

CPE/EE 322
Engineering Design VI
Lesson 2: Needs Assessment

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Outline

1. Establishing need
2. Service to humanity
3. Types of problems: prediction, explanation, and invention
4. Focusing on others: the key to success
5. The design proposal

Objectives

[G. Volland, Engineering by Design, Chapter 2](#)

- Recognize the needs to justify an engineering [problem-solving](#) effort
- Discuss the ways in which the need for a design may develop
- Classify problems in distinct categories of prediction, explanation, and invention, or some combination thereof
- Recognize the hazards associated with focusing on oneself and not on the needs of others
- Prepare a design proposal that justifies the need to develop a technical solution to a problem

Lab 2 — Command Line

- Go to the IoT [repository](https://github.com/kevinwlu/iot.git)
- Study Lessons 1 and 2
- Open a terminal

```
$ hostname
```

```
$ env
```

```
$ ps
```

```
$ pwd
```

```
$ git clone
```

```
https://github.com/kevin
```

```
wlu/iot.git
```

```
$ cd iot
```

```
$ ls
```

```
$ cd
```

```
$ df
```

```
$ mkdir demo
```

```
$ cd demo
```

```
$ nano file
```

```
$ cat file
```

```
$ cp file file1
```

```
$ mv file file2
```

```
$ rm file2
```

```
$ clear
```

```
$ man uname
```

```
$ uname -a
```

```
$ ifconfig
```

```
$ ping localhost
```

```
$ netstat
```

Assignment 2 — Needs Assessment

Group Assignment

- Identify needs that justify an electrical and computer engineering problem-solving effort
- Start preparing a design proposal that justifies the need to develop a technical solution to a problem

Program Outcome 5: (Teaming and Leadership)

5.2 (Teamwork) Students will participate in a modest-sized team to develop initial ideas into a full project, with the final objectives of the team evolving from the collaboration rather than being defined a-priori.

Establishing Need

- Safety and quality of life
- Improving an existing product or system to
 - Eliminate shortcomings in the original design or fabrication by incorporating new technology and manufacturing methods
 - Better serve the changing needs of the user populations
 - Increase the commercial viability of the product by responding to competition in the marketplace
 - Reduce costs
- New products driven by commercial incentives
- Personal experiences
- Opportunities from scientific advances

Vending Machines and the IoT



References

[Internet Coke Machine](#)

[The little-known story of the first IoT device](#)

[A prancing pony provides nourishment](#)

[John Ronald Reuel Tolkien](#) 1892—1973

- In the 1970s, the Stanford Artificial Intelligence Laboratory ([SAIL](#)) connected a computer to manage a [Canteen](#) vending machine at the "[Prancing Pony](#)" kitchen (see [Bree](#))
- In 1982, a group of computer science students at the Carnegie Mellon University installed micro-switches in a [Coke Machine](#) to sense *how many* bottles were present in each of its six columns of bottles, and wrote a server program to keep track on *how long* each bottle had been in the machine, allowing the [Finger](#) command to check the status

Lipsticks and the IoT

[Meet Kevin Ashton, Father of the Internet of Things](#)



- [Kevin Ashton](#) got assigned to help launch a line of cosmetics for Oil of Olay at Procter & Gamble ([P&G](#)) in London, and found that one shade of lipstick always seemed to be sold out at his local store
- Driving in traffic, he thought that there had to be a more thorough way to track products, and what if one took the radio microchip out of the credit card and stuck it on a lipstick
- Made a presentation titled "[the Internet of Things](#) (IoT)" about using [RFID](#) to help manage supply chain at P&G in 1999
- "The way innovation really happens is less by magic and genius than by a lot of small steps and bits of luck"

Service to Humanity

- Engineers usually focus on society's most basic physical needs such as food, shelter, heat, health care, and communication
- Engineers must work closely with many people from potential customers to fellow engineers, marketing specialists, financial advisors, field and factory workers, stylists, technicians, manager, and others who will contribute to the development of a successful design solution
- Engineering is a people-oriented and people-rich profession
- Engineers are focused on the needs of others whom they serve



Three Basic Types of Problems



[Sidney Parnes](#) 1922—2013, President (1967—1984) of the Creative Education Foundation ([CEF](#)), defined three basic types of problems in 1967

- **Problems of prediction**
Calculate a result or predict system behavior by applying equations, physical laws, tools of data analysis, *etc.*
- **Problems of explanation**
Seek the causes for a phenomenon or observed behavior
- **Problems of invention**
Develop a new and effective solution to a problem

Engineers should consider if a problem is a combination of these problem types

Focusing on Others: the Key to Success

A focus on self can lead to poor decision making; engineers should focus on others (in particular, the expected users of the design) to reduce the likelihood of a design error at any or all of three different levels

- Concrete level
Specific physical sources identified as contributing causes of the failure
- Process level
Invalid assumptions, faulty reasoning, or the flawed execution of a procedure led to the failure
- Values/attitudes/perspective level
A flawed value system contributes to the failure

Engineering code of ethics provide professional guidelines for responsible behavior, and responsibility is the ability to respond to other people's needs

Design Proposal

A design proposal should answer the following questions that can be used to structure the proposal

1. Objective (why?)
2. Background (who? where?)
3. Methodology (how? when?)
4. Expected results (what?)
5. Costs (how much will it cost?)

The design proposal is a plan that should be concise yet complete

The Heilmeier Catechism

<http://www.darpa.mil/work-with-us/heilmeier-catechism>

- What are you trying to do? Articulate your objectives using absolutely no [jargon](#).
- How is it done today, and what are the limits of current practice?
- What's new in your approach and why do you think it will be successful?
- Who cares?
- If you're successful, what difference will it make?
- What are the risks and the payoffs?
- How much will it cost?
- How long will it take?
- What are the midterm and final exams to check for success?

George Heilmeier 1936—2014

https://en.wikipedia.org/wiki/George_H._Heilmeier

1958—1970: [RCA](#) Labs in Princeton, New Jersey

1964: Discovered new electro-optic effects in liquid crystals that led to the first working liquid-crystal displays ([LCDs](#))

1975—1977: As Director of the Defense Advanced Research Projects Agency ([DARPA](#)), initiated major efforts including artificial intelligence

1977—1990: VP / CTO, TI

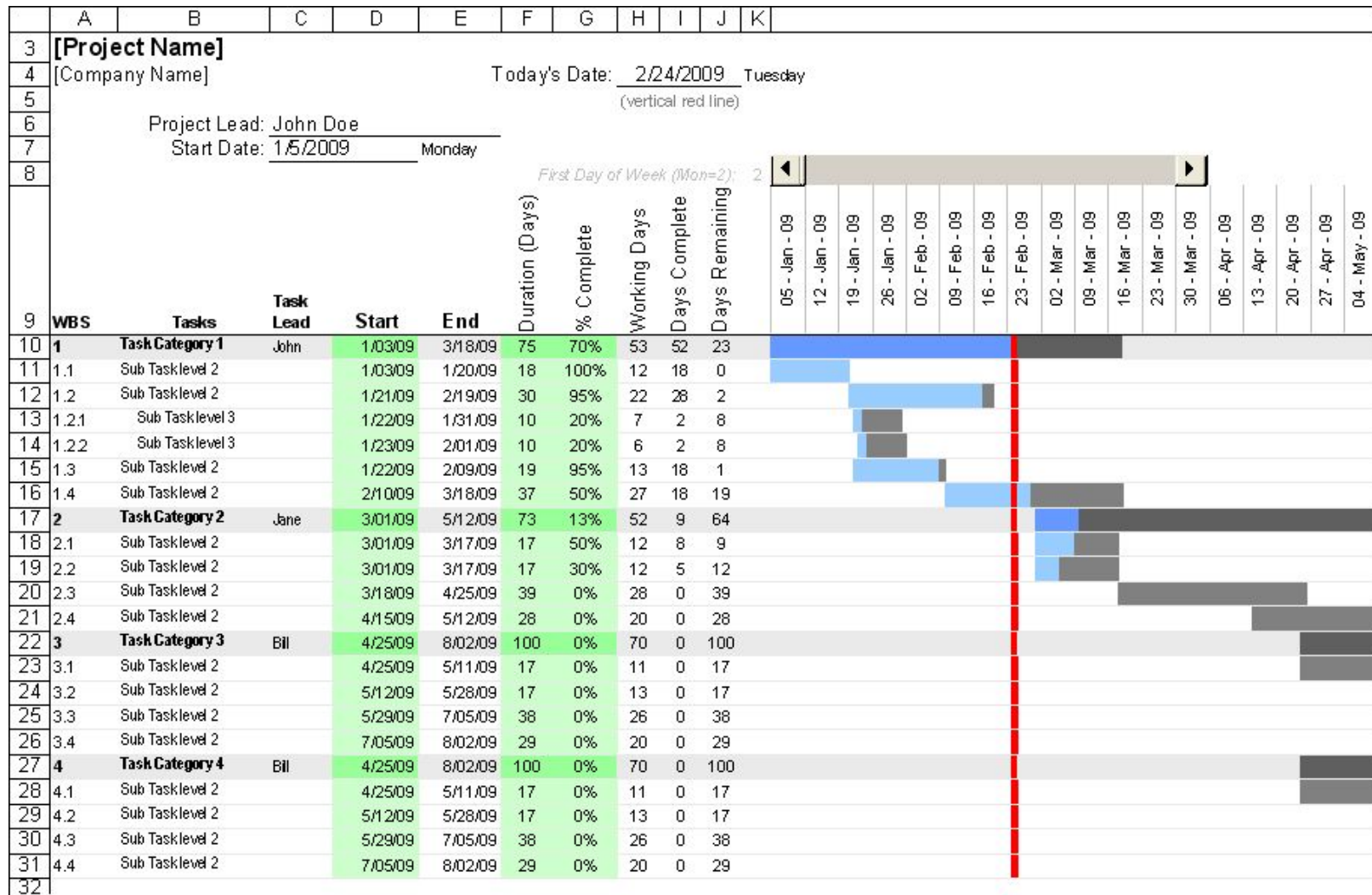
1991—1997: President and CEO of Bellcore/[Telcordia](#)



Business Case Template

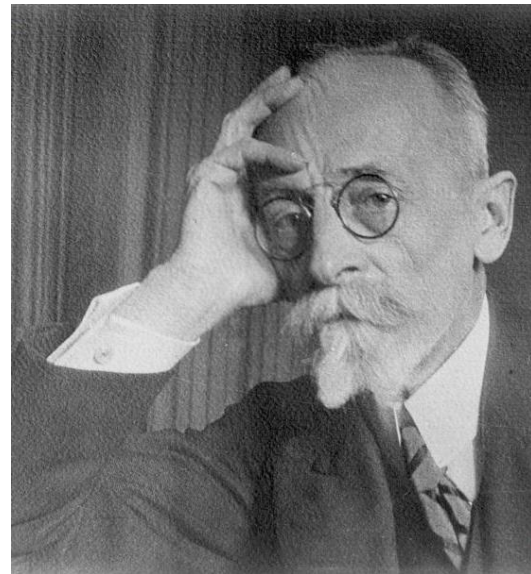
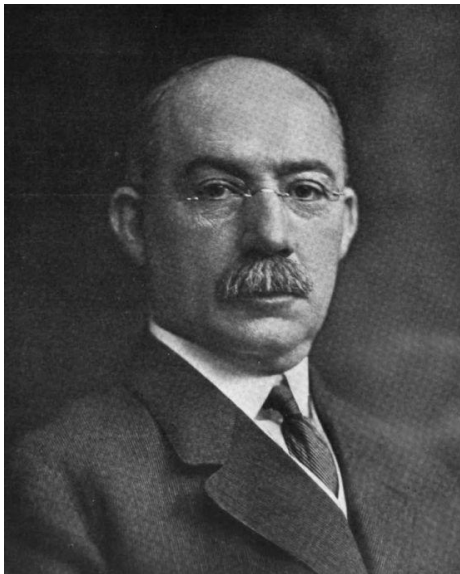
- **Needs:** establish a sense of urgency for the opportunity or solution, and what's causing the problem
- **Scope:** help [stakeholders](#) understand the scope of the proposed project
- [Schedule](#): lay out a high-level plan for implementing the project
- **Impact:** Highlight the benefits of the project
- **Risks:** Highlight the key risks to the project
- **Financials:** Summarize the costs and return on investment (ROI) of the project
- **Recommendations:** Restate the key points

Work Breakdown Structure (WBS) and Gantt Chart



Henry Gantt and Karol Adamiecki

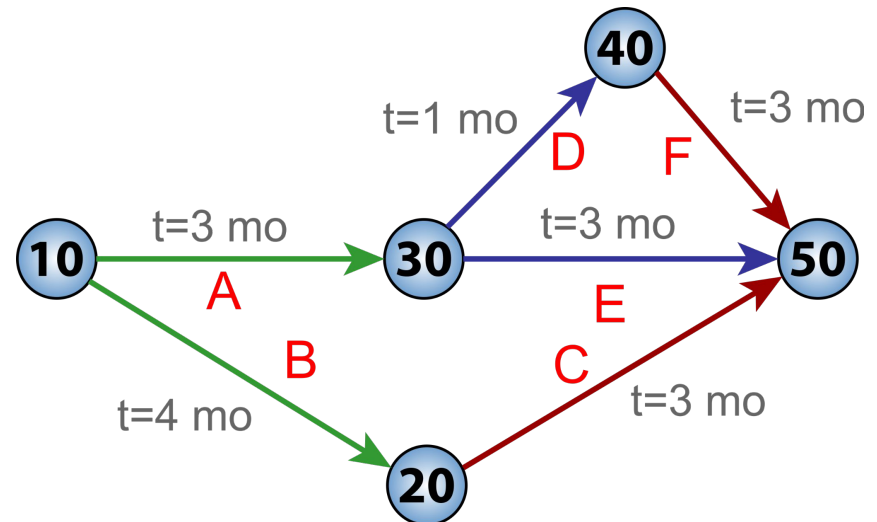
- [Henry Gantt](#) 1861—1919 designed his charts in 1910 to 1915
- M.Eng. in mechanical engineering, Stevens, 1885
- [Karol Adamiecki](#) 1866—1933 developed [Harmonograms](#) in 1896
- Published his work in Polish and Russian



PERT and CPM

- The program (or project) evaluation and review technique ([PERT](#)) is a statistical tool used in project management, which was designed to analyze and represent the tasks involved in completing a given project
- First developed by the United States Navy in 1958, it is commonly used in conjunction with the critical path method ([CPM](#)) that was introduced in 1957

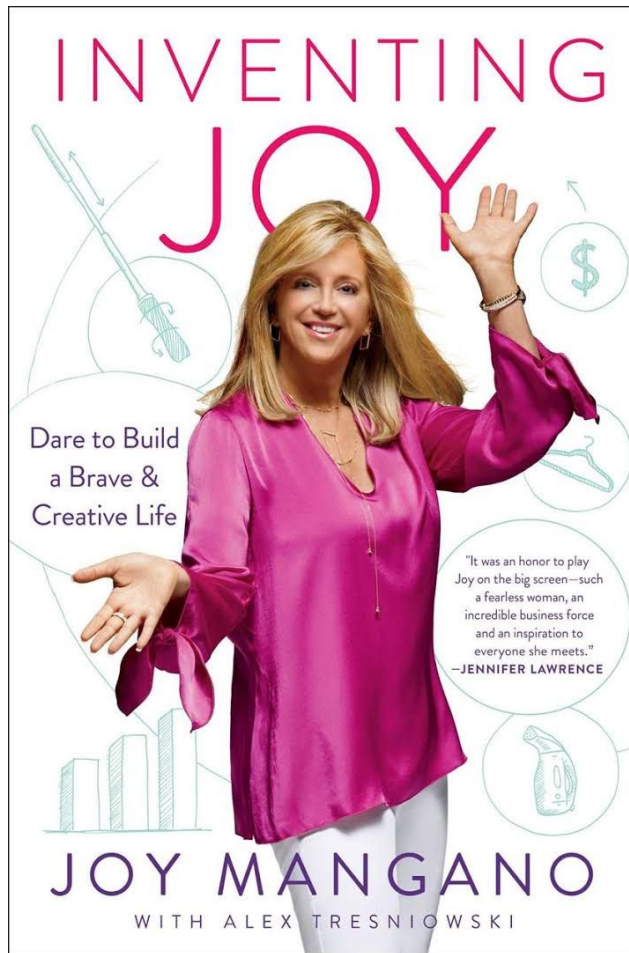
PERT network chart for a seven-month project with five milestones (10 through 50) and six activities (A through F)



Lesson 2 Summary

- Engineering designs are intended to satisfy human needs
- Technical problems can be classified into three basic categories: problems of prediction, problems of explanation, and problems of invention (or some combination thereof)
- Success is more likely if one focuses on others and not on oneself
- Design proposals provide the engineer with the opportunity to justify the expenditure of time, money, and effort for a problem-solving project, and to generate an initial plan for completing the project

We All Have Similar Needs

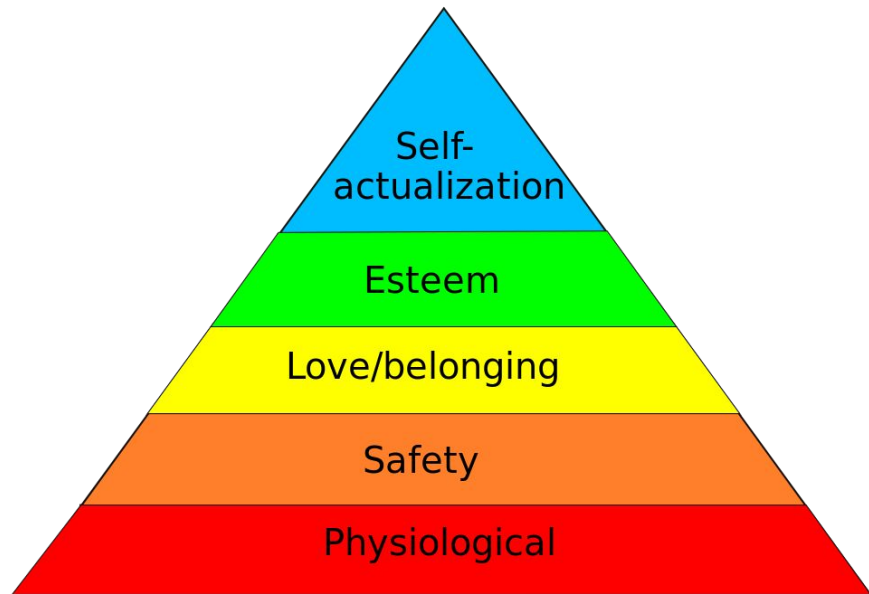


- [Joy Mangano](#) holds more than 100 patents for her inventions
- "I think my products have been successful because they have mass appeal."
- "I'm just like everybody else out there. I'm a mom, I work, I have a house to clean, things to organize. We all have similar needs, and I address them."

Abraham Maslow 1908—1970



- [Abraham Maslow](#) was an American psychologist who created [Maslow's hierarchy of needs](#), a theory of psychological health predicated on fulfilling innate human needs in priority, culminating in [self-actualization](#)



The Haves and the Have-Nots

"There are only two families in the world, the Haves and the Have-Nots." [*Don Quixote*](#), Part II (1615), Book III, Chapter 19 by [Miguel de Cervantes](#) 1547—1616



- [Jean-François Millet](#) 1814—1875 completed [The Gleaners](#) in 1857 (the [Musée d'Orsay](#) in Paris)
- It depicts three peasant women gleaning a field of stray stalks of wheat after the harvest in the sunlit distance beyond
- With unsettling [irony](#), the painting illustrated a realistic view of poverty and the [working class](#)

Sources and Contributions

[CONFIER, c'est quelquefois livrer](#) (*Les Misérables*, Volume I, Book IV)

- [Victor Hugo](#) 1802—1885 wrote abundantly in an exceptional variety of [genres](#)
- His work touched upon most of the political and social issues and the artistic trends of his time
- He drew his inspiration from everything he heard and saw, writing it down in his diary
- His [Les Misérables](#) was first published in 1862 with 2783 pages and 655 478 French words in five volumes for a total of 48 books and 365 short chapters of a few pages
- More than a quarter of the novel digresses to essays that argue a moral point or display his encyclopedic knowledge but do not advance the plot, nor even a subplot
- He explained the work's overarching structure as "The starting point: matter, destination: the soul"



Carbon Neutrality

- [Carbon neutrality](#) refers to achieving net zero carbon dioxide emissions associated with transportation, energy production, agriculture, and industrial processes by balancing those with removal (often through [carbon offset](#)) or simply eliminating those altogether (the transition to the "post-carbon economy")
- A [carbon footprint](#) also includes other [greenhouse gases](#) (GHGs), usually carbon-based, measured in terms of their carbon dioxide equivalence
- The term climate neutral reflects the broader inclusiveness of other greenhouse gases in [climate change](#), even if carbon dioxide is the most abundant
- The term "net zero" is increasingly used to describe a broader more comprehensive commitment to decarbonization and climate action, moving beyond carbon neutrality by including more activities under the scope of indirect emissions (e.g., from the generation of purchased electricity, steam, and heating/cooling; or caused by vendors within the supply chain, outsourced activities, and employee travel and commute), and often including a science-based target on emissions reduction, as opposed to relying solely on offsetting

Matchstick Puzzle

Move one matchstick to fix this equation



A matchstick puzzle equation: 96 - 78 = 1. The digits are constructed from matchsticks: 9 (6 sticks), 6 (6 sticks), - (1 stick), 7 (5 sticks), 8 (7 sticks), = (2 sticks), and 1 (1 stick). The total number of matchsticks is 29.

Blowers — Dust, Fume, and Noise



People-First Language

- [People-first language](#) (PFL) is an objective and respectful way to speak about people with disabilities and AFN (access and functional needs) by emphasizing the person first, rather than the disability, e.g., "a person with diabetes" or "a person with alcoholism" instead of "a diabetic" or "an alcoholic"
- [Americans with Disabilities Act](#) (ADA) was signed into law on 1990-07-26, and amended on 2008-09-25
 - Title I — employment
 - Title II — public entities (and public transportation)
 - Title III — public accommodations (and commercial facilities)
 - Title IV — telecommunications
 - Title V — miscellaneous provisions
- Beginning on 2011-03-15, only dogs are recognized as [service animals](#) under ADA titles II and III

Web Accessibility

- In 1998, the U.S. Congress amended [Section 508](#) of the Rehabilitation Act of 1973 to require Federal agencies to make their electronic and information technology accessible to people with disabilities
- [Web accessibility](#) refers to the inclusive practice of removing barriers that prevent interaction with, or access to websites, by people with disabilities including
 - Visual impairments: blindness, low vision, poor eyesight, and [color blindness](#)
 - Motor/mobility: difficulty or inability to use the hands from conditions such as Parkinson's Disease, muscular [dystrophy](#), cerebral [palsy](#), and stroke
 - Auditory: deafness or hearing impairments
 - Seizures: photo-[epileptic](#) seizures caused by visual strobe or flashing effects
 - Cognitive/Intellectual: developmental disabilities, learning disabilities ([dyslexia](#), [dyscalculia](#), *etc.*), and cognitive disabilities of various origins, affecting memory, attention, developmental "maturity," problem-solving and logic skills, *etc.*
- [Web accessibility evaluation tools list](#)

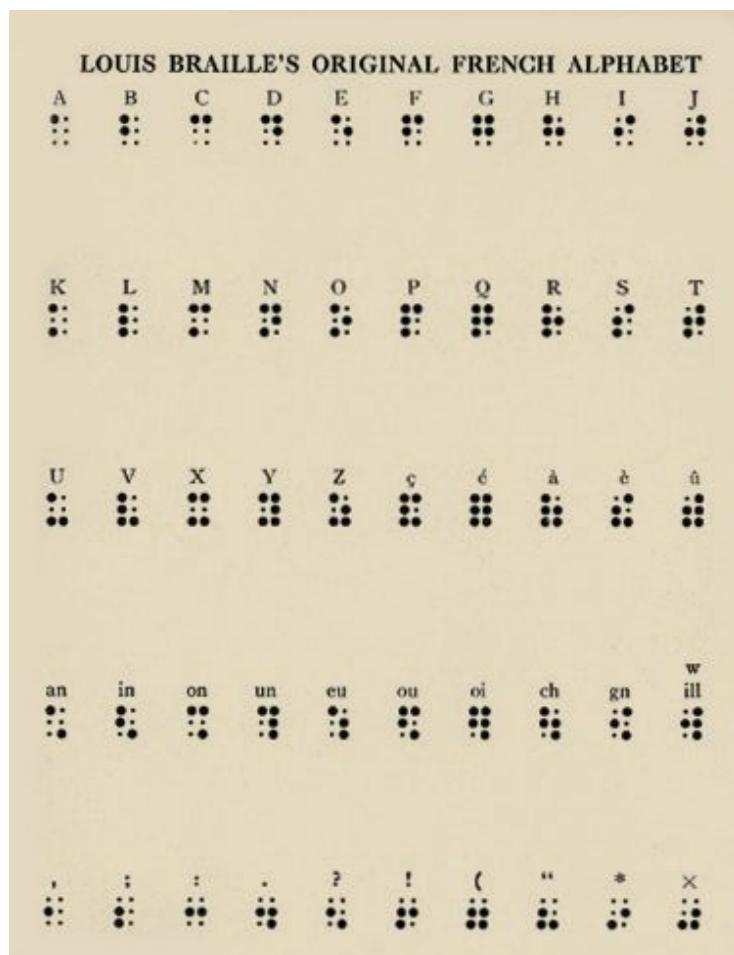
WCAG

- The Web Content Accessibility Guidelines ([WCAG](#)) are part of a series of web accessibility guidelines published by the Web Accessibility Initiative ([WAI](#)) of the World Wide Web Consortium ([W3C](#)), the main international standards organization for the internet
- The guidelines specify how to make content accessible, primarily for people with disabilities—but also for all user agents, including highly limited devices, such as mobile phones
- The current version, WCAG 2.0, was published in December 2008 and became an ISO standard, [ISO/IEC 40500:2012](#) in October 2012

Web Access Assistive Technologies

- [Screen reader](#) software that can read out, using synthesized speech, either selected elements of what is being displayed on the monitor (helpful for users with reading or learning difficulties), or which can read out everything that is happening on the computer (used by blind and vision impaired users), e.g., [alt attribute](#)
- Braille terminals, consisting of a refreshable braille display which renders text as [braille](#) characters (usually by means of raising pegs through holes in a flat surface) and either a mainstream keyboard or a braille keyboard
- Screen magnification software, which enlarges what is displayed on the computer monitor, making it easier to read for vision impaired users
- Speech recognition software that can accept spoken commands to the computer, or turn dictation into grammatically correct text — useful for those who have difficulty using a mouse or a keyboard
- Keyboard overlays that can make typing easier or more accurate for those who have motor control difficulties
- Access to subtitled or sign language videos for deaf people

Louis Braille 1809—1852



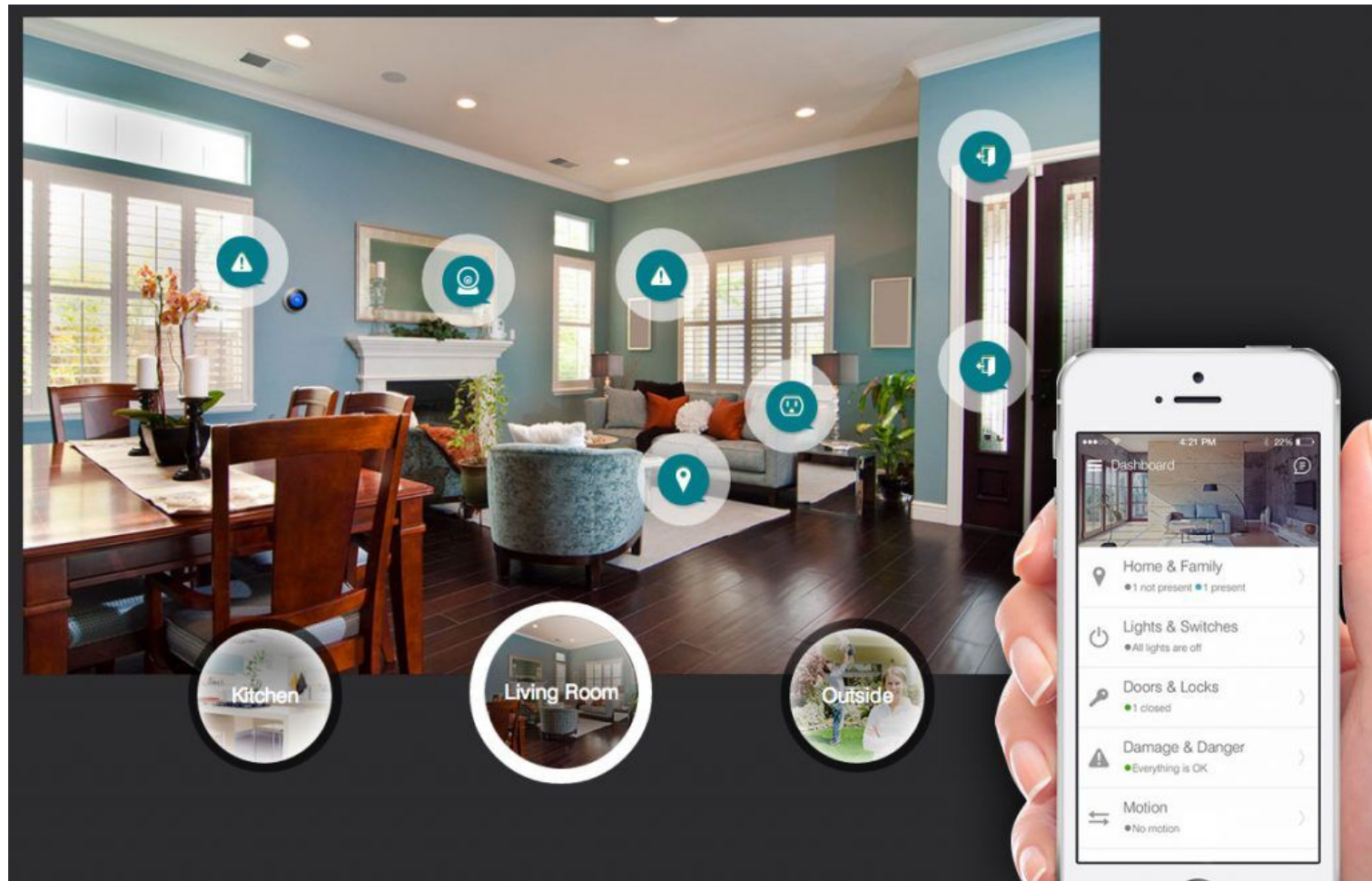
- In 1819, [Louis Braille](#) attended L'Institut National des Jeunes Aveugles ([INJA](#)) in Paris and later taught there
- While still a student, he began developing a system of tactile code that could allow blind people to read and write quickly and efficiently
- He presented his work to his peers for the first time in 1824
- [INJA](#) adopted the [Braille](#) system in 1854, two years after his death
- Braille was adopted by schools for the blind in the U.S. in 1916, and a universal braille code for English was formalized in 1932

Universal Design for Learning

- Recognizing that the way individuals learn can be unique, the [Universal Design for Learning](#) (UDL) framework, first defined by [David H. Rose](#), Ed.D. of the Harvard Graduate School of Education and the Center for Applied Special Technology ([CAST](#)) in the 1990s, calls for creating curriculum from the outset that provides
 - Multiple means of representation to give learners various ways of acquiring information and knowledge
 - Multiple means of expression to provide learners alternatives for demonstrating what they know
 - Multiple means of engagement to tap into learners' interests, challenge them appropriately, and motivate them to learn
- Curriculum, as defined in the UDL literature, has four parts: instructional goals, methods, materials, and assessments
- UDL is intended to increase access to learning by reducing physical, cognitive, intellectual, and organizational barriers to learning, as well as other obstacles

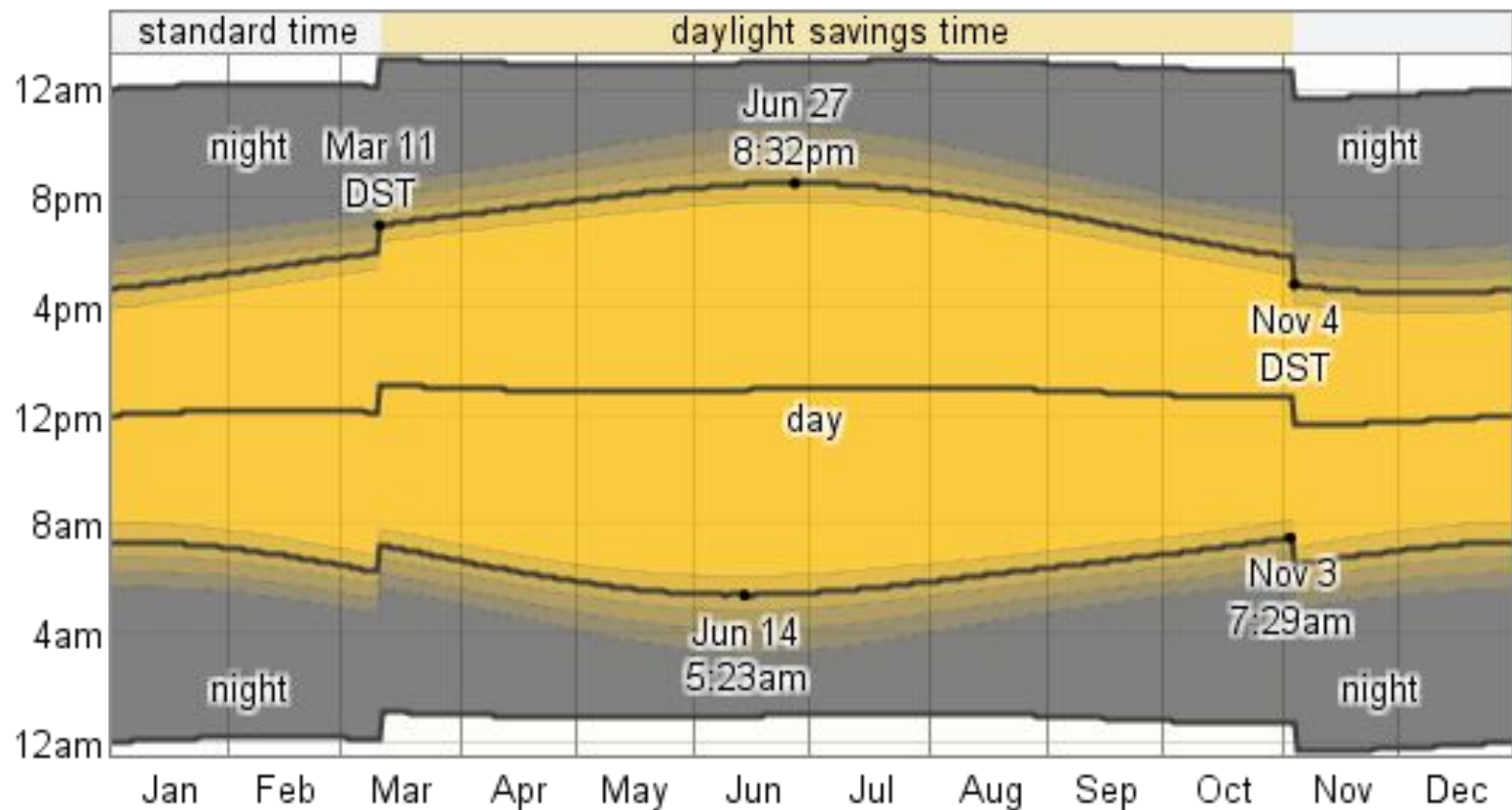
Connected Home

[Iris](#), [SmartThings](#), [Wink](#), etc.



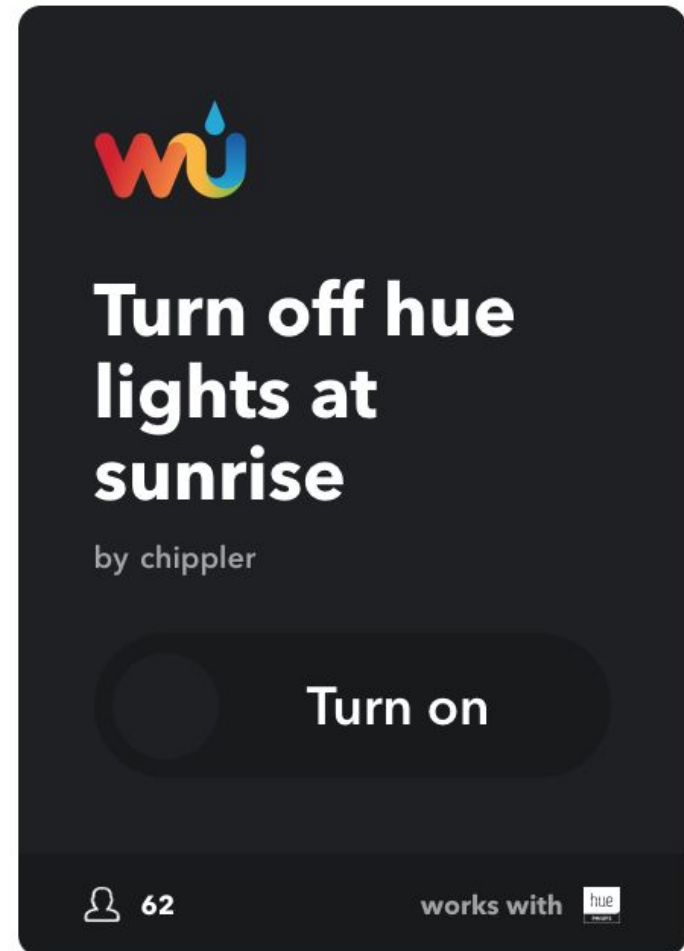
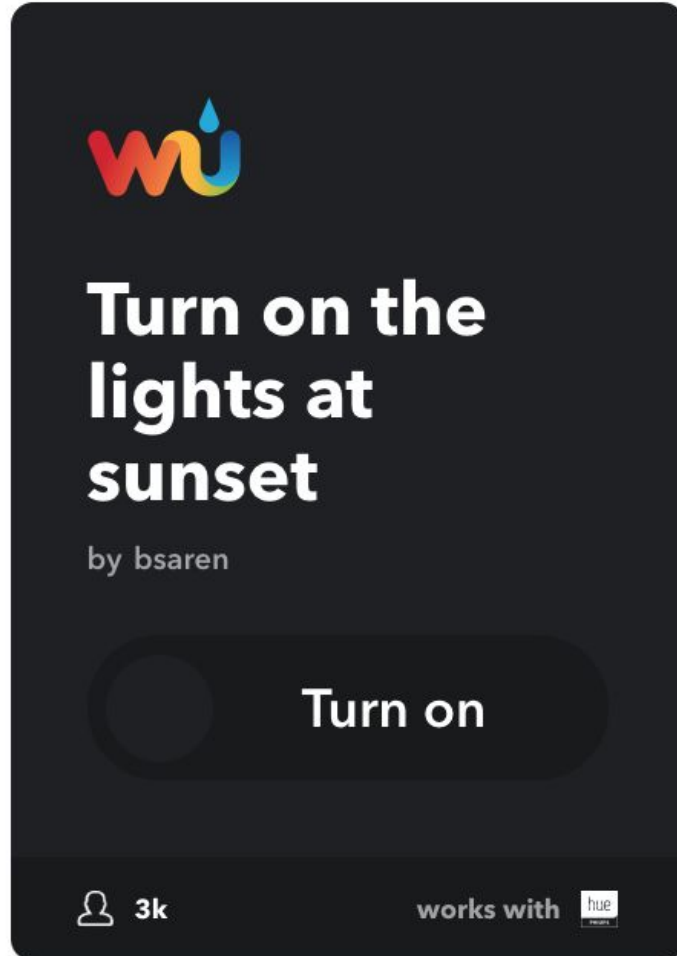
Daily Sunrise/Sunset Time (2012)

<https://weatherspark.com/averages/31081/New-York-United-States>



Weather Underground Applets

<https://ifttt.com/discover>



Connected Vehicles

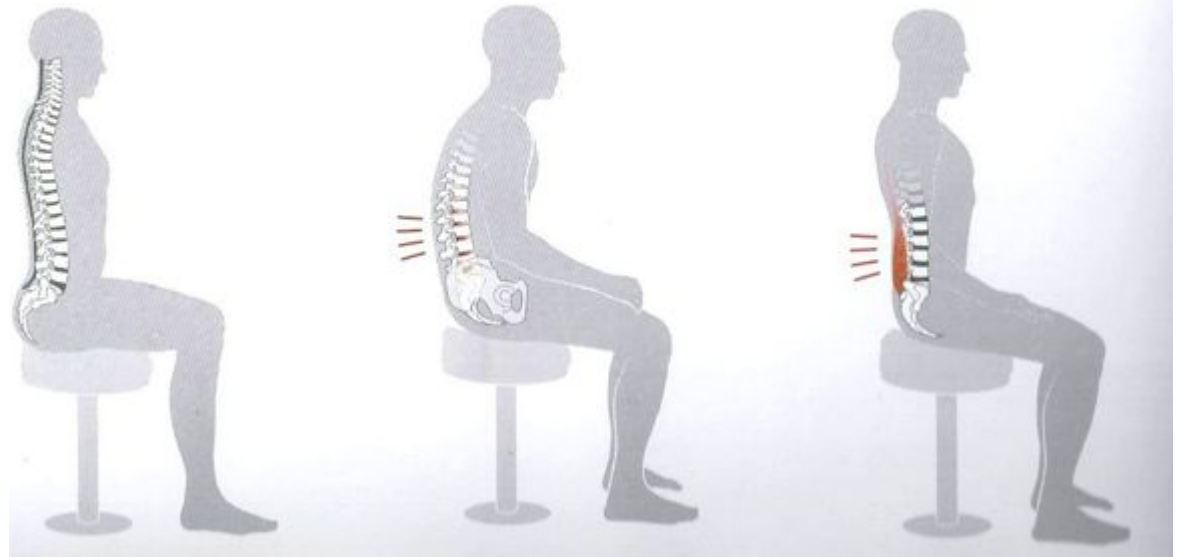
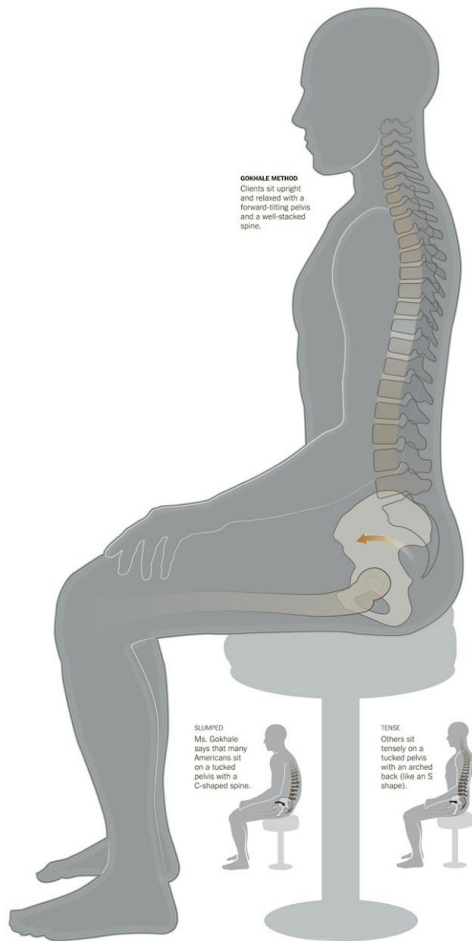
[Automatic](#), [Delphi](#), [Mojio](#), TomTom [CURFER](#), etc.



Postural Awareness

The [Gokhale Method](#) developed by [Esther Gokhale](#) emphasizes a upright and relaxed posture on a forward-tilting pelvis with a well-stacked J-shaped spine as opposed to a tucked pelvis with

- A slumped C-shaped spine
- An arched S-shaped spine



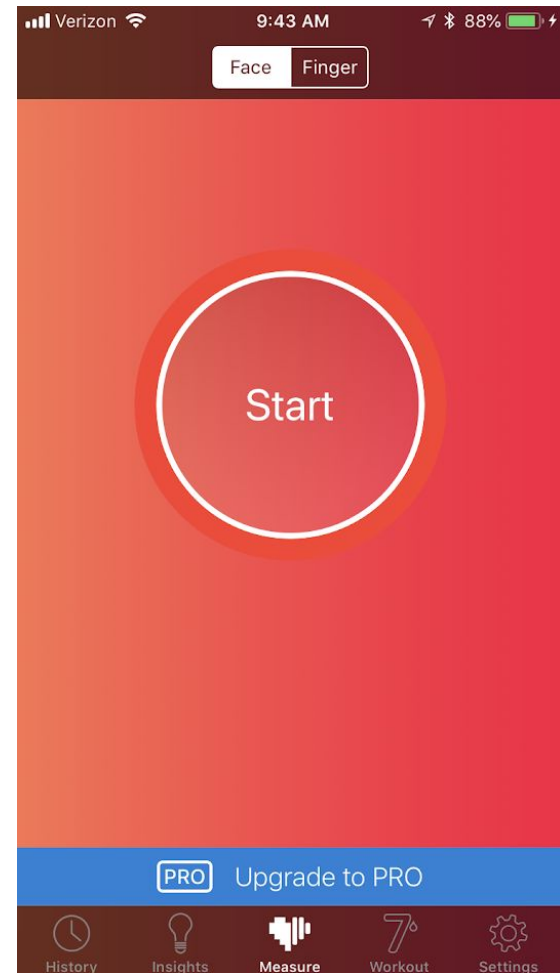
Posture and Activity Trackers

UPRIGHT



Heart Health Monitors

[Azumio](#), [Cardio](#), [Qardio](#), [Runtastic](#)



Smart Thermometers

[Kinsa](#), [Nokia Thermo](#)

