iterations thereof are the original ideas and sole property of the owner and inventor, Robert Gassman.

¹⁰⁷ Sketches and ideas by author, 2009.

*breadth of surface finishes including textured surfaces. The resulting product can be produced efficiently using injection molded plastics.*¹⁰⁸



Figure 48: Top- Acrylic pieces cut and assembled to form the secondary safety faceplate and the primary switch plate for this device; Bottom left- Secondary safety faceplate installed over a decorator switch; Bottom right- Primary switch plate snapped in place over the decorator switch and secondary safety faceplate.¹⁰⁹

Experiment 6- This exploration demonstrates a further developed iteration of the invention described in experiment four, which is a spring-loaded decorator-shaped multi-outlet

¹⁰⁸ This product and all iterations thereof are the original ideas and sole property of the owner and inventor, Robert Gassman.

¹⁰⁹ Images and ideas by author, 2009.

receptacle. Using physical models, I experiment with the fabrication of this device by testing various functions, proportions, materials, finishes, ergonomics, installation methods, productions costs, and aesthetics (Fig. 49). The resulting product can be produced efficiently using injection molded plastics.¹¹⁰

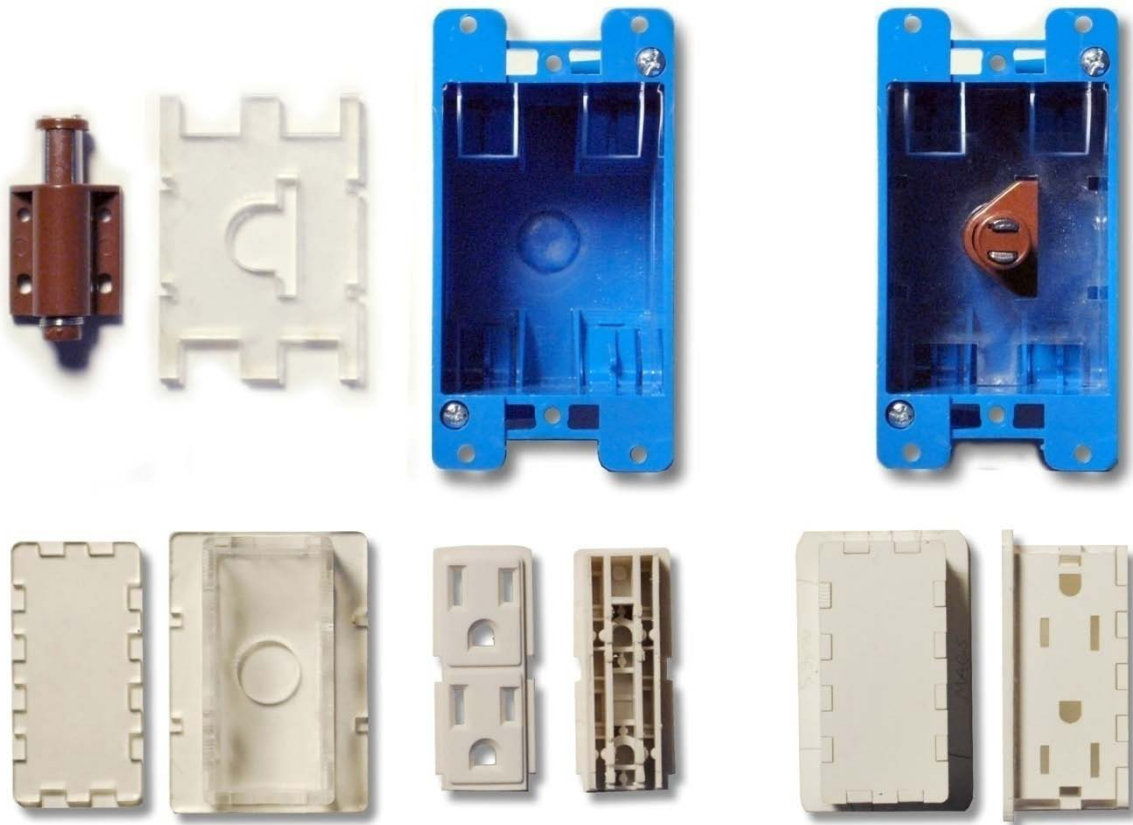


Figure 49: Top- A temporary armature using a magnetic cabinet fastener, acrylic, and standard electrical device box; Bottom- Acrylic pieces cut and assembled to form an iteration of a spring-loaded decorator-shaped multi-outlet receptacle.¹¹¹

Experiment 7- This exploration demonstrates a further developed iteration of the invention described in the previous experiment four, which is a Spring-loaded decorator-shaped multi-outlet receptacle. By testing different plug/ outlet configurations, a solution is derived that can fit a maximum number of plugs in the decorator-shaped outlet box. This system could potentially situate 8 outlets within the given dimension. Demonstrated in this experiment is

¹¹⁰ This product and all iterations thereof are the original ideas and sole property of the owner and inventor, Robert Gassman.

¹¹¹ Images and ideas by author, 2009.

an iteration of an outlet box that safely orients 4 electrical plugs, two on each side of the box (Fig. 50). Each electrical plug is connected to this device parallel to the wall surface that the component is installed. This plug orientation can reduce the risk of bending and damaging plugs and cords attached to the device.¹¹²

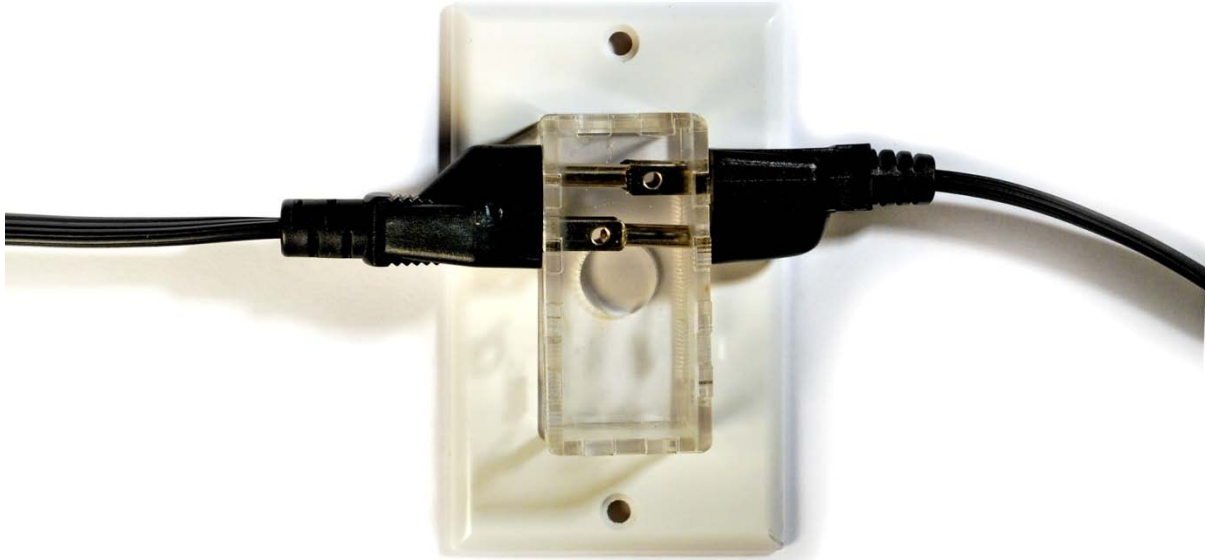


Figure 50: A spring-loaded decorator-shaped multi-outlet receptacle demonstrating an overlapping plug orientation. This orientation safely situates plugs within the electrical outlet box, always maintaining like conductors on a similar plane.¹¹³

Experiment 8- This exploration demonstrates a further developed iteration of the invention described in previous experiment four, which is a Spring-loaded decorator-shaped multi-outlet receptacle. This experiment develops the proper dimensions for this product to work within the existing residential electrical standard. It is important for this device to work within this standard so it can be directly and easily integrated into new and existing electrical systems. This spring-loaded decorator-shaped multi-outlet receptacle works with contemporary standard decorator faceplates and fits within standard electrical device boxes (Fig. 51). By maintaining decorator-style proportions, the device also aesthetically compliments other decorator-style electrical components.¹¹⁴

¹¹² This product and all iterations thereof are the original ideas and sole property of the owner and inventor, Robert Gassman.

¹¹³ Images and ideas by author, 2009.

¹¹⁴ This product and all iterations thereof are the original ideas and sole property of the owner and inventor, Robert Gassman.

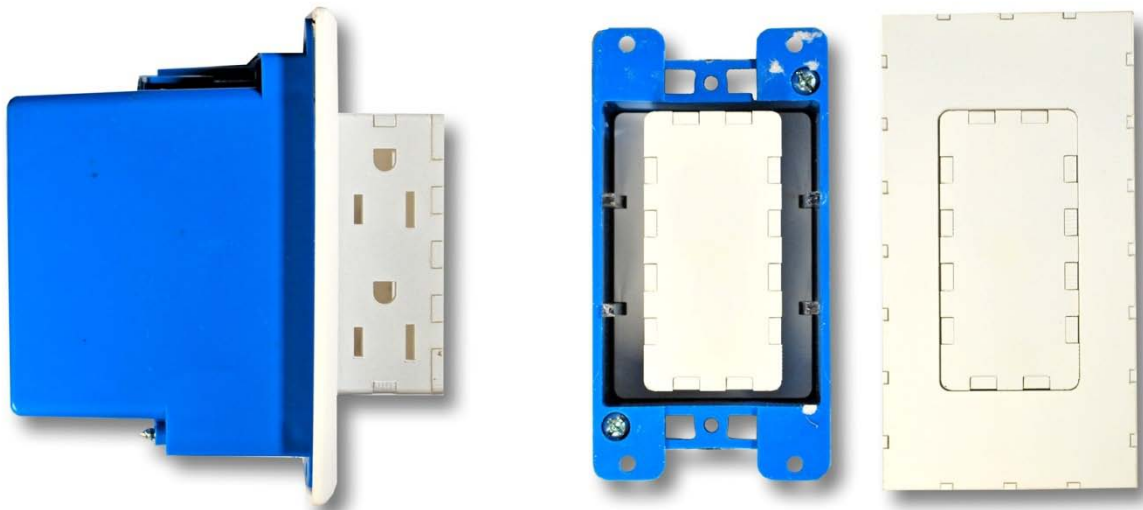


Figure 51: Left and center- A spring-loaded decorator-shaped multi-outlet receptacle within a standard electrical device box; Right- this device interfacing with a decorator-style faceplate.¹¹⁵

Experiment 9- *This exploration demonstrates further developed iterations for the inventions described in experiments three and four, which are a spring-loaded decorator-shaped multi-outlet receptacle and a two piece faceplate system that renders an entire faceplate as a useable switch. Testing these products within a standard residential wall system simulates the practical application of these devices (Fig. 52). This testing reveals positive and negative aspects of these product iterations that may potentially confront a final user. By enhancing positive elements and correcting negative aspects of these devices before their final production, a superior product will result.*¹¹⁶

¹¹⁵ Images and ideas by author, 2009.

¹¹⁶ These products and all iterations thereof are the original ideas and sole property of the owner and inventor, Robert Gassman.

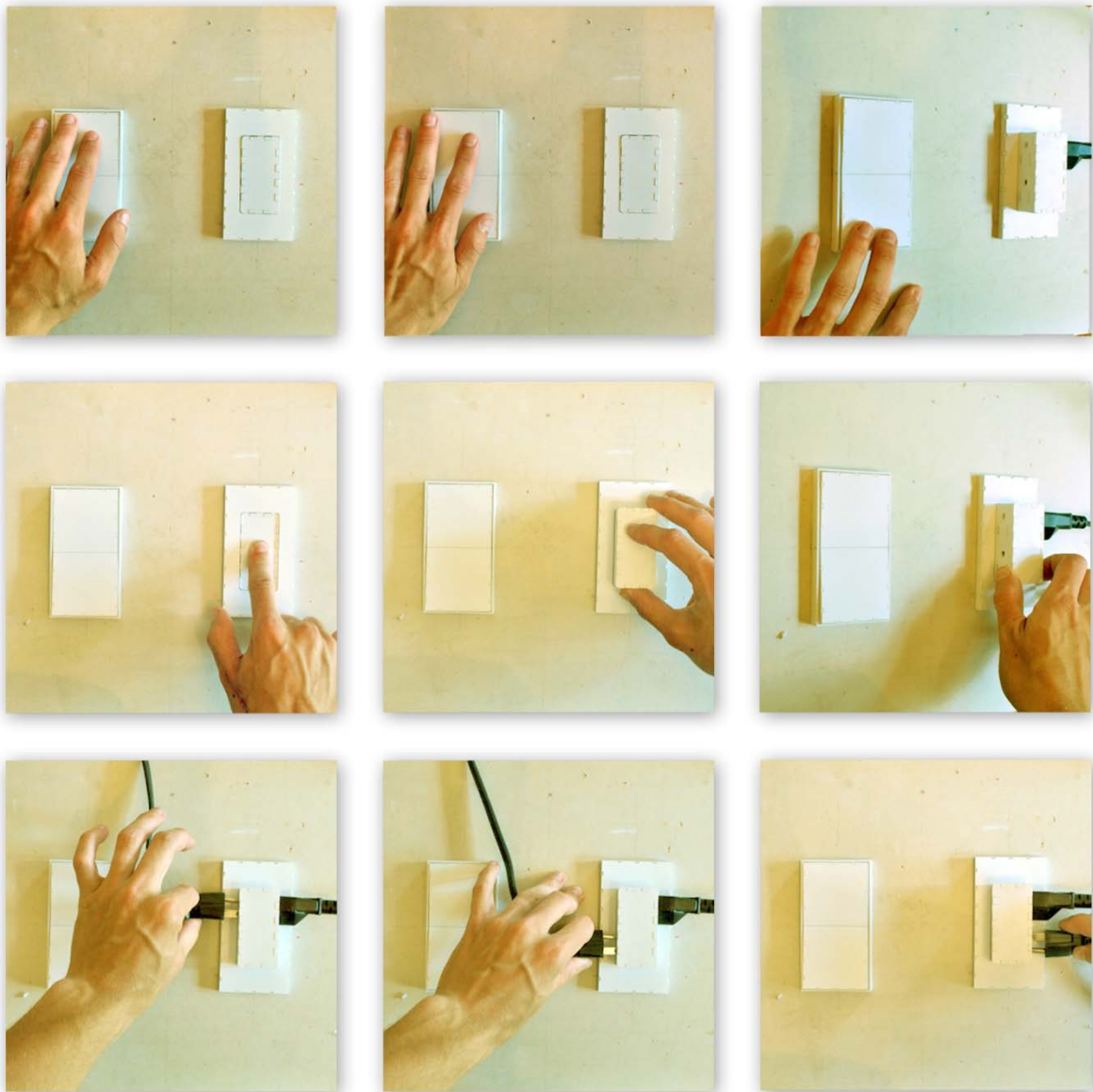


Figure 51: Testing the spring-loaded decorator-shaped multi-outlet receptacle and the two piece faceplate system that renders an entire faceplate as a useable switch while installed in a standard residential wall system.¹¹⁷

¹¹⁷ Images and ideas by author, 2009.

CHAPTER 6

THE RESULTS

This architecturally based thesis has culminated with the conceptualization, design, and production of two incrementally advanced electrical components (Fig. 52). These electrical components have been developed through a scientific method of design by analytically reengineering two critically integral elements of contemporary residential architecture, the single-pole electrical switch and the duplex outlet receptacle. Using a scientific design approach, I scrutinized standard electrical switches and outlet receptacles to reveal an over 100 year history for these components. This examination exposed the slow, century-long evolution that these electrical devices and many other architecturally oriented products have maintained. Through a series of observations, the positive and negative aspects of historic and contemporary electrical switches and outlet receptacles were catalogued and analyzed. This data was then applied to produce hybrid electrical components that offer incrementally superior designs compared to the established electrical standard. By incrementally advancing these architecturally integral electrical components, in turn an incremental advance has also been made within the profession of architecture.

Standard electrical toggle switches and duplex outlet receptacles have been functional products for nearly 100 years and have met the needs of many residential users since their inception. However, within our daily lives we are surrounded by many objects and products that we deem functional. But, why should we settle for products that are just functional, acceptable? Should we not strive for positive human progress? If possible, I feel it is our duty to constantly make better the world which we live. Every great product, invention, idea, person, has room for improvement. I support the incremental advancement of products not for the sake of change, but to provide superior designs that can solve problems and improve life. I offer these new electrical component designs, not as final solutions, but to establish a new foundation for future designers to improve upon. I advocate a scientific life, always in the pursuit of knowledge and answers. How can I make life better? If we dare to question the

world around us and collaborate with each other, we can incrementally improve our own lives and the lives of others.

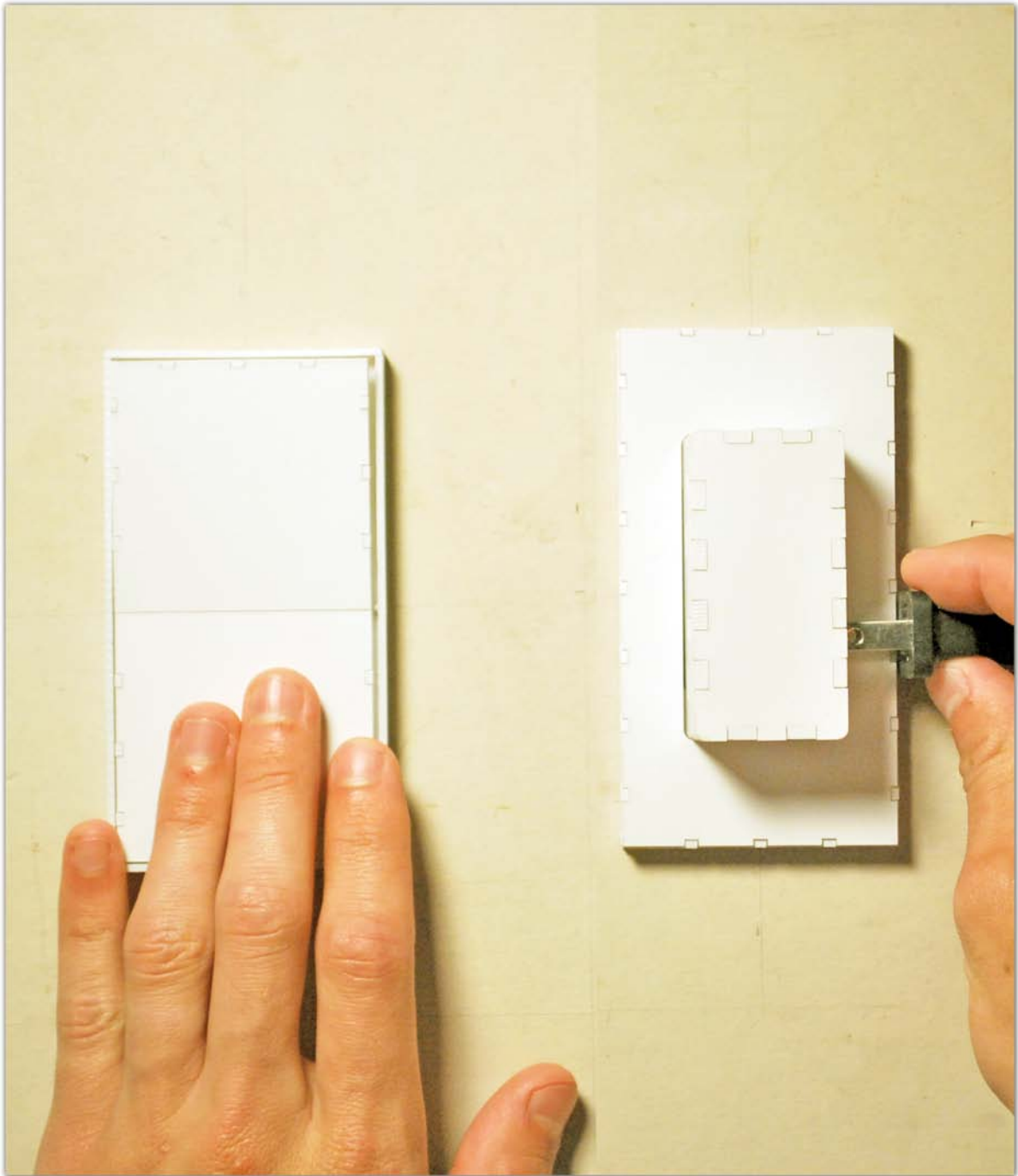


Figure 52: The results.¹¹⁸

¹¹⁸ Image by author, 2009.

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