7

Interactivity

The advancement of technology has entirely altered the nature of how we consume information. Whereas only a generation ago most visualisations would have been created exclusively for printed consumption, developments in device capability, Internet access and bandwidth performance have created an incredibly rich environment for digital visualisation to become the dominant output. The potential now exists for creative and capable developers to produce powerful interactive and engaging multimedia experiences for cross-platform consumption.

Unquestionably there is still an fundamental role for static (i.e. not interactive) and print-only work: the scope offered by digital simply enables you to extend your reach and broaden the possibilities. In the right circumstances, incorporating features of interactivity into your visualisation work offers many advantages:

- It expands the physical limits of what you can show in a given space.
- It increases the quantity and broadens the variety of angles of analysis to serve different curiosities.
- It facilitates manipulations of the data displayed to handle varied interrogations.
- It increases the overall control and potential customisation of the experience.
- It amplifies your creative licence and the scope for exploring different techniques for engaging users.

The careful judgements that distinguish this visualisation design process must be especially discerning when handling this layer of the anatomy. Well-considered interactivity supports, in particular, the principle of 'accessible' design, ensuring that you are adding value to the experience, not obstructing the facilitation of understanding. Your main concern in considering potential interactivity is to ensure the features you deploy are useful. This is an easy thing to say about any context but just because you *can* does not mean to say you *should*. For some who possess a natural technical flair, there is often too great a temptation to create interactivity where it is neither required nor helpful.

Having said that, beyond the functional aspects of interactive design thinking, depending on the nature of the project there can be value attached to the sheer pleasure created by thoughtfully conceived interactive features. Even if these contribute only ornamental benefit there can be merit in creating a sense of fun and playability so long as such features do not obstruct access to understanding.

There is a lot on your menu when it comes to considering potential interaction design features. As before, ahead of your decision making about what you *should* do, you will first consider what you *could* do. To help organise your thinking, your options are divided into two main groups of features:

- Data adjustments: Affecting what data is displayed.
- Presentation adjustments: Affecting how the data is displayed.

> There is an ever-increasing range of interfaces to enable interaction events beyond the mouse/touch through gesture interfaces like the Kinect device, oculus rift, wands, control pads. These are beyond the scope of this book but it is worth watching out for developments in the future, especially with respect to the growing interest in exploring the immersive potential of virtual reality (VR).

When considering potential interactive features you first need to recognise the difference between an *event*, the *control* and the *function*. The event is the input interaction (such as a click), applied to a control (maybe a button) or element on your display, with the function being the resulting operation that is performed (filter the data).

Where once we were limited to the mouse or the trackpad as the common peripheral, over the past few years the emergence of touch-screens in the shape of smartphones and tablets has introduced a whole new event vocabulary. For the purposes of this chapter we focus on the language of the mouse or trackpad, but here is a quick translation of the equivalent touch events. Note that arguably the biggest difference in assigning events to interactive data visualisations exists in the inability to register a mouseover (or 'hover') action with touch-screens.

Mouse/trackpad event	Touch event
Left click, right click	Single-finger tap, two-fingered tap
Double click	Double tap
Click, drag and drop	Tap, drag and drop
'Mouseover' or pointer 'hover'	Tap
Wheel scroll	Swipe (move), pinch/reverse pinch (for zoom)
Unique: keyboard controls	Unique: rotate

7.1 Features of Interactivity: Data Adjustments

> I will temporarily switch nomenclature to 'user' in this chapter because a more active role is needed than 'viewer'.

This first group of interactive features covers the various ways in which you can enable your users to adjust and manipulate your data. Specifically, they influence *what* data is displayed at a given moment.

Framing: There is only so much one can show in a single visualisation display and thus giving users the ability to modify criteria to customise what data is visible at any given point is a strong advantage. Going back to the discussion on editorial thinking, in Chapter 5, this set of adjustments would specifically concern the 'framing' of what data to isolate, include or exclude from view.

> For those of you familiar with databases, think of this group of features as similar in scope to modifying the criteria when querying data in a database.

Example events/controls	Example functions
Select a button or link	Apply a categorical data filter (one or several combinations)
Select an item from a menu list	Apply a quantitative data filter (one value or range of values)
Select multiple items from a check-box or menu list	Modify the data representation (chart type or encodings)
Select to alter the state of a toggle or radio button	Modify the values that form the basis of calculated results
Alter the position of a handle along a scale slider	Reset all values to their original state
Alter the position of two handles along a scale slider (to create a range)	
Type a value into an input box	

In 'Gun Deaths' (Figure 7.1), you can use the filters in the pop-up check-box lists at the bottom to adjust the display of selected categorical data parameters. The filtered data is then shown in isolation above the line from all non-selected groups, which are shown below the line. The 'Remove filters' link can be used to reset the display to the original settings.

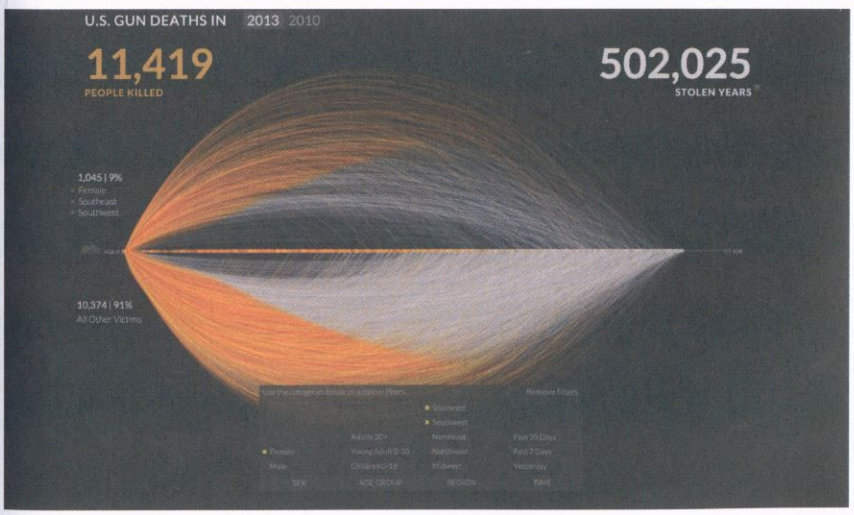


Figure 7.1
US Gun Deaths

Notice the subtle transparency of the filter menu (in Figure 7.1) so that it doesn't entirely occlude the data displayed beneath.

In the bubble map view of the 'FinViz' stock market analysis site, you can change the values of the handles along the axes to modify the maximum and minimum axis range, which allows you effectively to zoom in on

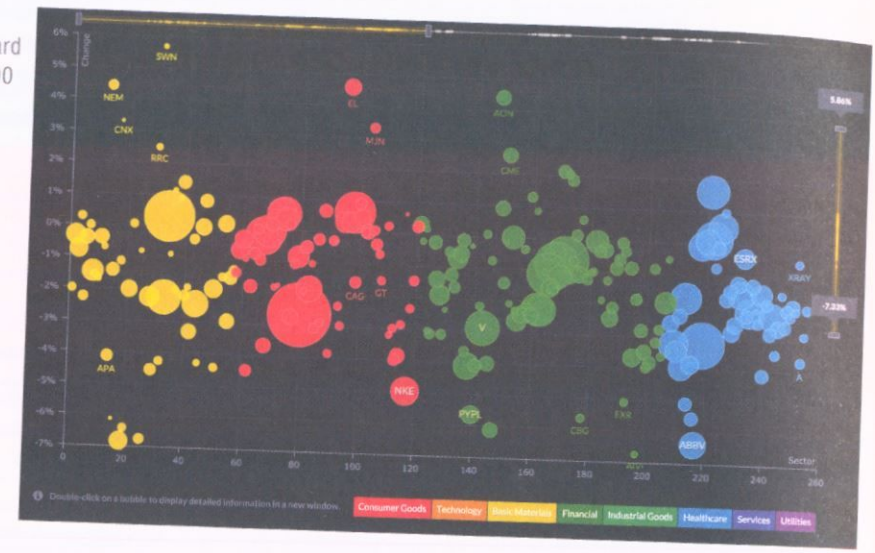


Figure 7.2 FinViz: Standard and Poor's 500 Index

You will see that many of these interactive projects include links to share the project (or view of the project) with others via social media or through offering code to embed work into other websites. This helps to mobilise distribution and open up wider access to your work.

the records that match this criterion. You can also select the dropdown menus to change the variables plotted on each axis.

Navigating: There are dynamic features that enable users to expand or explore greater levels of detail in the displayed data. This includes lateral movement and vertical drill-down capabilities.

Example events/controls	Example functions
Select a mark from within a chart	Expand to reveal the sub-category value
Scroll to modify zoom level	Increase or decrease the level of detail of the data (its 'granularity')
Select zoom level from a scale	Zoom in and out of a view level
Select a button or link	Move ('pan') around a display
Select and drag	Access an underlying dataset
	Link to data sources

Figure 7.3 The Racial Dot Map

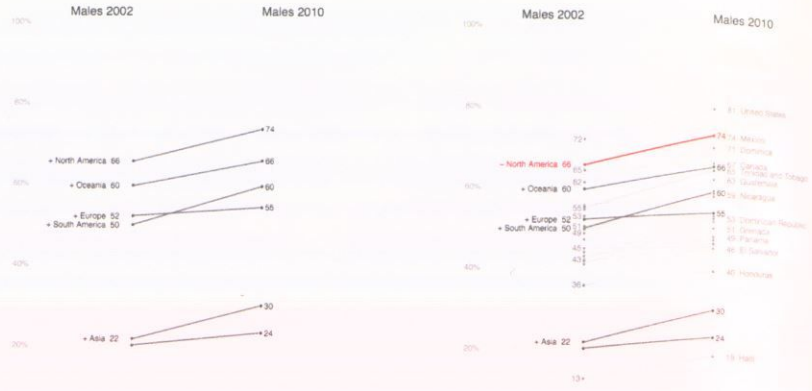
The dot map in Figure 7.3, showing the 2010 Census data, displays population density across the USA. As a user you can use a scrollable zoom or scaled zoom to zoom in and out of different map view levels. The map can also be navigated laterally to explore different regions at the same resolution.

This act of zooming to increase the magnification of the view is known as a geometric zoom. This is considered a data adjustment because through zooming you are effectively re-framing the window of the included and excluded data at each level of view.

In the 'Obesity Around the World' visualisation (Figure 7.4), selecting a continent connector expands the sub-category display to show the marks for all constituent countries. Clicking on the same connector collapses the countries to revert back to the main continent-level view.

The 'Social Progress Imperative' project (Figure 7.5) provides an example of features that enable users to view the tabulated form of the data – the highest level of detail – by selecting the 'Data

Figure 7.4 Obesity Around the World



Table' tab. The data adjustment taking place here is through providing access to the data in a non-visual form. Users can also export the data by clicking on the relevant button to conduct further local analysis.

Figure 7.5 Excerpt from 'Social Progress Index 2015'

Map | Performance | Data Table

<> Embed ↓ Export

Countries	Social Progress...	Basic Human Nee...	Foundations of ...	Opportunity
Norway	88.36	94.80	88.46	81.82
Sweden	88.06	94.83	86.43	82.93
Switzerland	87.97	95.66	86.50	81.75
Iceland	87.62	95.00	86.11	81.73
New Zealand	87.08	92.87	82.77	85.61
Canada	86.89	94.89	79.22	86.58
Finland	86.75	95.05	82.58	82.63
Denmark	86.63	96.03	82.63	81.23
Netherlands	86.50	94.80	83.81	80.88
Australia	86.42	93.73	79.98	85.55
United Kingdom	84.68	92.22	79.04	82.78
Ireland	84.66	93.68	76.34	83.97
Austria	84.45	95.04	82.53	75.77
Germany	84.04	94.12	81.50	76.49
Japan	83.15	95.01	78.78	75.66
United States	82.85	91.23	75.15	82.18

● Social Progress Index
● Basic Human Needs
● Foundations of Wellbeing
● Opportunity

Add aspect to compare

Group by country
Group by region

Display scores
Display ranks

Animating: Data with a temporal component often lends itself to being portrayed via animated sequences. The data adjustment taking place here involves the shifting nature of the timeframe in view at any given point. Operations used to create these sequences may be automatic and/or manual in nature.

Example events/controls	Example functions
Alter the position of a single handle along a scale slider	Automatically triggered animation
Alter the position of two handles along a scale slider (to create a range)	Automatic controlled animation (using buttons)
Select a button (play, pause, stop and reset, speed buttons)	Manually controlled animation (using a slider)
Land on the web page	

This next project (Figure 7.6) plots NFL players' height and weight over time using an animated heat map. When you land on the web page the animation automatically triggers. Once completed, you can also select the play button to recommence the animation as well as moving the handle along the slider to manually control the sequence. The gradual growth in the physical characteristics of players is clearly apparent through the resulting effect.

Sequencing: In contrast to animated sequences of the same phenomena changing over time, there are other ways in which a more discrete sequenced experience can suit your needs. This commonly exists by letting users navigate through predetermined, different angles of analysis about a subject. As you navigate through the sequence a narrative is constructed. This is a quintessential example of storytelling with data exploring the metaphor of the anecdote: 'this happened' and then 'this happened'...

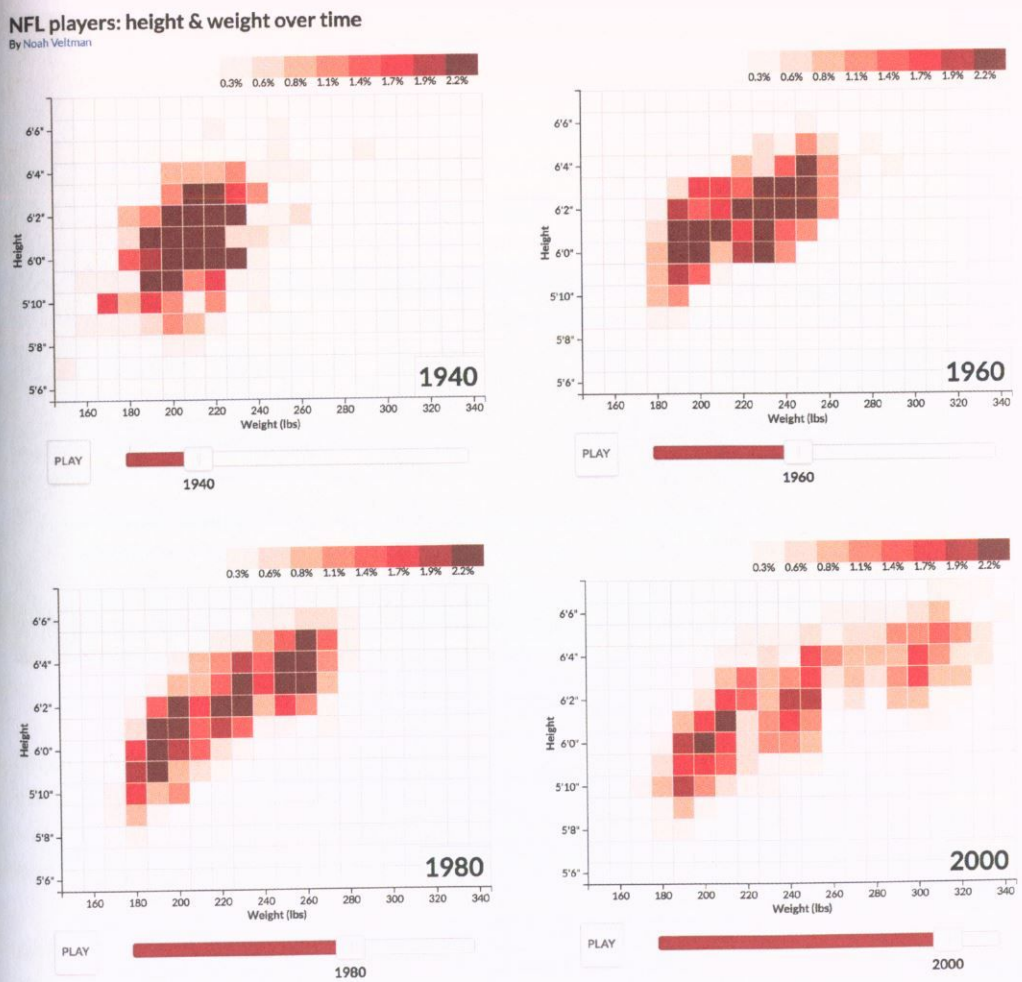


Figure 7.6 NFL Players: Height & Weight Over Time

Example events/controls	Example functions
Select tabs	Navigate through a sequence of pages
Select pagination elements (such as a dot stepper)	Navigate through a sequence of displays (within the page)
Select buttons	Manually controlled reveal/fade (using a slider)
Alter the position of a single handle along a scale slider	
Sideward scroll (unique to trackpads, Mac Mouse)	

The project 'How Americans Die' (Figure 7.7) offers a journey through many different angles of analysis. Clicking on the series of 'pagination' dots and/or the navigation buttons will take you through a pre-prepared sequence of displays to build a narrative about this subject.

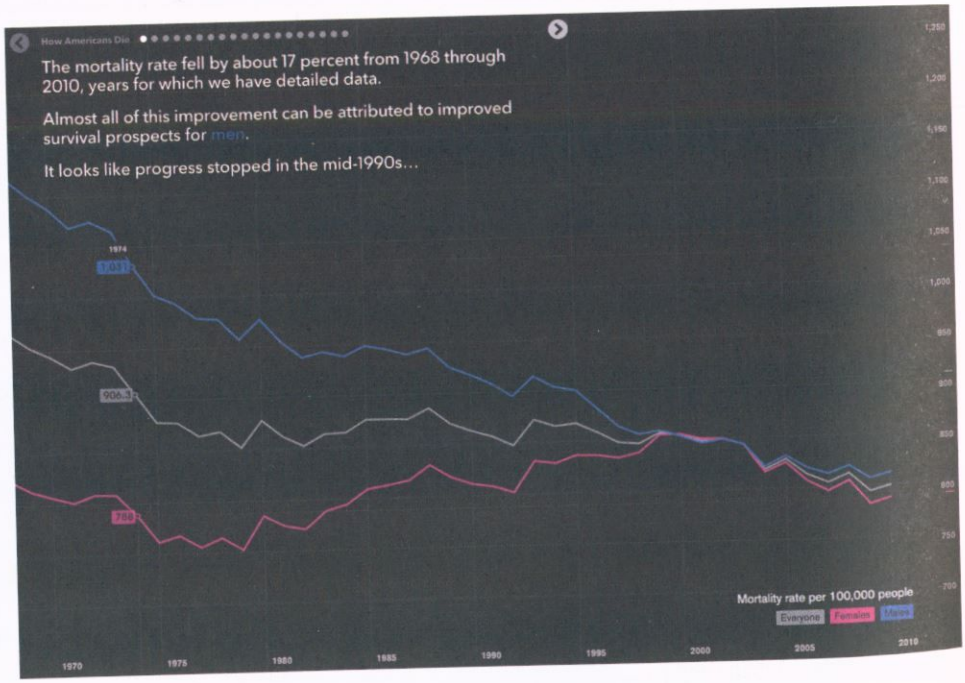


Figure 7.7 Excerpt from 'How Americans Die'

Sometimes data exists in only two states: a before and after view. Using normal animated sequences would be ineffective – too sudden and too jumpy – so one popular technique, usually involving two images, employs the altering of the position of a handle along a slider to reveal/fade the respective views. This offers a more graduated sequence between the two states and facilitates comparisons far more effectively as exhibited by the project shown in Figure 7.8.

A different example of sequencing – and an increasingly popular trend – is the vertical sequence. This article from the *Washington Post* (Figure 7.9) profiles the beauty of baseball

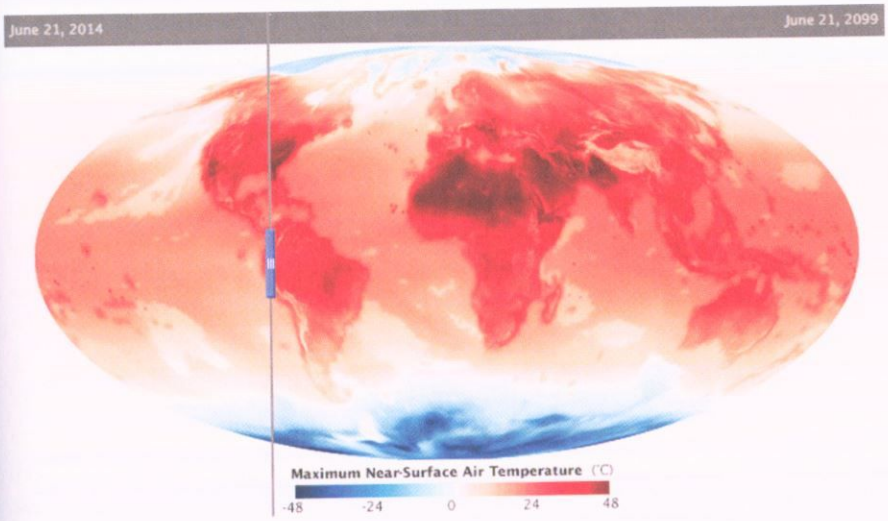


Figure 7.8 Model Projections of Maximum Air Temperatures Near the Ocean and Land Surface

player Bryce Harper's swing and uses a very slick series of illustrations to break down four key stages of his swing action. As you scroll down the page it acts like a lenticular print or flip-book animation. Notice also how well judged the styles of the illustrations are.

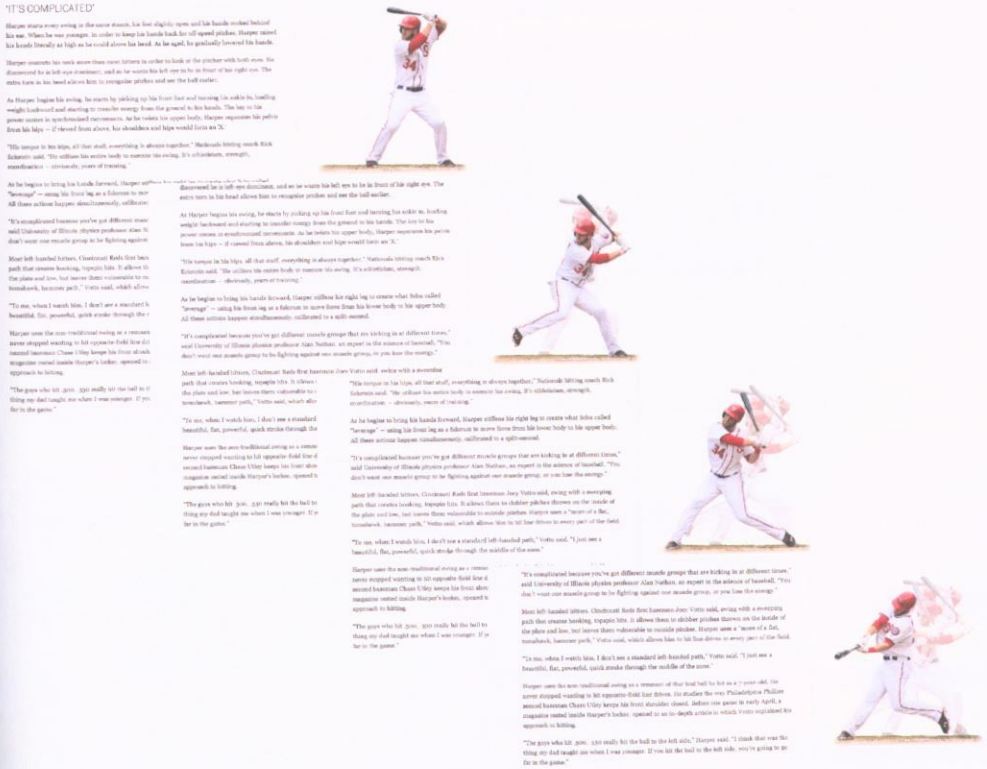


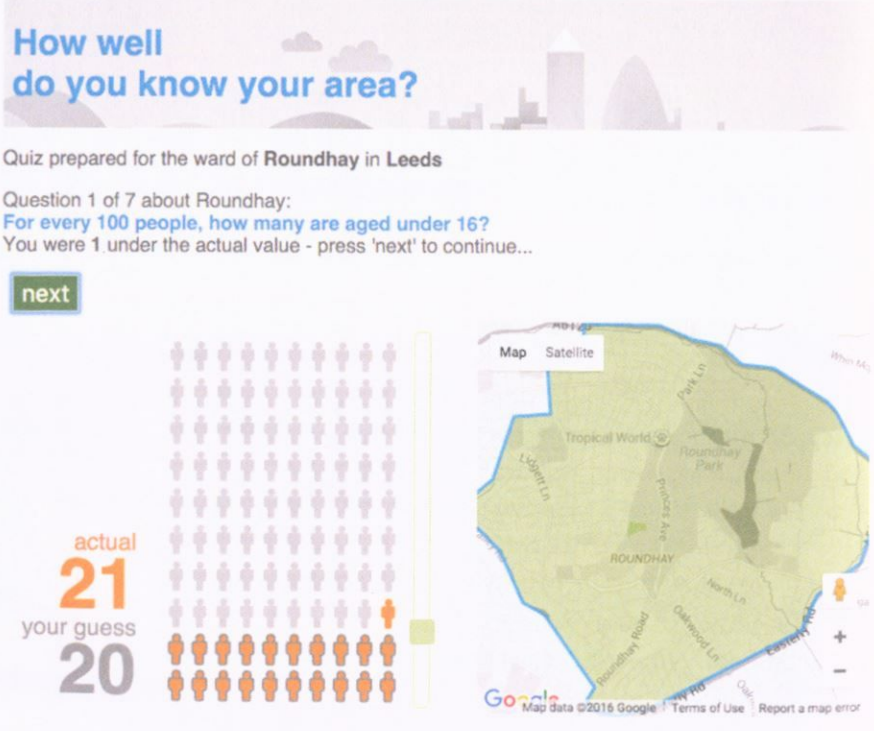
Figure 7.9 Excerpt from 'A Swing of Beauty'

Contributing: So far the features covered modify the criteria of what data is included/excluded, that then help you dive deeper into the data, and move through sequenced views of that data. The final component of 'data adjustment' concerns contributing data. Sometimes there are projects that require user input, either for collecting further records to append and save to an original dataset or just for temporary (i.e. not held beyond the moment of usage) participation. Additionally, there may be scope to invite users to modify certain data in order to inform calculations or customise a display. In each case, the events and controls associated with this kind of interaction are designed to achieve one function: input data.

Example events/controls	Example functions
Select a button or link	Input data values
Select an item from a menu list	
Select multiple items from a check-box or menu list	
Select to alter the state of a toggle or radio button	
Select a mark from within a chart	
Alter the position of a handle along a scale slider	
Type a value into an input box	

The first example 'How well do you know your area?' (Figure 7.10) by ONS Digital, employs simple game/quiz dynamics to challenge your knowledge of your local area in the UK. Using the handle to modify the position along the slider you input a quantitative response to the

Figure 7.10
How Well Do You Know Your Area?



questions posed. Based on your response it then provides feedback revealing the level of accuracy of your estimation.

In the next project (Figure 7.11), by entering personal details such as your birth date, country and gender into the respective input boxes you learn about your place in the world's population with some rather sobering details about your past, present and future on this planet.

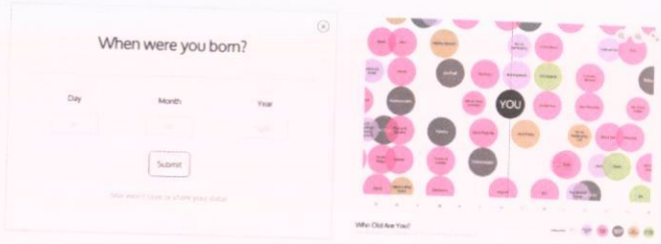


Figure 7.11 Excerpt from 'Who Old Are You?'

Figure 7.12 shows an excerpt from '512 Paths to the White House'. In this project the toggle buttons are used to switch between three categorical data states (unselected, Democratic and Republican) to build up a simulated election outcome based on the user's predictions for the winners in each of the key swing states. As each winner is selected, only the remaining possible pathways to victory for either candidate are shown.

> Inevitably data privacy and intended usage are key issues of concern for any project that involves personal details being contributed, so be careful to handle this with integrity and transparency.

Adjusting the position of the handle along the slider in the Better Life Index project (Figure 7.13) modifies the quantitative data value representing the weighting of importance you would attach to each quality of life topic. In turn, this modifies the vertical positioning of the country flowers based on the recalculated average quality of life.

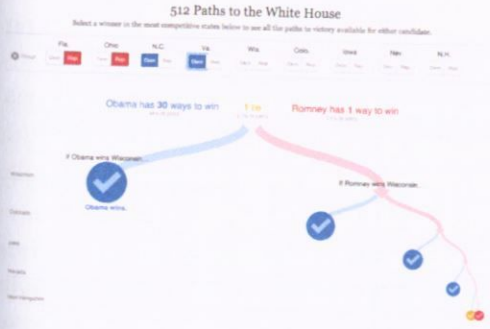


Figure 7.12 512 Paths to the White House

Figure 7.13 OECD Better Life Index

7.2 Features of Interactivity: Presentation Adjustments

In contrast to the features of 'data adjustment', this second group of interactive features does not manipulate the data but rather lets you configure the presentation of your data in ways that facilitate assistance and enhance the overall experience.

Figure 7.14 Nobel Laureates

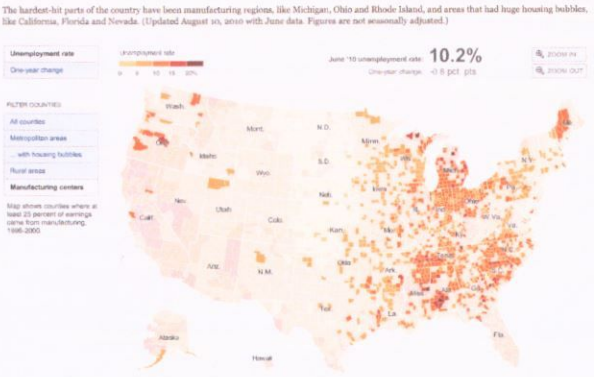


Figure 7.15 Geography of a Recession

Figure 7.16 How Big Will the UK Population be in 25 Years' Time?

Focusing: Whereas the 'framing' features outlined previously modified what data would be included and excluded, 'focus' features control what data is visually emphasised and, sometimes, how it is emphasised. Applying such filters helps users select the values they wish to bring to the forefront of their attention. This may be through modifying the effect of depth through colour (foreground, mid-ground and background) or a sorting arrangement. The main difference with the framing features is that no data is eliminated from the display but simply relegated in its contrasting prominence or position.

The example in Figure 7.14 provides a snapshot of a project which demonstrates the use of a focus filter. It enables users to select a radio button from the list of options to emphasise different cohorts of all Nobel Laureates (as of 2015). As you can see the selections include filters for women, shared winners and those who were still living at the time. The selected Laureates are not coloured differently, rather the unselected values are significantly lightened to create the contrast.

The project shown in Figure 7.15 titled 'Geography of a Recession' allows users to select a link from the list of filters provided on the left to emphasise different cohorts of counties across the USA. Once again, the selected counties are not coloured differently here, the unselected regions are de-emphasised by washing-out their original shades.

'Brushing' data is another technique used to apply focus filters. In this next example (Figure 7.16), looking at the UK Census estimates for 2011, you use the cursor to select a range of marks from within the 'violin plot' display in order to view calculated statistics of those chosen values below the chart.

The next example (Figure 7.17), portraying the increase or cuts in Workers' Compensation benefits by US state, demonstrates a technique known as 'linking', whereby hovering over a mark in one chart display will then highlight

Example events/controls	Example functions
Select a button or link	Applying contrasting colours to emphasise selected data
Select an item from a menu list	Rearrange the order of the data values
Select multiple items from a check-box or menu list	Choose values to form statistical calculations
Select to alter the state of a toggle or radio button	Highlight associated data values across charts
Alter the position of a handle along a scale slider	
Alter the position of two handles along a scale slider (to create a range)	
Select a mark from within a chart	
Mouseover a mark from within a chart	
Select a range of marks from within a chart ('brushing')	
Type a value into an input box	

an associated mark in another chart to draw attention to the relationship. In this case, hovering over a state circle in any of the presented 'grid maps' highlights the same state in the other two maps to draw your eye to their respective statuses. You might also see this technique combined with a brushing event to choose multiple data marks and then highlight all associations between charts, as also demonstrated in the population 'violin plot' in Figure 7.16.

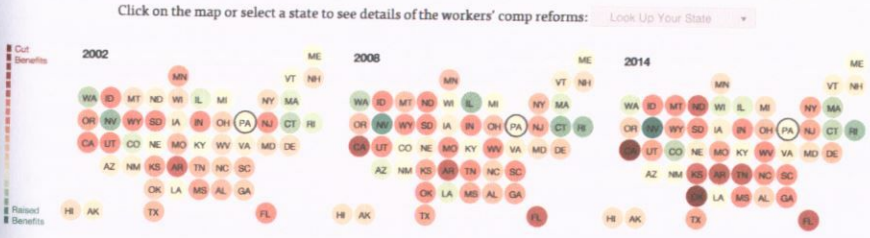


Figure 7.17 Excerpt from 'Workers' Compensation Reforms by State'

Sorting is another way of emphasising the presentation of data. In Figure 7.18, featuring work by the Thomson Reuters graphics team, 'ECB bank test results', you see a tabular display with sorting features that allow you to reorder columns of data by clicking on the column headers. For categorical data this will sort values alphabetically; for quantitative data, by value order. You can also hand-pick individual records from the table to promote them to the top of the display to facilitate easier comparisons through closer proximity.

Linking and brushing are particularly popular approaches used for exploratory data analysis where you might have several chart panels and wish to see how a single record shows up within each display.

Annotating: As you saw in the previous chapter on data representation, certain combinations of marks and attributes may only provide viewers with a sense of the order of magnitude of the values presented. This might be entirely consistent with the intended tone of the project. However, with interactivity, you can at least enable viewers to interact with marks to view more details momentarily. This temporary display is especially useful because most data

Figure 7.18 Excerpt from 'ECB Bank Test Results'

Test results overview

Click on columns to sort and group overall results. Click on rows to select and compare specific banks.

BANK				ECB ADJUSTMENTS			NEED TO RAISE
Name	Country	Assets end of 2013 (€ bln.)	Ownership	Worst CET1 ratio over stressed scenario (%) Threshold:5.5%	AQR adjustment (€ mil.)	Basis points	Capital shortfall post net capital raised (€ mil.)
Monte dei Paschi	Italy	199.1	state (listed)	-0.1%	4,246.0	687	2,110.0
Piraeus	Greece	92.0	state (listed)	4.4%	2,792.0	558	0.0
National Bank of Greece	Greece	109.1	state (listed)	-0.4%	2,257.0	794	930.0
Rabobank	Netherlands	674.1	co-op	8.4%	2,093.0	367	0.0
Banco Popolare	Italy	126.5	state (listed)	4.7%	1,603.0	320	0.0
HSH Nordbank	Germany	109.3	state	6.1%	1,594.0	394	0.0
Commerzbank	Germany	561.4	state (listed)	8.0%	1,522.0	288	0.0
BCPE	France	1,065.4	state (listed)	7.0%	1,517.0	304	0.0

representations are already so busy that permanently including certain annotated apparatus (like value labels, gridlines, map layers) would overly clutter the display.

Example events/controls	Example functions
Select a link or button	Reveal annotations in a local tooltip/pop-up
Select a mark from within a chart	Reveal annotations in a separate panel
Mouseover a mark from within a chart	
Select to alter the state of a toggle or radio button	
Alter the position of a handle along a scale slider	

The example in Figure 7.19, profiles the use of language throughout the history of US Presidents' State of the Union addresses, using circle sizes to encode the frequency of different word mentions, giving a gist of the overall quantities and how patterns have formed over time. By hovering over each circle you get access to a tooltip dialogue box which reveals annotations such as the exact word-use quantities and extra contextual commentary.

One issue to be aware of when creating pop-up tooltips is to ensure the place they appear does not risk obstructing the view of important data in the chart beneath. This can be especially intricate to handle when you have a lot of annotated detail to share. One tactic is to utilise otherwise-empty space on your page display, occupying it with temporary annotated captions only when triggered by a select or hover event from within a chart.

Orientating: A different type of interactive annotation comes in the form of orientation devices, helping you to make better sense of your location within a display – where you are or what values you are looking at. Some of these functions naturally supplement features listed in the previous section about 'data adjustment' specifically for navigation support.

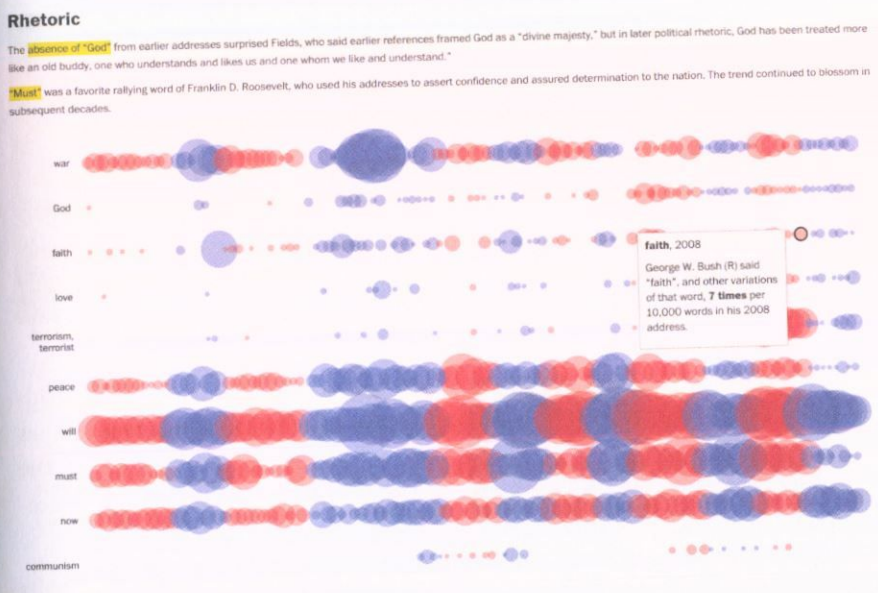


Figure 7.19 Excerpt from 'History Through the President's Words'

Example events/controls	Example functions
Select a link or button	Display values for current position
Select a mark from within a chart	Show visual guides for current position
Mouseover a mark from within a chart	Reveal layer of chart apparatus
Select to alter the state of a toggle or radio button	Highlight changes
Scroll to move	

This snapshot, again from the 'How Americans Die' project (Figure 7.20), dynamically reveals the values of every mark (both x and y values) in this line chart depending on the hover position of the cursor. This effect is reinforced by visual guides extending out to the axes from the current position.

Figure 7.21 displays the language of tweets posted over a period of time from the New York City area. Given the density and number of data points, displaying the details of the mapping layer would be quite cluttered, yet this detail would provide useful assistance for judging the location of the data patterns. The effective solution employed

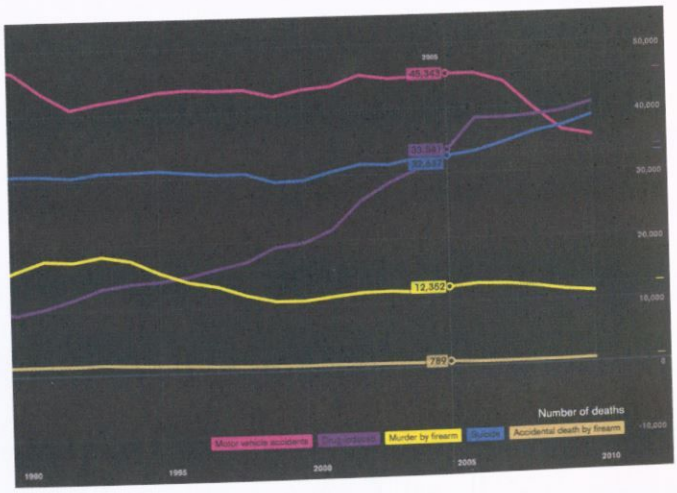


Figure 7.20 Excerpt from 'How Americans Die'

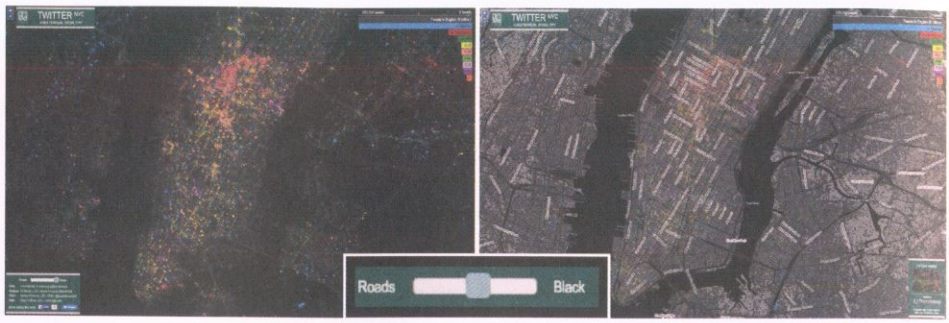


Figure 7.21 Twitter NYC: A Multilingual Social City

Figure 7.22 Killing the Colorado: Explore the Robot River

lets you access both views by providing an adjustable slider that allows you to modify the transparency of the network of roads to reveal the apparatus of the mapping layer.

Finally, as mentioned in the previous section, navigating through digital visualisation projects increasingly uses a vertical landscape to unfold a story (some term this 'scrollytelling'). Navigation is often seamlessly achieved by using the scroll wheel to move up and down through the display. To assist with orientation, especially when you have a limited field of view of a spatial display, a thumbnail image might be used to show your current location within the overall journey to give a sense of progress. The project featured in Figure 7.22 is a great example of the value of this kind of interface, providing a deep exploration of some of the issues impacting on the Colorado River.

7.3 Influencing Factors and Considerations

You now have a good sense of the possibilities for incorporating interactive features into your work, so let's turn to consider the factors that will have most influence on which of these techniques you might need to or choose to apply.

Formulating Your Brief

Skills and resources: Interactivity is unquestionably something that many people aspire to create in their visualisation work, but it is something greatly influenced by the skills possessed, the technology you have access to and what they offer. These will be the factors that ultimately

shape your ambitions. Remember, even in common desktop tools like Excel and Powerpoint, which may appear more limited on this front, there are ways to incorporate interactive controls (e.g. using VBA in Excel) to offer various adjustment features (e.g. links within Powerpoint slides to create sequences and navigate to other parts of a document).

Timescales: It goes without saying that if you have a limited timeframe in which to complete your work, even with extensive technical skills you are going to be rather pushed in undertaking any particularly ambitious interactive solutions. Just because you want to does not mean that you will be able to.

Setting: Does the setting in which the visualisation solution will be consumed lend itself to the inclusion of an interactive element to the experience? Will your audience have the time and know-how to take full advantage of multi-interactive features or is it better to look to provide a relatively simpler, singular and more immediate static solution?

Format: What will be the intended output format that this project needs to be created for? What device specifications will it need to work across? How adaptable will it need to be?

The range and varied characteristics of modern devices present visualisers (or perhaps more appropriately, at this stage, developers) with real challenges. Getting a visualisation to work consistently, flexibly and portably across device types, browsers and screen dimensions (smartphone, tablet, desktop) can be something of a nightmare. Responsive design is concerned with integrating automatic or manually triggered modifications to the arrangement of contents within the display and also the type and extent of interactive features that are on offer. Your aim is to preserve as much continuity in the core experience as possible but also ensure that the same process and outcome of understanding can be offered to your viewers.

While the general trend across web design practice is heading towards a mobile-first approach, for web-based data visualisation developments there is still a strong focus on maximising the capabilities of the desktop experience and then maybe compromising, in some way, the richness of the mobile experience.

For ProPublica's work on 'Losing Ground' (Figure 7.23), the approach to cross-platform compatibility was based around the rule of thumb 'smallify or simplify'. Features that worked on

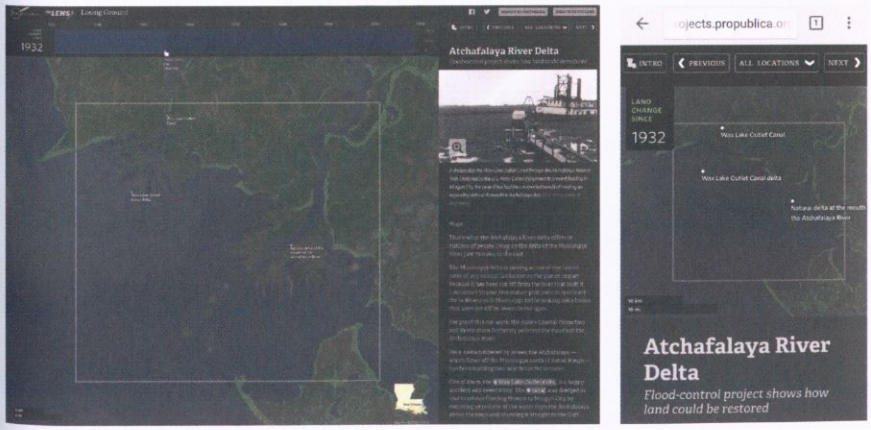


Figure 7.23
Losing Ground

ProPublica's primary platform of the desktop would have to be either simplified to function practically on the smartphone or simply reduced in size. You will see in the pair of contrasting images how the map display is both shrunk and cropped, and the introductory text is stripped back to only include the most essential information.

Other format considerations include whether your solution will be primarily intended for the Web, but will it also need to work in print? The proverb 'horses for courses' comes to mind here: solutions need to be created as fit for the format it will be consumed in. The design features that make up an effective interactive project will unlikely translate directly as a static, print version. You might need to pursue two parallel solutions to suit the respective characteristics of each output format.

Another illustration of good practice from the 'History through the Presidents' words' (Figure 7.24) includes a novel 'Download graphic' function which, when selected, opens up an entirely different static graphic designed to suit a printable, pdf format.

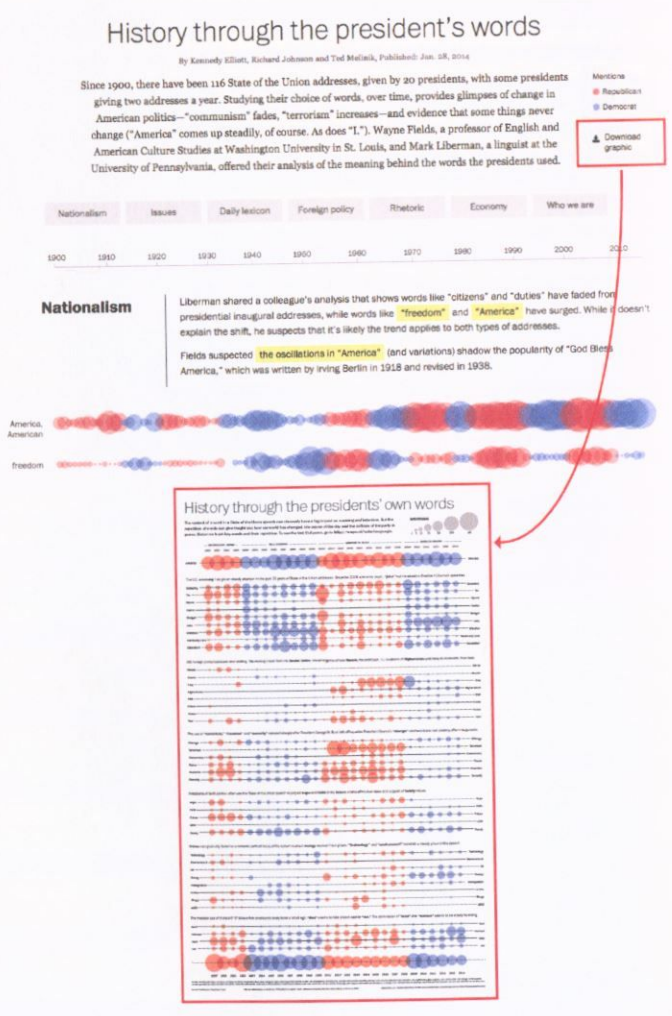


Figure 7.24
Excerpt from 'History Through the President's Words'

Purpose map: Interactivity does not only come into your thinking when you are seeking to create 'Exploratory' experiences. You may also employ interactive features for creating 'Explanatory' visualisations, such as portraying analysis across discrete sequenced views or interactively enabling focus filters to emphasise certain characteristics of the data. The general position defined on the purpose map will not singularly define the need for interactivity, rather it will inform the type of interactivity you may seek to incorporate to create the experience you desire.

There will also often be scope for an integrated approach whereby you might lead with an explanatory experience based around showing headline insights and then transitions into a more exploratory experience through offering a set of functions to let users interrogate data in more detail.

Working With Data

Data examination: As profiled with the functions to facilitate drill-down navigation, one of the keen benefits of interactivity is when you have data that is too big and too broad to show in one view. To repeat, you can only show so much in a single-screen display. Often you will need to slice up views across and within the various hierarchies of your data.

One particular way the physical properties of the data will inform your interaction design choices is with animation. To justify an animated display over time, you will need to consider the nature of the change that exists in your data. If your data is not changing much, an animated sequence may simply not prove to be of value. Conversely, if values are rapidly changing in all dimensions, an animated experience will prove chaotic and a form of change blindness will occur. It may be that the intention is indeed to exhibit this chaos, but the value of animated sequences is primarily to help reveal progressive or systematic change rather than random variation.

The speed of an animation is also a delicate matter to judge as you seek to avoid the phenomenon of change blindness. Rapid sequences will cause the stimulus of change to be missed; a tedious pace will dampen the stimulus of change and key observations may be lost. The overall duration will, of course, be informed by the range of values in your temporal data variable. There is no right or wrong here, it is something that you will get the best sense of by prototyping and trialling different speeds.

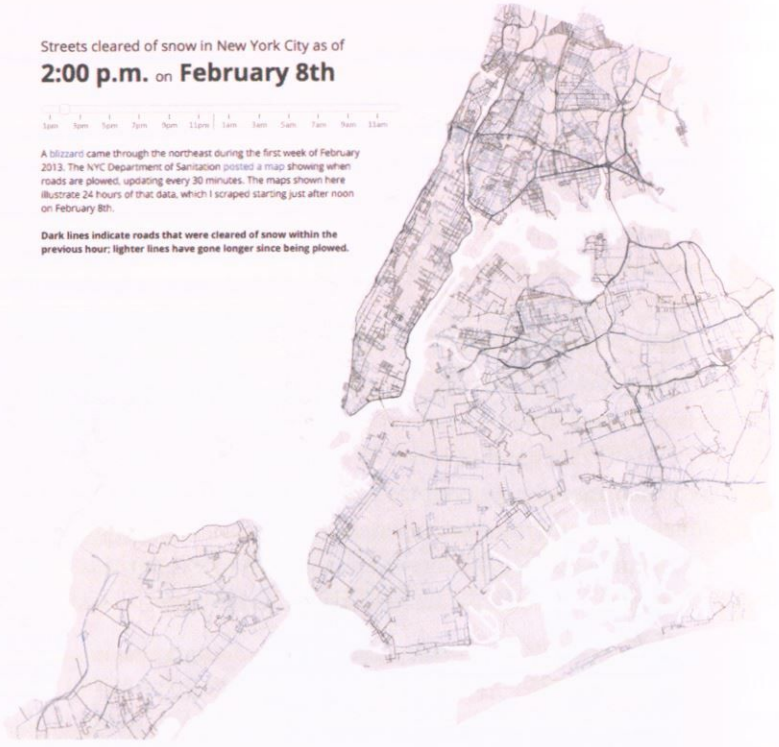
Establishing Your Editorial Thinking

Angle, framing and focus: If you have multiple different angles of analysis you wish to portray then these will have to be accommodated within the space allocated. Alternatively, using interactivity, you could provide access to them via sequenced views or menus enabling their selection. The value of incorporating the potential features to achieve this – and the specific range of different options you do wish to facilitate – will be informed by the scope of the decisions you made in the editorial thinking stages.

Thinking again about animations, you must consider whether an animated sequence will ultimately convey the clearest answer to an angle of interest about how something has changed over time. This really depends on what it is you want to show: the dynamics of a 'system' that changes over time or a comparison between different states over time?

The animated project in Figure 7.25 shows the progressive clearing of snow across the streets of New York City during the blizzard of February 2014. The steady and connected fluidity of progress of the snow-clearing is ideally illustrated through the intervals of change across the 24 hours shown.

Figure 7.25
Plow: Streets Cleared of Snow in New York City



Sometimes, you might wish to compare one moment directly against another. With animated sequences, there is a reliance on memory to conduct this comparison of change. However, our ability to recall is fleeting at best and weakens the further apart (in time) the basis of the comparison has occurred. Therefore, to facilitate such a comparison you ideally need to juxtapose individual frames within the same view. The most common technique used to achieve this is through *small multiples*, where you repeat the same representation for each moment in time of interest and present them collectively in the same view, often through a grid layout. This enables far more incisive

> 'Generations of masterpieces portray the legs of galloping horses incorrectly. Before stop-gap photography, the complex interaction of horses' legs simply happened too fast to be accurately apprehended ... but in order to see the complex interaction of moving parts, you need the motion.' [Paraphrasing] **Barbara Tversky and Julie Bauer Morrison, taken from *Animation: Can it Facilitate?***

comparisons, as you can see through 'The Horse in Motion' work by Eadward Muyrbidge, which was used to learn about the galloping form of a horse by seeing each stage of the motion through individually framed moments.

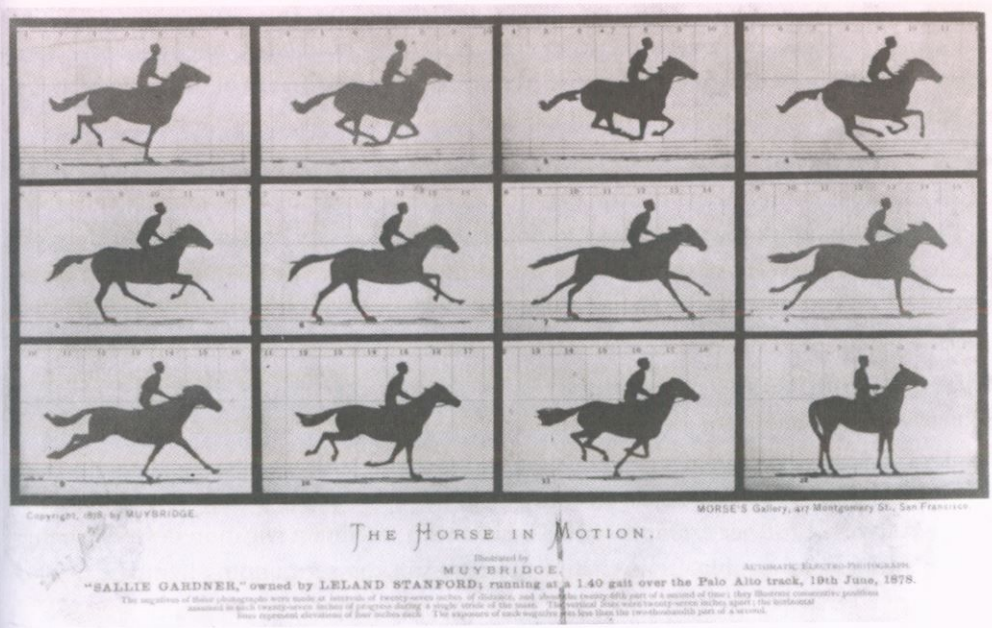


Figure 7.26 The Horse in Motion

Data Representation

Chart type choice: Some charts are inherently visually complex and ideally need interactivity to make them more accessible and readable for the viewer. The bump chart, chord diagram, and Sankey diagram are just a few of the charts that are far more readable and, by extension, usable if they can offer users the means to filter or focus on certain selected components of the display through interactivity.

Trustworthy Design

Functional performance: Faith in the reliability, consistency and general performance of a visualisation is something that impacts on the perception of a project as 'trustworthy'. Does it do what it promises and can I trust the functions that it performs? Projects that involve the collection of user-inputted data will carry extra risk around trust: how will the data be used and stored? You need to alleviate any such concerns upfront.

> 'Confusing widgets, complex dialog boxes, hidden operations, incomprehensible displays, or slow response times ... may curtail thorough deliberation and introduce errors.' **Jeff Heer and Ben Schneiderman, taken from *Interactive Dynamics for Visual Analysis***

Accessible Design

Useful: Does it add value? Resort to interactivity only when you have exhausted the possibility of an appropriate and effective static solution. Do not underestimate how effective a well-conceived and executed static presentation of data can be. This is not about holding a draconian view about any greater merits offered by static or print work, but instead recognising that the brilliance of interactivity is when it introduces new means of engaging with data that simply could not be achieved in any other way.

Unobtrusive: As with all decisions, an interactive project needs to strive for the optimum ease of usability: minimise the friction between the act of engaging with interactive features and the understanding they facilitate. Do not create unnecessary obstacles that stifle sparks of curiosity and the scent of intrigue that stirs within the user. The main watchword here is affordance, making interactive features seamless and either intuitive or at least efficiently understandable.

Visual accessibility: To heighten the accessibility levels of your work you may offer different presentations of it. For people with visual impairments you might offer options to magnify the view of your data and all accompanying text. For those with colour deficiencies, as you will learn about shortly, you could offer options to apply alternative, colour-blind friendly palettes. A further example of this is seen with satellite navigation devices whereby the displayed colour combinations change to better suit the surrounding lightness or darkness at a given time of day.

Elegant Design

Feature creep: The discipline required to avoid feature creep is indisputable. The gratuitous interactive operation of today is the equivalent of the flashy, overbearing web design trends of the late 1990s and early 2000s. People were so quick and so keen to show how competent and expressive they could be through this (relatively) new technology that they forgot to judge if it added value.

If your audience is quite broad you may be (appropriately) inclined to cover more combinations of features than are necessary in the hope of responding to as many of the anticipated enquiries as well as possible and serving the different types of viewer. Judging the degree of flexibility is something of a balancing act within a single project: you do not want to overwhelm the user with more adjustments than they need, nor do you want to narrow the scope of their likely interrogations. For a one-off project you have to form your own best judgement; for repeatedly used projects you might have scope to accommodate feedback and iteration.

Minimise the clicks: With visualisation you are aiming to make the invisible (insights) visible. Conversely, to achieve elegance in design you should be seeking to make visible design features as seamlessly inconspicuous as possible. As Edward Tufte stated, 'the best

design is invisible; the viewer should not see your design. They should only see your content'.

Fun: A final alternative influence is to allow yourself room for at least a little bit of fun. So long as the choices do not gratuitously interrupt the primary objective of facilitating understanding, one should not downplay the heightened pleasure that can be generated by interactive features that might incorporate an essence of playability.

Summary: Interactivity

Data adjustments affect what data is displayed and may include the following features:

- Framing: isolate, include or exclude data.
- Navigating: expand or explore greater levels of detail in the displayed data.
- Animating: portray temporal data via animated sequences.
- Sequencing: navigate through discrete sequences of different angles of analysis.
- Contributing: customising experiences through user-inputted data.

Presentation adjustments affect how the data is displayed and may include the following features:

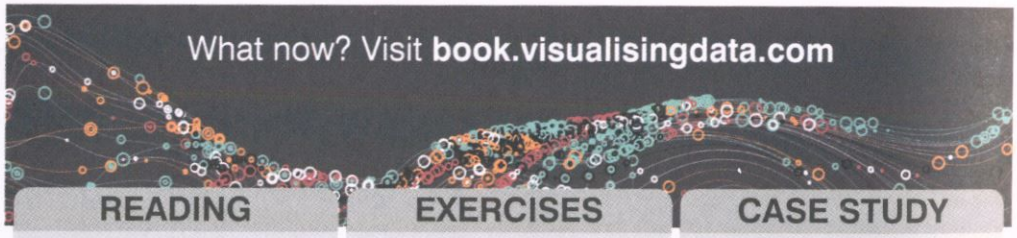
- Focusing: control what data is visually emphasised.
- Annotating: interact with marks to bring up more detail.
- Orientating: make better sense of your location within a display.

Influencing Factors and Considerations

- Formulating the brief: skills and resources, timescales, setting, and format will all influence the scope of interactivity. What experience are you facilitating and how might interactive options help achieve this?
- Working with data: what range of data do you wish to include? Large datasets with diverse values may need interactive features to help users filter views and interrogate the contents.
- Establishing your editorial thinking: choices made about your chosen angle, as well as definitions for framing and focus will all influence interactive choices, especially if users must navigate to view multiple angles of analysis or representations portrayed through animated sequences.
- Data representation: certain chart choices may require interactivity to enable readability.
- Trustworthy design: functional performance and reliability will substantiate the perception of trust from your users.
- Accessible design: any interactive feature should prove to be useful and unobtrusive. Interactivity can also assist with challenges around visual accessibility.
- Elegant design: beware of feature creep, minimise the clicks, but embrace the pleasure of playability.

Tips and Tactics

- Initial sketching of concepts will be worth doing first before investing too much time jumping into prototype mode.
- Project management is critical when considering the impact of development of an interactive solution.
- Backups, contingencies, version control.
- Do not be precious about – nor overly impressed with – 'cool'-sounding interaction features that will disproportionately divert precious resources (time, effort, people).
- Beware of feature creep: keep focusing on what is important and relevant. A technical achievement is great for you, but is it great for the project?
- Version control and file management will be important here.



READING

Visit the chapter's library of further reading and references to continue your learning about the potential for interactivity in data visualisation

EXERCISES

Undertake these practical exercises to help refine your skill and understanding about effectively employing interactivity

CASE STUDY

Work through the next instalment of the Filmographics case-study narrative, discussing how interactivity would be employed