TUFTE DESIGN CONCEPTS IN MUSICAL SCORE CREATION

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ABSTRACT

This paper introduces several examples of utilizing the information design concepts of Edward Tufte in musical notation and score-design. Tufte is generally considered a modern pioneer in the field of information design. Throughout several authoritative texts [1] [2] [3] [4], Tufte's work displays countless examples of successful and unsuccessful attempts of displaying information while also offering a few personal redesigns of especially troubled instances. Overall, Tufte reveals interesting concepts which could be useful when applied to designing musical notation systems. The author presents three personal notational examples which have been aided by Tufte's work. Information design is a vast multidisciplinary field which could provide composers and musicians with an abundance of technical approaches to complex notational challenges.

1. INTRODUCTION

The task of displaying information in a visual way is often a challenging one, riddled with difficult decisions, pitfalls, and corrupting influences [5]. All throughout history, experts and students of science and the arts alike have stumbled in their attempts to visually communicate ideas or concepts. The lessons of successful models of information design (see Figure 1) have often gone unnoticed, leading to poor work which could have been prevented. Edward Tufte's work in the field of information design brings examples, concepts, and lessons from across human history in an effort to show how the visual realm can be a powerful tool for communication.

Mr. Tufte's first book on data visualisation, *The Visual Display of Quantitative Information*, published in 1982 [1], stands as a landmark work in the field of data visualisation [6]. This book provides a clear and concise roadmap, richly packed with intellectual tools for the effective display of visual information. Elegant examples drawing from some of the most brilliant thinkers in history are beautifully displayed in order to showcase their qualities, paired in stark contrast with examples of poorly-executed displays.

Since the release of *Visual Display*, which is mostly focused on the logic of statistical evidence, Mr. Tufte has broadened his focus to include any design relying on visual reasoning strategies. This conceptual expansion has yielded equally acclaimed results in the realm of visual design [7], with his later three books [2] [3] [4] providing an abundance of compelling cases advocating for the ethical, aesthetically grounded, and truthful representation of visual evidence. His examples extend across many diverse applications including choreography, weather-maps, train-schedules, and the causal analysis of historically significant events.

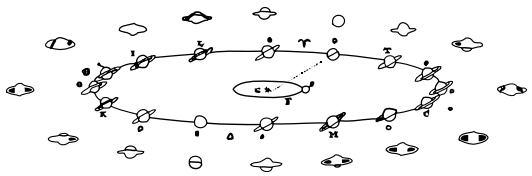


Figure 1. This orbital diagram by Christiaan Huygens in 1659 displays 32 images of Saturn across two different perspectives. The clarity of design in this diagram is frequently referenced by Tufte [1] as a superb example of *small multiple* design, as well as proof that good information design has existed for a long time.

1.1 General Principles of Design

While the examples Tufte draws upon to illustrate his ideas and notions in visual design span many cultures spread across hundreds of years, there are several main underlying themes which can be traced throughout his work. Among one of the most well known is the idea of *chartjunk*, which refers to the superfluous use of graphical elements (*i.e.* gradient shading or skeuomorphism) which serve no logical purpose in communicating the intended information. Chartjunk makes interpreting the intended information of a graphic difficult, since the eye is presented with extra non-essential stimuli. The creation of chartjunk can be avoided by making use of what Tufte coined the data-ink ratio, the *data-ink ratio*, which is the proportion of data-representative ink to total ink used in the graphic. The

more ink that is used on non-representative graphics, the more the designer endangers the clarity of the graphic's intent.

In each of his publications, dozens of techniques and examples are shown describing how to layer, differentiate, and communicate information efficiently. The notions of chartjunk and data-ink ratios hold at their core the idea that graphical representations of information should maximise the space which they inhabit. This promotes the efficient transfer of ideas, un-obscured by the noise of poor design. Without a careful understanding of how graphical content interacts with itself, and indeed, other content, it is easy to obfuscate critical concepts while simultaneously detracting thinking and attention from the observer. While minimalism may come to mind when adopting Tufte's design strategies, he does not advocate for the avoidance of complexity. In fact, many examples are dense and complicated, showing at times thousands of data-points in a single image.

Above all, Tufte's principles ask the designer to employ techniques relevant to the cognitive task at hand. It is up to the designer to choose a methodology which communicates the primary message of the presented information. As Tufte clearly states [8]:

> If the thinking task is to understand causality, the task calls for a design principle: show causality. If a thinking task is to answer a question and compare it with alternatives, the design principle is show comparisons.

1.2 Information Design and the Score

The inclusion of diverse graphical examples in Tufte's books, spanning across many different disciplines and points in history, is an effort to showcase the universality of his theories. These graphic examples are meant to inspire and provoke thought on a variety of possible scenarios when designing, while also demonstrating how a technique can be used in a given discipline. Information design is interdisciplinary in nature, and can be applied to nearly anything where information is represented graphically.

Therefore, it would not require any stretch of the imagination to apply Tufte's principles when creating a musical score. Composers, especially of contemporary music, work with an ever-expanding palette of sonic parameters [9]. While most composers are not specifically attempting to display data or evidence for something that already exists, visuals are employed to provide reasoning for something that is about to happen (*i.e.* a performance).

Today, extended techniques, electronic processing, and even new instruments themselves place interesting demands on the composer. In many cases, complicated ideas must be communicated graphically to the performer, making careful distinctions between the representative elements of dynamic, technical, rhythmic, timbral, and pitched content. Further distinctions between micro- and macro-formal trends are often useful for performers, and add more demands to the score.

2. EXAMPLES IN SCORE-DESIGN

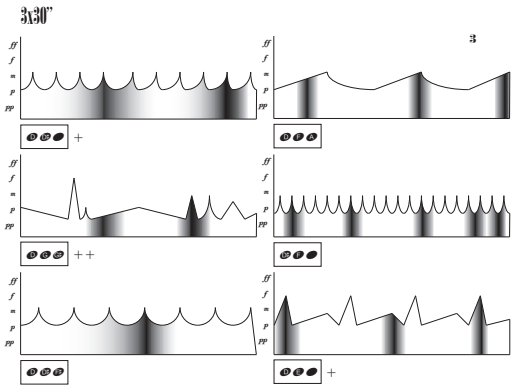
The following sections will discuss three examples of Tuftian design theories employed by the author in his own compositions, including one work from a scientific study. These examples will discuss specific musical ideas, and how information design theories can provide the composer with a useful toolbox for finding innovative solutions to graphical demands.

2.1 Graph-based Notation in de Chrome

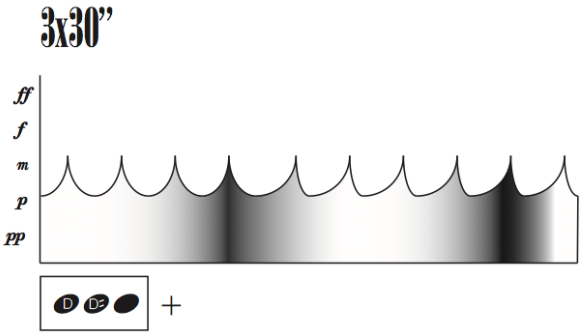
The first example inspired by Tufte's writings on information design is a piece entitled *de Chrome* written by the author in 2012, seen in Figure 2. This composition gives the performer a role in shaping the piece on a micro-level, while the larger form is dictated. Choices can be made by the performers on which content to perform and which pitches to sound, but are limited to a sub-phrasal level. Overall, the piece is to be performed by 3-5 players on any instrument.

This piece is comprised of graphical sub-phrases grouped together by page, which can be seen in Figure 2aa. Each *graph* depicts the dynamic contour of a sustained sound, with dynamic references located on the y-axis. The duration of each sub-phrase is indicated by the two numbers in the top left-hand corner page, best seen in Figure 2bb. In this case, the performers are instructed to choose any three sub-phrases (with no repeats), and to perform each one for thirty seconds; hence the notation of *3x30"*. After the completion of the phrases, the performers may move onto the next page. The gradient shading refers to the level of *timbral pressure* exerted in each phrase. Black indicates a heavy amount of force while white indicates little or no extra force. This can correspond to the pressure exerted on the bow, embouchure, etc.

The small box beneath the contour-graph contains the group of pitches the performer may choose from when sounding the sub-phrase. Note-heads with no indicated pitch are to be interpreted as *non-pitched* sustained sounds. This simply means the performed sound must, above all, not contain any tuned-pitch as detuned sounds are appropriate. Outside the box, percussive articulations are marked with the + symbol.



(a) *a*



(b) *b*

Figure 2. Subfigure *a* displays page 3 of *de Chrome*, which includes a collection of 6 sub-phrases. Subfigure *b* shows the first subphrase in detail.

2.2 Design Theories in de Chrome Score

The goal of *de Chrome* was to create a dynamic tonal landscape while guiding performers through their own decisions in interpreting the score. Since there are no temporal-metric markers higher than the sub-phrasal level, the concept of *small-multiples* was employed to give performers a better view each sub-phrase.

Small-multiples, popularized by Tufte in *Envisioning Information* [2], consists of a series of design elements showing multi-variate information. This design model directly encourages comparisons and promotes awareness between data-sets. The eye can easily move from one element to the next while maintaining a larger analytical perspective. In the case of *de Chrome*, the data is replaced by musical notation. To promote awareness and cohesion between performers in a graphically dominant score such as this, small-multiples bring each sub-phrase into view. The distinct differences between each sub-phrase can easily be identified, allowing each performer to blend, hear, and interact with one another.

In addition to the small-multiple design, the use of gradient shading to convey the timbral-pressure parameter was purposefully fitted within the negative space of the contour-line. Grey-scales are superior to colouring techniques in displaying hierarchical content. As mentioned by Tufte in *Visual Display*, grey-scales give an immediate multi-functional element to the inhabitant information, allowing for increased viewing resolution in a smaller space, and using less ink. An additional benefit to the increased information resolution of the employed visual techniques in *de Chrome* is the opening of white space for extra notation from the performer.

2.3 Scoring Bi-manual Action

The second score in this example is a percussion solo piece written by the author between 2013-2014. Entitled *Dextral Shift*, this work is focused on the bi-manual nature of percussion performance. With the exception of method books which are educational in purpose, most written percussion pieces are not too concerned with separating the left- and right-hands. *Dextral Shift* was conceptually inspired by the author's previous research in the field of laterality [10]. Laterality is an interdisciplinary field concerned with the behavioural differences between the left- and right-sides of the body. Everyone engages a preferred-side (*i.e.* left or right) when it comes to a specific task [11]. This score was designed with the two hands notated separately, with specific actions assigned based on the abilities dictated by handedness.

In Figure 3, two excerpted stems from the *Dextral Shift* score can be seen. This piece was written for four pitched temple-bowls in the left-hand, and one detuned tom-tom for the right-hand. On the left-side of the score along the y-axis are indicators denoting the notational domains of the hands. These domains are split by the center x-axis. The y-axis also doubles as an indicator of pitch/instrumental differentiation and dynamic intensity. In the left-hand, the closer a note is written to the center line, the lower the pitch. For the right-hand, notes written close to the center line indicate a striking area closer to the rim of the drum-head. Notes written further from the center line are to be played further from the rim of the drum-head. Dynamic markings also rely on the y-axis and are represented as a continuous line, shaded softly behind the note-heads. The markings for dynamics of each hand are again separated by the center line. The further from the center the grey-shading goes, the louder the dynamics for the notes placed over it.

2.4 Design Theories in Dextral Shift Score

Several important design strategies were employed in the creation of the *Dextral Shift*' s notational system. This piece is essentially two different scores presented as one. The left- and right-hands, except for a few short sections, are notated individually. Each hand is tasked with perform-

ing its own content on a different instrument using different techniques. This division was the primary goal of the composition, as it was intended to explore the physical difficulties of combining and separating the hands from each other.

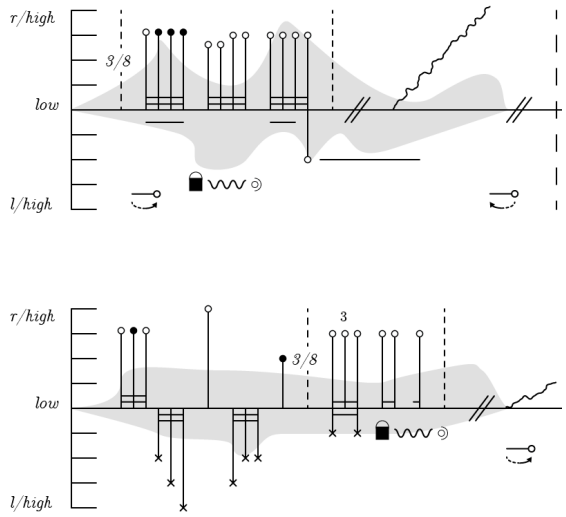


Figure 3. Two excerpted lines from *Dextral Shift*. These segments display the graphical shading techniques of the dynamics, as well as the split of the left- and right-hands over the center line (*i.e.* x-axis).

While keeping the hands apart was the primary goal, creating a comprehensive and unified systemic structure for the notation was also a top priority. This was achieved by assigning multiple variables to the two-axis notational platform. The score uses the same space and graphical language to display several different parameters all at once, in what Tufte describes as *layering and separation* [2]. Dynamic intensity and instrumentation share the same indicators (i.e. the high-low-high notation), which allowed for compact notational techniques. The grey-shaded dynamic contour freed space from the traditional dynamic notation techniques, which usually includes both graphical elements and text. The removal of such elements allowed for the mirrored note stemming from the center line. Further space was uncluttered by omitting traditional staff-lines as well. Instead, *staff-markers* are shown at the beginning of each musical system, of which there are three per page.

These multi-purposed graphic elements allowed for information to be concentrated along the center line, creating a reliable focal point for the performer. Comparisons, changes, and detailed compositional information are easily embedded within the score in an intuitive manner. Extra text which is usually required for dynamic or tempo markings, along with their own graphical content, are no longer necessary. The efficiency and compactness of this design strategy speaks directly to Tufte's design teachings in reducing administrative elements, while simultaneously increasing the data-ink ratio on the page. The system of notation in *Dextral Shift* places weighted emphasis on the most important elements of the score, while enabling graphical flexibility. The removal of staff lines clears-up the page and avoids the activation of negative space. Unused grid-space, especially those with pronounced lines, can often be confusing [12]. The unnecessary interaction of graphical elements can make the discernment of important information from non-important/existing information quite difficult [13].

2.5 Using Disinformation Design

The last example of using Tufte's design theories in creating a musical score comes from a scientific study performed by the author [14]. This example does not come from a specific piece intended for concert performance, but from a gestural analysis study on the effects of handedness. An experiment was devised in order to study how the hands are used when performing unrehearsed music, also known as sight reading. Insight from this study was used to better understand the role of the participant's internal-timing mechanisms in relation to their hand use.

In an effort to challenge the participants' sense of timing, the author composed a short rhythmic exercise. This exercise, roughly one minute in length, gradually increased in rhythmic complexity as it progressed. The beginning of the score contained simple 8th-note and quarternote rhythms and ended with a series of tricky multi-metered syncopations. Tuplets and other poly-metered rhythmic units require the performer to use delicate time-keeping techniques in order to perform a given passage accurately. The gradual change in difficulty allowed the performer to establish a comfortable counting routine before more difficult material appeared.

A major challenge in creating the experimental exercise score was developing a rhythmic environment which seamlessly moved from one segment to the next. Making the participants feel comfortable was important, as it would allow them to exhibit their most natural tendencies. Any extreme changes in notation or glaring multi-rhythmic tangles of obvious difficulty would undoubtedly put the participant at unease.

2.6 Design Theories in Sight-Reading Score

In designing how the score for the handedness experiment, tuplets and syncopated groupings were the primary mechanisms for the introduction of challenging material. Tuplets require complex counting strategies, even when performing rehearsed material [15], as they contain beats falling outside of the traditional beat-matrix. The design concept

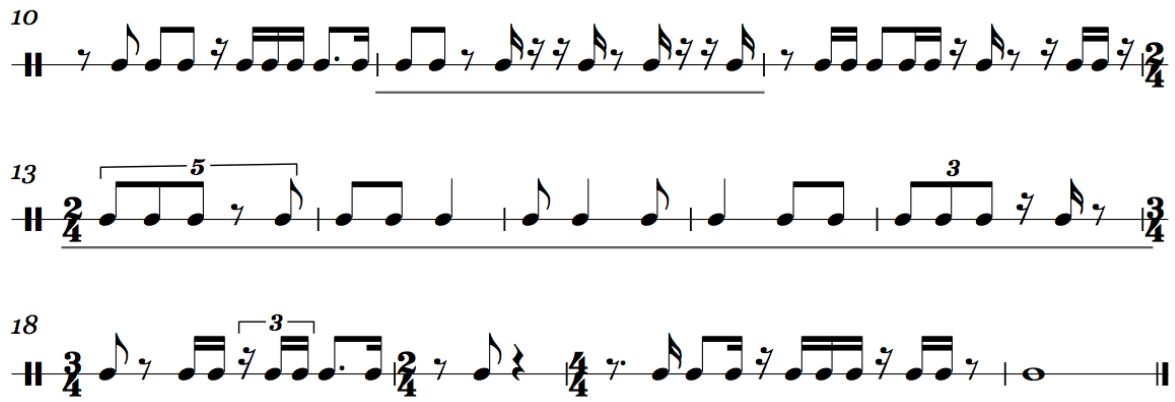


Figure 4. This is an excerpt from the handedness study music. The underlined segments highlight the areas where Tufte's concepts on disinformation design were employed.

of *disinformation design*, found in the book *Envisioning Information* [3] was used.

Disinformation design is in most ways the complete opposite of information design; the goal is obscure the truth or to produce an illusion. In Tufte's book *Visual Explanations*, an entire chapter is co-authored with magician Jamy Ian Swiss, as various examples of technical explanations and magic guidebook diagrams are discussed in detail. The notational methodology for the excerpt presented in the handedness study specifically disguised the introduction of new, and more challenging material.

In Figure 4, the underlined segments highlight areas where disinformation design tactics were employed. The first underline (measure 11) is a syncopated 3/4 pattern using 16th-notes. The measure begins with two 8th-notes, establishing a firm rhythmic foundation for the measure. The syncopated rhythm is written using 16th-notes only for the note-heads, and a collection of 16th-note and 8th-note rests for the spaces in between. The busy notation of this measure obscures a sense of regularity, and masks the metric identity of the measure. The graphical repetition of the 16th-note rest pairs serves as a kind of notational anomaly. When two rests are paired of equal value, they are usually grouped into one. Using two rests requires more subdividing by the performer which is reliant on internal counting strategies.

Measure 11 was repeatedly misplayed by the participants of the handedness study, as many had to suddenly dial-in on the resolution of their internal counting, which usually happened too late. The designed *error-zone* provided an opportunity to observe which hand would be used when intensified timing-based decisions needed to be performed. Consistent with previous findings on the matter [16], the preferred-hand performed most of the notes in this measure.

The second underlined segment seen in Figure 4 begins with a quintuplet figure with an 8th-note rest on the fourth beat. Following the quintuplet figure is another syncopated rhythm. The visual presentation of the syncopation is partially what makes it challenging. The isolated 8th-note on the quintuplet leads into the syncopated rhythms consisting of a 3/8 feel over several 2/4 measures. The graphical representation of the last quintuplet note in measure 13 leads into the next bar, much like the 8th-note in measure 15. While they look similar, one is bound to the beat-matrix while the other is not. This entire system (mm.13-17), was one of the most complicated segments to read. A clear majority of participants performed these measures with only their preferred-hand.

3. DISCUSSION

Musical content is represented graphically in a diverse and varied landscape, full of rich historical context and traditions. In musical notation, there is no right or wrong way to pursue or represent an idea. Composers often work with abstracted concepts in a visceral way, which is in turn reinterpreted by the performers and the audience. Conversely, information design is often grounded in verifiable data. Graphical elements are used in information design to give form to numbers and reveal trends. Information design is concerned with the visual presentation of evidence. For these differences, perhaps musical notation techniques may have remained separate from the quantitatively-driven world of information design. Music' s representation on paper is entirely arbitrary, and often self-containing. In contemporary music, the composer devises a new graphical language for each piece [17], largely shaped by what the composer wants to communicate.

Quantitatively speaking, the way in which traditional music is represented revolves around a grid-based system, where exact information can be presented. Timing and pitch can be precisely notated, but this system has been challenged to a great extent due to its limitations in displaying highly-

specified technical information [18]. The limitations of grid-based notation gave way to graphical-based methods. Interestingly enough, the two systems have generally been segregated and have been thought to conflict with one another [19].

4. CONCLUSION

This paper sought to explore the possibilities of combining information design tactics, most notably those of Edward Tufte, and musical composition. Tufte's books trace common mistakes and important solutions in presenting information throughout history. These examples and lessons can provide musicians with a rich resource for solutions to displaying challenging musical material. As previously mentioned in Section 1.1, one of the primary questions designers of graphical content should ask is: *What is the thinking task*? The graphical representation of any given idea should help aid that task.

The examples presented herein were solely produced by the first author, as it was not the goal of this article to critique the works of others, or to highlight what makes a score good or bad. Composers are free to use any method or system necessary to express themselves, and in most cases the ends justify the means. Traditional western notation is highly customisable, and serves as the framework for a great deal of the contemporary music written today. It is, at its core, a highly successful and excellent example of information design. Furthermore, while it has the potential to be graphically difficult to navigate, western notation's visual grammar is widely recognized and familiar to its users. The difficulties of understanding its systemic structure are usually overcome in the early stages of a musicians career, allowing the experienced and professional to transcend any possible limitations of the notation in their music making.

Tufte's work is at its heart multidisciplinary, leaving an open framework for the interpretation of musicians. His ideas open the door to countless other persons and organizations who have discovered solutions to complex graphical questions. Musical composition is certainly complicated and multidisciplinary as well. Inspiration can be drawn from anything when writing music. The work of Edward Tufte and the world of information design has the potential to be a rich resource for imaginative compositions in the future.

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