

Data Visualization Essay

PROJECT MANAGEMENT VISUALIZATION

Colin Murphy | Interactive Data Visualization | 18/03/2018 | R00011057

Introduction

Data visualization is the approach that humans use to perceive information and obtain meaning from visuals. This is a process that is used to convey information succinctly and simply to aid the interpretation of data. In simple terms it communicates a narrative or information in an as efficient manner as possible using some form of visual methodology. Visualization leverages the idea behind the adage *a picture is worth a thousand words*; this idea is backed up in the book written by (Card, MacKinlay, & Shneiderman, 1998) that states “visual and manipulative use of external world amplifies cognitive performance ... and the visual representation, by holding partial results outside the mind, extends the persons working memory”. Visualization utilizes a user’s visual system and their inherent ability to recognize and understand different structures and patterns, which overcomes limitations in our attention and memory systems. This links to one of the 10 heuristics by (Nielsen, 1998) “recognition rather than recall”. This means that a user should be able to recognize what the visual is trying to convey rather needing to learn and remember new meaning.

Visuals allow all the information to be displayed at once, meaning that users aren’t required to keep complicated and numerous figures in their mind as with a table or list of information where the user must remember value **a** to compare it to **b** and remember **b** value to compare it to **c** and so on. One of the strengths of visuals is it presents that data and allows comparison based on a visual clue e.g. is **a** value bar bigger than **b** and **c** value and so on.

Mapping the data and visual to reflect real world expectations increases the ability for the information to be understood and the effectiveness of the visualization. A big step in the visualization process is to take the data and find the best method to translate and represent it.

This is done by representing the data using shapes, size, colour, text, position to display information or insight to the user. These elements allow the visual to impart some information that is of importance to a user or organization. Visualization allows

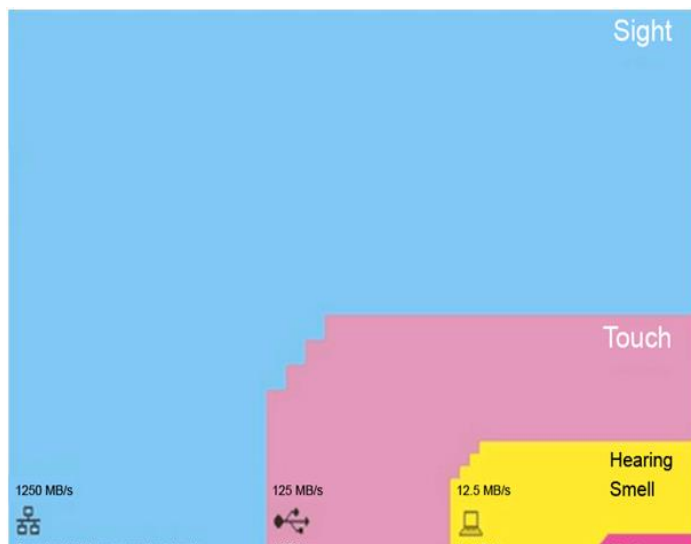


Figure 1 Bandwidth of our senses by Tor Norretranders

for the dissemination of complex data by condensing the information into a compact and easy to understand images.

To illustrate the power of visualization and our visual processing system Tor Norretranders represent visually the bandwidth of human senses by strength comparative to a computer, which is shown above. (Hasanov, 2015) Another study by University of Pennsylvania found that the “*human retina would transmit data at roughly the rate of an Ethernet connection, or 10 million bits per second*” (Medicine, 2006). The sheer volume of information transmitted by our visual senses highlights just how important our sight is and shows how strongly humans depend on visuals. From a psychology standpoint visualization aids in the identifying of patterns and information that may not have been obvious from viewing a table or a list of statistical figures.

Visualization and Project Management.

Project management is the creating, planning, executing and controlling of a project. Visualization contributes to this process by providing a tool to help in the decision-making process. It does this through displaying of data on the project and helping users analyze the health of a project. This allows an organization to view trends and the progress for a project, a team or even an individual. With this data at hand in a simple and easy to understand manner, organizations can make time-efficient, strategic decisions to benefit the running of the organization. Data visualization allows for the exploration of data in a more user-friendly form and opens the possibility of filtering and analysis of data in new ways.

One of the most common and widely used methods of evaluating projects is the Iron Triangle which lists out the constraints or measures of a project in terms cost, time and scope. These constraints are taken at the end of a milestone or the project conclusion, and the data can be measured against a list of expected outcomes set down at the planning phase during the project’s inception. The Iron Triangle can sometimes be augmented with another triangle of quality, risk and resources but this is limited in scope and be mapped back to the original three criteria: quality – scope, risk – time and resources – cost. These criteria are then measure by using techniques like Kanban, CPM, PERT, burndown etc.

Visualization has a positive effect on project management which can be seen in its wide scale adoption by organizations in the form of business intelligence dashboards, infographics, graphs and other visualization techniques. Data visualization accommodates immediate user engagement as it lowers the barrier of

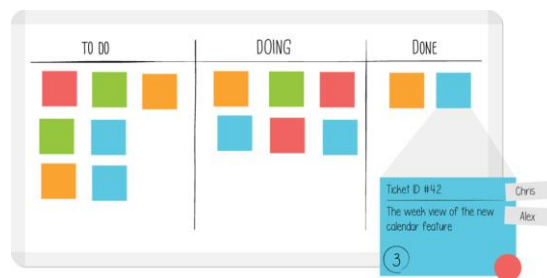
understanding, which can raise the likelihood of them having higher involvement in the system and with the data being displayed. The idea is that visualization should tell a story or idea based on what the developer needs to communicate without compromising the integrity of the data itself. The author of the data visual needs to avoid confirmation bias which is presented in the idea behind the saying “there are three kinds of lies: lies, damned lies, and statistics” by Benjamin Disraeli. If the data is manipulated or malformed in any way so that it becomes deceptive, it becomes useless at best but in project management context it could prove to be damaging. It could cause poor decisions to be made, compounding a minor misdirection into more serious ramifications. It could also be used to mislead managers or directors to believe a project is doing far better than it is.

The second consequence could be a non-malleolus side-effect from lack of testing and validation of the data. Any visualization used by an organization must be put through a rigorous testing process to ensure the integrity of the data. The data visualization should be validated to see whether the conclusion that are derived from the visualization are valid or match the expected outcomes of a predetermined scenario.

Visualization technique

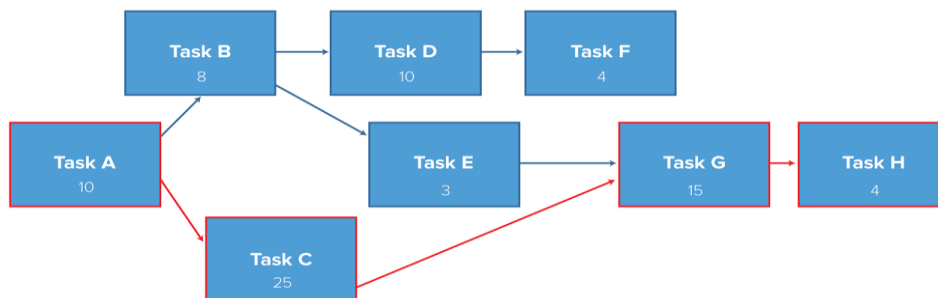
There are four commonly used visualization techniques within project management: Kanban, Critical path method, Gantt and Burndown.

Kanban in terms of visualization is similar in concept to having card or post-it notes where a task title, description and an estimated amount of time are displayed. A compendium of these tasks that are required for the completion of the project is derived. This technique is useful both before the project begins as it allows management to have a clear idea of the tasks that will make up the project and allow for the estimation of time required. Its use during the project allows developers to track tasks, usually broken into three sections of: to do, doing and done. As the project is being executed it allows the management to get a simple and easy view of what has been completed, what is being worked on and what has yet to be done.



Visual cues used are relatively simple with shape, text and positioning being the primary. The shape is representative of a task, the text is substantive of the task and the position informs the user of one of the three conditions/ states of the task – to do, doing and done.

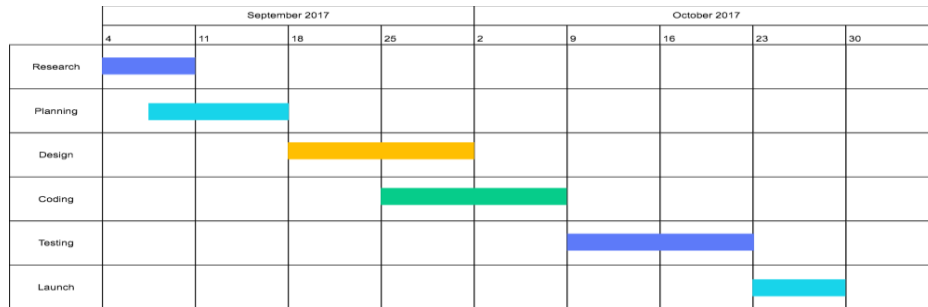
With Kanban aiding in the collection of task definition and time it requires, from this a Critical path method can be developed. This allows a project manager to take the tasks from the previous process and create a path that identifies the critical and non-critical tasks, the tasks are ordered so that tasks that are dependent on others should come after them in the scheduling before they can be started. This is an example of a Directed Acyclical Graph which can be represented visually as a network graph, this type of graph allows for each task to be represented as a node with a line connecting to the next task in the timeline. It differs from the tree or node-link diagrams which follows a more rigid hierarchical structure whereas network diagrams allow for a loose connection of nodes regardless of their position. The line represents a possible unidirectional path or direction that is representative of a relationship. To put it simply, the node is a task, the line is the connection to the next logical task. The order is either by importance, tasks that are of higher important come first, or by necessity if a task is required to be done before the next can start.



The benefit for visualizing this type of data is it allows for a user to view the potential paths that a project can take. It condenses complex data and concepts in one concise piece of visual information that is easy to understand. Visual cues used in CPM are shape, colour and text. Shape is primarily used to represent both the nodes (the tasks) and the lines (relationships). Colour is used to convey urgency of the path and highlights other salient information like the start and end date etc. Text conveys the concrete information to the user like the earliest/latest start and end times.

A Gantt chart is used to visualize the schedule of a project, using the CPM analyses to decide what is the best practical method of executing the project. The Gantt chart allows for the clear planning of time and tasks whereas before there was no

potential paths to take. It sets out an exact timeline by measuring the tasks or activities against time. It specifies the project tasks in context of time by outlining the start and end time for each task, the order of execution and the overall timing of a project. It makes it easier to understand the project tasks, the length each task will take and gives a high-level view of the schedule of the project.



Gantt charts are a more typical type of visualization as it makes use of cues and structure that are more commonly known to general users such as having fixed and labeled X Y Axes, the use of bars to represent tasks and the position from left to right describing the flow of time with the position of the bars relating to a point in the projects timeline. On a Gantt the X axis is usually reserved for the task title and the Y the temporal data of the project. The task can be represented using three visual cues, a shape normally a box with a size that correlates to the amount of time a task will take and colour which can be used to group tasks. As well as these cues there are the labels that represent a concrete version of the data to give exact times. The final cue used is positioning to convey where a task is in the time span of the project.

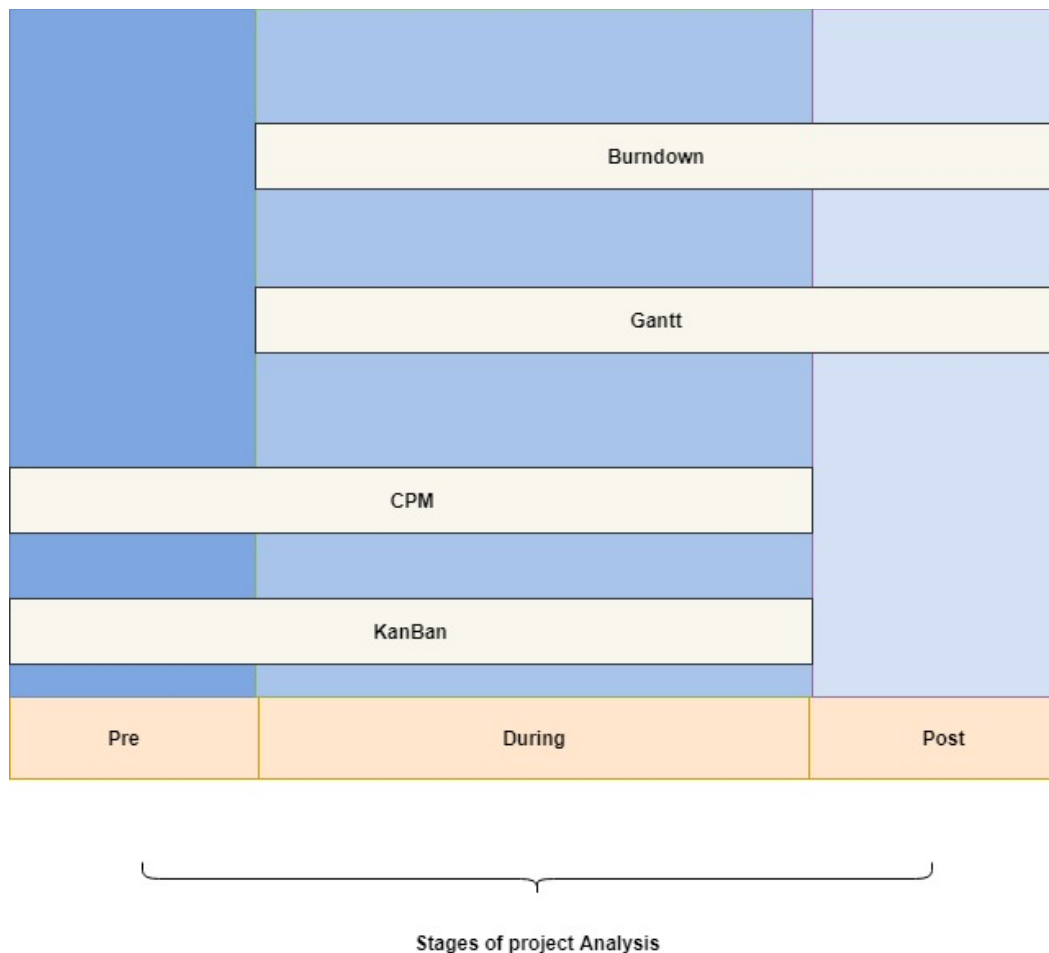
The benefit of Gantt visualization techniques in project management is to give a clear forecast of a project's time span and allows for the gathering of essential information for the project's success in one location and communicates it to a group of users in a way to can be understood to even to those uninitiated to the complexities of project management. The relative simplicity of the chart to convey complex data allows the avoidance of "paralysis by analysis" – Ansoff by creating a simple chart that doesn't take any learning to understand.

A burndown chart is the Realtime representation of the progress for a project as it happens. It builds on the concepts of the Gantt to track tasks over a time span. How it differs is that it that's all the time required to complete every task is used as a start point and this time burns down as tasks are completed on the project timeline. Whereas the other visualization are beneficial before and during a project initiation, the burn down is focused only on the project as it runs. The aim

is to have the task time reach zero the same time the time allocation for the project does. The benefit of this type of analysis is to allow projects managers to see if a project is moving along a troubled path and if so take corrective measures.

Burndown charts are relatively simplistic but powerful charts generally displayed using line graphs; they use cues like the X and Y axis to communicate the projects required time for tasks and the allocated time to complete the project. In a burndown there are usually two lines: the actual progress of the team that is updated live as the project progresses and a projected or expected project line that shows where the latter line should be tracking at each stage of the project.

The below image shows when each visualization technique is use during a projects life cycle. The Pre is the planning stage of the project, the during is as the project is execution phase. Finally, is the post which is can be the most valuable as it allows organization to gauge how well the project went and learning what they can taking it into the next project.



To expand on these visuals and add to the project management process a unifying visual could be created. Using the concept of the iron triangle as the basis of the visual, the visual could take the shape of a triangle with a node on each of the apexes representing the three sides – Cost, Scope and Time. Each node would not only signify an aspect of the triangle but also link to a visual representation of that field. The idea of the node would be to give a percentage of the completion of the area as well as allowing the user interactivity. The interactivity would be in the form of allowing the user to click on the node and be presented with the corresponding display.

Cues used in this visualization would be shape, colour and text for the primary visual and the secondary would take the form of one of the above described methods of project management visualization. The text would provide concrete information such as the label of the section and its completion score in percentage. The colour would represent the completion of the section. Shape will be used to show the nodes and give a visual representation of the triangle, removing it from just an abstract concept.

The benefit this would have to project management as stated before is it would give managers a concrete version of the iron triangle to work with. It would also present an organization with an easy to understand snapshot of a project's health which could be scaled up to show multiple projects at the same time.

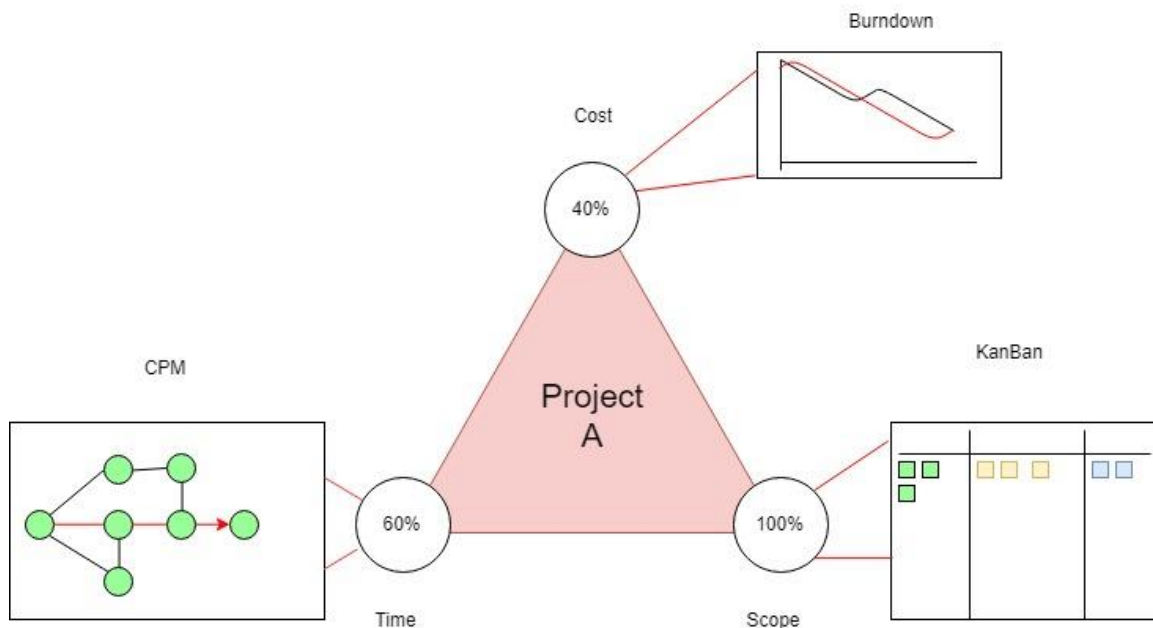


Figure 4 Visualization of the Iron Triangle

Above is a conceptualization of a unifying project management visualization based on the iron triangle method.

Conclusion.

In the domain of Project management there is a vast amount of data generated and requiring analysis. But it is not just good enough to get the results of analyses, the figures must be packaged in a way to optimize understandability and interest to a user. A well-formed and accurate statistic that can't be consumed by its intended audience is of no use. This is because information is only as useful as how well it is understood and used. The value that visualization brings to an organization is that it makes complex data and analysis easier for a user to ingest and draw conclusion from. By increasing usability, it will help to promote repetitive use of the visuals and allowing of more informed decisions across a spectrum of uses regardless of the skill or education on the represented topic. By unifying multiple visual techniques under one umbrella method it centralizes information further and allows manager and organization to increase their ability to make ever more speedy and informed decision for the betterment of their organization and stakeholder.

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