Educational institutions play an instrumental role in social and political change, and are responsible for the environmental and social ethics of their institutional practices. The essays in this volume critically examine scholarly research practices in the age of the Anthropocene, and ask what accountability educators and researchers have in 'righting' their relationship to the environment. The volume further calls attention to the geographical, financial, legal and political barriers that might limit scholarly dialogue by excluding researchers from participating in traditional modes of scholarly conversation. As such, *Right Research* is a bold invitation to the academic community to rigorous self-reflection on what their research looks like, how it is conducted, and how it might be developed so as to increase accessibility and sustainability, and decrease carbon footprint. The volume follows a three-part structure that bridges conceptual and practical concerns: the first section challenges our assumptions about how sustainability is defined, measured and practiced; the second section showcases artist-researchers whose work engages with the impact of humans on our environment; while the third section investigates how academic spaces can model eco-conscious behaviour. This timely volume responds to an increased demand for environmentally sustainable research, and is outstanding not only in its interdisciplinarity, but its embrace of non-traditional formats, spanning academic articles, creative acts, personal reflections and dialogues. *Right Research* will be a valuable resource for educators and researchers interested in developing and hybridizing their scholarly communication formats in the face of the current climate crisis.
Science, humanities and design might seem like unrelated fields. Yet, information designers, who unpack complex data involving real-world issues, can benefit from the ability to synthesize these seemingly disparate practices. To learn more integrated, humanistic approaches to data visualization, we might look to a time when science and the arts were less divided. The following chapter focuses on poet-scientist Johann Wolfgang von Goethe, the Romantic-era polymath. Goethe called his scientific method ‘tender empiricism’, a complementary practice to analytical empiricism. Goethe believed in portraying the same phenomena under subtle, changing conditions. While observing, collecting and visualizing, he also searched for what might be missing. A plant, for example, is not a collection of parts; it also portrays the process of growth even in static form. For Goethe, observational discoveries can change the inquiring mind. In contrast to data visualization practice today, which often focuses on summaries and abstract charts, Goethe believed that authentic, insightful truth dwells in real-world details. The second half of the chapter illustrates how Goethe’s ‘tender empiricism’ can be applied to design pedagogy. These case studies show how a Goethean
Introduction

Scientists study nature. Humanists study human experience. Designers make the artificial world. Yet today, in sustainability and digital humanities projects, these long-divided camps collaborate and co-create. For instance, when planning and implementing a sustainability project that involves data visualization and communication to the public, teams think like scientists: they collect information and analyze it, and conduct research in a structured way. To represent and communicate the data, teams must think like humanists. They try to adopt the perspective of their audience, with empathy for how it feels not to understand a topic. From this insight, designers determine how they present information, from simple to elaborate, and how much to guide readers with explanatory prose and pictures. Even as they design the final product on digital platforms, teams also need to remain attentive to how humans evolved to read their natural environment. These principles translate into how we read charts and maps, ‘landscapes’ of data, in the blink of an eye. In the end, the fields of science, the humanities and design all inform the work of interdisciplinary teams, in support of the most effective, human-centered projects.

For these sustainability teams, we need interdisciplinary people too. Each individual of the team embodies the interdisciplinary ethos. To look for role models for this type of interleaved work, we can acquaint ourselves with a time before scholars and makers specialized. Here, poets could study science and scientists could learn from poets. Visualization, meanwhile, wasn’t just a tool for building abstract charts and applicable insights. Through the ‘mind’s eye’, visualization could also be a tool for beholding and perceiving phenomena without abstract concepts in the way. This provided the beholder a sense of philosophical and spiritual well-being—and also practical benefits in creating richer inquiries.

Consider Johann Wolfgang von Goethe (1749–1832), the late Enlightenment and Romantic-era polymath. Goethe wrote masterpieces of poetry, fiction and autobiography that elevated him to Shakespearean
status in Germany and abroad. However, during his life and especially today, Goethe has enjoyed less recognition for his work in science, a lifelong body of work that included illustrated essays in botany and optics. In this oft unrecognized work, Goethe transcended a duality between the subject, the human inquirer, and object, nature. This blurring prevents people from recognizing Goethe’s work as proper science. In science and philosophy, the figures most responsible for this duality included the astronomer Galileo Galilei (1564–1642) and the philosopher-mathematician René Descartes (1596–1650). Galileo is one of the early pioneers of data visualization. He relied upon sight to gather data, such as the rings of Saturn and the moons of Jupiter. He then illustrated these collections to crystallize insight and published them for the public. His aim: debunk and dispel antiquated beliefs about how the universe worked. In his book *Starry Messenger*, he wrote, ‘What was observed by us is the nature of matter of the Milky Way itself, which, with the aid of the spyglass, may be observed so well that all the disputes that for so many generations have vexed philosophers are destroyed by visible certainty, and we are liberated from wordy arguments’. Yet Galileo believed that the primary qualities of matter consisted of only what could be measured and quantified, and then turned into universal principles through math. He relegated much of the sensuous world, as experienced by us, to secondary qualities that fell outside of science’s concern.

Descartes, meanwhile, believed that nature could be understood as a machine or instrument, with the human as the objective inquirer. Before Galileo and Descartes, science was often practiced as a type of folk ‘natural philosophy’, and even many non-Indigenous societies lived with a more animist concept of the natural world—as glimpsed in the concept of Mother Nature. In western societies, the Galilean and Cartesian influence on science diverted the field from the humanities and the arts. These once overlapping fields parted ways—and even occupied different orbits—compelled by distinctive principles and practices, bodies of knowledge and values.

We might stereotype Enlightenment thinkers as adherents to science, reductive and rational; the Romantic poets, aesthetes driven

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by emotion. Yet Romantic poets such as J. W. von Goethe poured over *On the Nature of Things*, an epic, ancient Roman poem of natural science by Lucretius. The poem espouses the worldview of the ancient Greek philosopher Epicurus, who believed that swerving atoms bring life into becoming and unbecoming. At once, the Romantics were swayed by the vivid observations, ethereal ideas and beautiful words of the poem. To paraphrase Lucretius, poetry’s ‘honeyed cup’ of figurative language could help us accept a world reigned by natural laws, not gods. Here, we’re left to contemplate the bitter serendipity of randomness, not fate, and the here-and-now, with no afterlife. As a poet-scientist in this tradition of ‘sweet science’, Goethe could alternate between literary and lab work, conducting scientific experiments in botany and optics. In his notebooks and publications, Goethe expresses his ideas often in the form of brief descriptive sketches, illustrations, anecdotes and biographical notes that infuse the scientific method with poetry and storytelling. Mindful of diverse audiences and how his ideas would be received, he even wrote a poem that attempted to popularize his botanical method. Here is an excerpt of a poem where he details a leaf, just to see how poetry can sweeten his work in botany:

To see, each leaf elaborates the last—
Serrated margins, scalloped fingers, spikes
That rested, webbed, within the nether organ—
At length attaining preordained fulfillment.
Oft the beholder marvels at the wealth
Of shape and structure shown in succulent surface—
The infinite freedom of the growing leaf.  

Of his scientific method, Goethe writes, ‘Every object well-contemplated opens a new organ of perception in us’. He called this relationship a tender, or delicate, empiricism. For Goethe, the relationship between subject and object was less about mastery, interrogation and control, and more about vulnerability, relationships and pliability. In an authentic encounter with phenomena, the subject in an investigation


can be reshaped by the encounter itself. As Arthur Zajonc, Emeritus Professor of Physics at Amherst College, writes, ‘You have to live in that world of phenomena. You have to attend carefully. “Every object well-contemplated”—not just casually contemplated, but well-contemplated, attended to over time, repeatedly—changes who you are to the point where you begin to see things that you didn’t see originally, and perhaps which no one before you has seen’.4

Unlike Galileo, Goethe lingers on observation without trying to abstract a specific encounter with his object into a universal principle. He was sensuous in an intuitive, perceptive way of a poet, rather than sensory, in an empiricist’s way.5 Goethe contrasted this experimental method—a sequential and logical elaboration of a whole picture from the particulars—with writing. In writing, the author must filter out extraneous sequences that might become boring to a reader. In Goethe’s experimental method, however, the scientist so thoroughly explores every angle, creating minute variations of an experiment with, say, light and color fringes on the edges of black-and-white shapes, so that it can be understood from many points of view. The best experiments enact a series of subtle variations upon a theme. As Craig Holdrege, cofounder of the Nature Institute in upstate New York, writes, ‘We need to learn to move in the world of particulars in a way that allows us to disclose their essential characteristics’.6 Ideally, multiple people can engage in the experiment so that the whole is engaged in the singular experience.

In this chapter, Goethe’s tender empiricism provides an inspirational rather than authoritative model for working with data today. This model encompasses a mindset and methods for making information-rich projects. Together, this mindset and set of methods also promote values of sustainability, the humanities and ethical design. Goethe’s scientific work is an early example of thinking with a deep ecology mindset, a movement that began in literature in the 1970s. In deep ecology work, the inquirer considers the intrinsic value of all life, regardless

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4 Ibid., p. 130.
of its usefulness to human enterprise. By slowing down with tender empiricism, an awareness can grow of the inherent value of the original observation and what it can disclose about the greater story, regardless of our final purposes or projects.

Goethe also suggests methods for encountering and depicting what goes unmeasured and unquantified, and what can’t be mapped and patterned. Any time we create categories, we omit other categories that could have been in the collection. With this ecological mindset, researchers may also include more open-ended data collection techniques to guard against designing in their own biases from the launch of a project. Also, data are plural, and we derive meaning in data in how each entity relates to the other. In systems thinking, these relationships create a whole that’s greater than the parts, just as a flower, a living system, can’t be understood only by plucking it apart. Systems—and even more complex systems, networks of relationships—can’t be pictured through simple and abstract charts. But systems can be portrayed in conceptual maps and drawings that show relationships and enhance our abilities in radiant thinking. Relationships can also be written about, through essaying and providing context—activities that writers excel in.

Data visualization broadens our perspectives by showing us what isn’t visible in daily experience: comparisons, patterns, trends, flows, rhythms and relationships. As we read a chart or map, we’re zooming far out to see the big picture. Yet we’re also abstracting and generalizing from the original phenomena. Goethe’s tender empiricism, meanwhile, allow us to zoom the camera back into the particulars. While Goethe provides inspiration, his writings also provide pointers for getting back into touch with the root word of technology, the ancient Greek *techne*, which meant the inner craft of the creator. In his book *Theory U*, MIT professor Otto Scharmer writes, ‘Galileo transformed science by encouraging us to use our eyes, our senses, to gather external data. Now we are asked to broaden and deepen that method by gathering a much more subtle set of data and experiences from within. To do this, we have to invent another type of telescope: not one that helps us to observe only what is far out—the moons of Jupiter—but one that enables us to observe the observer’s blind spot by bending the beam
of observation back upon its source: the self that is performing the scientific activity.\footnote{Otto C. Scharmer, \textit{Theory U: Leading from the Future as it Emerges} (San Francisco: Berrett-Koehler Publishers, 2016), p. 15.}

Goethe’s way of science supports self-reflective questions, which can guide us toward better designed projects. ‘How can I see this with fresh eyes?’, ‘Am I rushing to judgment?’, ‘What might I be assuming?’ and ‘What am I missing?’ Through visualizing, sketching, portraying and writing, we can even try and answer some of these questions.

Through concrete examples, I will discuss how this deep ecology mindset and methods, as expressed by Goethe, can apply to working with data visualization projects today—especially within the scope of sustainability research and communication. More than a rigid step-by-step process, this essay intends to describe how a shift to an ecological mindset can help yield a richer relationship to objects of inquiry, which benefits makers and readers alike.

\section*{Goethe’s Way of Science}

Long before ecological thinking became mainstream after the 1970s, Goethe expressed similar principles in his scientific studies. Born in 1749 to a wealthy family, Goethe grew up in bustling Frankfurt. His earliest concerns revolved around human affairs. He studied law at the University of Leipzig and then at the University of Strasburg, but his restless curiosity about literature, science and medicine proved impossible to contain. Even at this early age and steeped in city life, Goethe understood that there was no division between the human world and the natural world. Even in his poetry, the supernatural anchored itself in a natural realism. Goethe, law graduate and burgeoning man of letters, would move back to Frankfurt to practice law. He also published \textit{The Sorrows of Young Werther}, a book about matters of the heart that would garner international acclaim. In literary circles, Goethe continued to publish works that defined the Storm and Stress movement, which countered the stately prose of the Enlightenment era.

Goethe’s life would change during a journey to the Rhine in 1774, when he was working on a project that would eventually become his
masterpiece *Faust*. Here, he met the Prince of Weimar, Karl August, who would soon become the Duke of Weimar. Impressed by the affable and renowned young writer, August invited Goethe to join him in his administration of the duchy. On November 7, 1775, Goethe arrived in Weimar, not knowing that his short visit would turn into a lifetime residency. Goethe would serve as the Minister of Finance, the Minister of War and the Minister of Arts, which connected him to the university at Jena, Weimar’s sister city. He would have access to the university’s natural science collections: bones and plants, primarily. He also immersed himself in the ducal gardens and the local forests in the duchy. This was the happiest time of Goethe’s life—by his own account, like a breath of fresh air: ‘I had the joy of exchanging the stuffiness of town and study for the pure atmosphere of country, forest, and garden’.  

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8 Ibid., p. 150.
Goethe launched this botanical research for practical, administrative reasons. But this inquiry would soon become personal and go much deeper, into the nature of plants and our relationship to them. Here, in the garden and forest, administrative tasks led Goethe to marvel at vegetative growth. In his own words:

Here in Weimar the forest was revealed to us in its full length and breadth [...] Conifer forests of all kinds, with their somber greenness and balsam fragrance, beech groves of more joyful appearance, the slender birch and the low, nameless underbrush, had each sought and won its place. We could survey all this in more or less well-forested regions extending for miles.  

In verdant forests Goethe studied roots, mosses, and flowers, and met herbalists searching for medicinal botanical ingredients. Goethe noted that his earliest studies resembled the history of botany: ‘I had progressed from superficial observation to useful application, from need to knowledge’. Here, he emphasizes collecting qualitative data with the purpose of preserving the integrity of forest life:

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Then when the practical utilization of trees arose for discussion, inquiries into their qualities also had to be made. The practice of tapping trees for resin, the abuse of which authorities gradually sought to restrict, led to an examination of the fine balsam juices associated with such trees from root to crown during two centuries of growth, nourishing them and keeping them eternally green, fresh, and alive.¹⁰

‘From root to crown’, Goethe sought to understand, not extract. From this experience, he created portrayals of four types of people who work with data: utilizers, fact-finders, contemplators and comprehenders. These types span the practical to the poetic, as he delineates them:

1. **The utilizers**, advocates and seekers of things practical, are the first to plow the fields of science, metaphorically speaking, and they aim at practical results. Self-confidence derived from experience gives them assurance; necessity gives them a certain breadth.

2. **Fact-finders**, those who crave knowledge for its own sake, require a calm, disinterested gaze, an inquisitive unrest, a clear mind. They are in constant contact with the first group, but work on results from the scientific point of view exclusively.

3. **The contemplators** are somewhat more original, for the mere increase of knowledge, unwittingly fosters interpretation and crosses over into it. Even the fact-finders, however much they make the sign of the crucifix at the very thought of imagination, before they realize it, they are compelled to call upon this selfsame power of assistance.

4. **The comprehenders**—in a deeper sense they might be called creators—are original in the highest sense of the term. By proceeding from ideas, they simultaneously express the unity of the whole, and it is almost the obligation of Nature to conform to the ideas.

Goethe began his research efforts as a utilizer. From the utilizers, Goethe discovered a form of research rooted in empirical observations. From the fact-finders—herbalists and botanists—Goethe encountered botanical

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¹⁰ Ibid.
specimen collections and the classification system invented by Carl Linnaeus. From the contemplators, the poet-scientists such as Lucretius, Goethe learned to be at once appreciative and skeptical of mainstream science. Ultimately, he saw himself as the comprehender, the creator. In placing the comprehender in the same spectrum as utilizers and fact-finders, he may have been inspired by the ancient Roman writer Lucretius, who wrote the epic poem *On the Nature of Things*. Romantic poets such as Goethe were influenced by Lucretius and his sensuous ideas. Lucretius believed in an Epicurean philosophy that advises us not to fear death. Indivisible atoms rain down on the world. A subtle swerve could happen between atoms, creating matter and life; when these bonds coalesce, they can become an organism; when they dissipate, they die. In this way, ‘Each living thing is not singular, but rather a plurality; even so far as it appears to us as an individual, nevertheless it remains an assembly’.11

The comprehenders can see in the parts an expression of the whole, without losing sight of the particulars. We can liken this to a potato, which is grown by planting a cut of potato in the earth. When we dig up the planted potato, we discover many other potatoes growing from the roots. Each new potato, when observed closely, is unique; at the same time, they are all expressions of one potato. Here, true theory is not abstract: it’s the real-world stage on which ideas play. And here, ideas are not abstract concepts or formulas: they are insights. Visualization is a way of seeing with the mind’s eye, as evidenced in the Indo-European root word for idea, *weid*, to see, which would evolve into the Greek word *oida*, to know: the root for idea.

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Goethe revered the Linnaean system, but began to question it as a sole method for relating to nature. Of Jean-Jacques Rousseau’s botanical studies and similar works arranged in accord with Linnaean Classification, Goethe wrote, ‘His method of narrowing down the plant world lends itself to the classification of plants according to families, as we have seen above; and since I too at that time had been led to

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conclusions of this kind, I was all the more forcibly impressed by his presentation [...] Nevertheless, I gradually became aware that some things on the path which he had marked out and I had taken, were holding me back, if not actually leading me astray.\footnote{Goethe (1989), pp. 158–159.}

Goethe, the nascent scientist, encounters Goethe, the longtime poet, and he attempts to reconcile the seeming duality. He expresses his unease with Linnaean taxonomies and hierarchical classifications, which implicitly assume dominion over nature:

...think of me as born poet, who, in order to do justice to his subjects, always seeks to derive his terminology directly from the subjects themselves, each time anew. Imagine that such a man is now expected to commit to memory a ready-made terminology, a certain number of words, and bywords, with which to classify any given form, and by a happy choice to give it a characteristic name. A procedure of that sort always seemed to me to result in a kind of mosaic, in which one completed block is placed next to another, creating finally a single picture from thousands of pieces; this was somewhat distasteful for me.\footnote{Ibid.}

Goethe continued to describe his discomfort with a rigid system that cuts up entities in order to understand a topic:

I recognized the necessity of this procedure, which had as its goal the discussion of certain external plant phenomena, according to general agreement and the elimination of all phenomena that are uncertain and difficult to represent. Nevertheless, when I attempted an accurate application of terminology, I found the variability of the organs the chief difficulty. I lost the courage to drive in a stake, or to draw a boundary line, when on the selfsame plant I discovered first round, then notched, and finally almost pinnate stems, which later contracted, were simplified, turned into scales, and at last disappeared entirely.\footnote{Ibid., p. 60.}

Here, Goethe has moved from emphasizing a collection of nouns—flowers, plants, and their parts—and toward a series of unfolding verbs—contract, turn, disappear. Note that these verbs derive from the plant’s own agency, and not from the need to utilize the plant as an object. In Goethe’s worldview, life exists not for a purpose but simply to be, integrated into an environment. Plants express themselves through
gestures and signifiers, disclosed in petals and unfurling forms—as if it were a language, a language of plants, not humans. Goethe laments the human need to understand nature to justify a theory, or even worse, so that nature can be manipulated for a purpose without first being appreciated in its own language and formative drive. Weeds, Goethe argues, are simply plants that flourish. But conceptualizing them as weeds makes them expendable to utilizers:

Why should he not call a plant a weed, when from his point of view, it really ought not to exist?15

Goethe contrasts this worldview with his own botany practice, which transcends the concept of nature as an object at the mercy of humans: ‘To the science of botany, the most colorful and complex flowers, the most delectable and beautiful fruits, are not more valuable—indeed, in a certain sense, are not worth as much—as a despised weed in its natural state, or a dried and seemingly worthless seed pod’.16

The subject-object duality, a relation of power and control, troubled Goethe, and informed his way of science as a tender empiricism. As Henri Bortoft writes in his book The Wholeness of Nature:

when (Goethe) referred to his way of science as ‘a delicate empiricism which makes itself utterly identical with the object,’ he intended this to be taken literally. This delicate empiricism is a far cry from the assertive empiricism of Francis Bacon’s experimental philosophy, which believed that, ‘nature exhibits herself more clearly under the trials and vexations of art than when left to herself.’ In Bacon’s image of science, nature must undergo questioning and intervention with instruments by the investigating scientists, who thereby remain entirely external to the phenomena they seek to know. Here we have a prime example of the separation of humanity from nature which characterizes the modern attitude [...] this is the result of an act of will which is assertive toward nature instead of receptive.17

Bacon, one of the founders of modern science, promoted a concept of nature as an objectified female, where its mysteries yield themselves only through vexing trials, alluding to violence. This jarring conception

15 Ibid., p. 82.
16 Ibid.
of the objective, empirical view, we could argue, has yielded today’s ecological crisis.

Goethe believes botanists can go deeper than the concepts and classifications that block true seeing. He also celebrates a poetic sensibility in structured inquiry. A weed can be as vibrant as a daisy. Poets make the familiar strange and notice what others might overlook. They seek intrinsic value in what we encounter in our experiences. We cannot get at truth by breaking it apart: once dissected, we can’t reassemble the parts to create an organic, living thing. For Goethe, wholeness reigns, and by being attentive to the particulars—the individual parts of the plant in relation to the plant’s environment and innate drive for growth—the wholeness and the unity of the plant can shine through.

Bortoft even argues that Goethe, the poet-scientist working with the data of experience, was not an empiricist: ‘Goethe did not try to find connections between phenomena by looking at them as collections of empirical facts from which generalizations can be made through induction, in the manner [...] advocated by Bacon [...] on the other hand, he did not attempt to provide coherence in the phenomena through speculative theory, especially not one which introduced elements which are outside of experience. Goethe’s aim was to stay within the experience (he was empirical) but without stopping at the sense experience of the particulars (he was not an empiricist)’.

Goethe was most interested in growth, change, and our own encounter with the phenomena. He coined the term morphology, the scientific study of change. For plants, this change involved metamorphosis. Where earlier scientists studied the historical development of plants, seeking to generalize a pattern while risking losing sight of the particular, original observation, Goethe studied the development of a singular plant. He sought to understand its formative drive toward growth from seed to stem, sepals, petals, stamen, and stigma; full flowering and fruit. This process, like breathing, enacts in a series of contractions and expansions, originating from an archetypal leaf. He writes:

We ought to have a general term with which to designate this diversely metamorphosed organ and with which to compare all manifestations of its form...we might equally well say that a stamen is a contracted petal,
as that a petal is a stamen in a state of expansion; or that a sepal is a contracted stem leaf approaching a certain stage of refinement, as that a stem leaf is a sepal expanded by the influx of cruder saps.\textsuperscript{19}

For Goethe, every part of the plant and flower was a leaf transformed through contraction and expansion—as evidenced by how false petals can appear amidst the stamen in cultivar roses, or in the zinnia from a garden plot.

Fig. 3 False petal in stamen. Photograph by Sweta Pendyala, August 5, 2018.

Plants have an inherent will to grow as part of a universal pattern, a vertical thrust syncopated with a spiral; at the same time, they are shaped by the contexts of their environment. The roots shoot down into the darkness of the earth while the flower expresses the plant’s manifest energies.

The morphology described here does not only refer to the object, the plant, but also to the subject: the person observing the plant. For Goethe sought to understand the phenomena by going into the sensory experience rather than away from it, as we tend to do in research that includes data analytics and visualization. ‘Far from being onlookers, detached from the environment’, writes Bortoft, ‘or at most manipulating

\textsuperscript{19} Johann Wolfgang von Goethe, \textit{Versuch der Metamorphose der Pflanzen zu Erklären} (n.p.: Ettinger, 1790), p. 120.
it externally, Goethean scientists are engaged with it in a way which entails their own development [...] in Goethean science, the scientist [...] has to become the instrument. This is quite a different matter from just using instruments externally, e.g., microscopes and telescopes, to augment the senses'.

In contrast to the mechanical and mathematical, Goethe sought to develop senses attuned to dynamic and the concrete experience: a new organ of seeing, very much like the mind’s eye. Carnegie Mellon design professor Terri Irwin outlines Goethe’s process of perceiving the plant through sensuous and then super-sensuous encounter:

1. **Exact Sense Perception:** The first step on a journey through the parts to the whole of the experience. Undertake a detailed observation of the parts of the phenomenon that can only be perceived outwardly through the full range of our senses. Suspend judgment and preconceptions as you observe all aspects of the phenomenon in an open, listening mood of wonder. View it all for the first time.

2. **Exact Sensorial Imagination:** Bring your observations of the parts of the phenomenon together in your imagination to experience the unity of the generative process. What you observed as static, disconnected parts are brought inward and made fluid as a dynamic process in time. The imagination is used as a tool of perception to visualize the ‘coming into being’ of the organism and its journey in the future to death/decay. It is only in this way that we can come to know the absent whole of the phenomena, which is a temporal being.

3. **Encountering the Whole:** Now active perception and imagining is stilled as you assume a posture of receptive attentiveness in order to let the phenomenon reveal something of its essential nature. The dynamic gesture of the previous stage is deepened to reveal the formative gesture of the organism or its ‘life principle’.

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4. **Becoming One with the Phenomenon:** After grasping the essential gesture of the organism and encountering ‘the whole’ in the previous step, you now go deeper into the phenomenon. The objective is to transcend the particular organism and come to recognize its archetype. Through intuitive perception we merge with the organism and come to recognize its archetype.\(^{21}\)

In the final stage, one becomes ‘utterly identical with the phenomenon’ through tender empiricism. For Goethe, this represents true theory, but not in the abstract theorizing of mechanism. Rather, theory represents beholding, visualizing with the mind’s eye. True theory resides in ‘the mental cinema’ described by writer Italo Calvino in 1984, ‘always at work in all of us—and always has been, even before the invention of cinema—and it never stops projecting images to our inner sight’.\(^{22}\)

### Applying Goethe’s Mindset for Complexity and Ecological Awareness, through Visualization and Drawing

At an October 2019 Thinking through Drawing Conference, held at the State University of New York at New Paltz, I experimented with this Goethean process for visualization. I co-created a drawing and visualization project with Denise Easton and Barb Siegel of the Plexus Institute. They lead workshops on understanding complexity for organizations such as the World Wildlife Fund. For this conference, we encouraged participants to practice visualization not as a tool for creating abstract charts that can be utilized for a purpose, but rather in the Goethean sense. This involved drawing flowers, at first as individuals, and then in small groups.

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\(^{21}\) Terry Irwin, ‘Goethean science and design: A phenomenological approach to understanding whole forms in nature & the built/designed world’, [www.academia.edu/18348890/Goethean_Science_and_Design_A_Phenomenological_Approach_to_Understanding_Whole_Forms_in_Nature_and_the_Built_Designed_World](www.academia.edu/18348890/Goethean_Science_and_Design_A_Phenomenological_Approach_to_Understanding_Whole_Forms_in_Nature_and_the_Built_Designed_World).

Participants began with Exact Sense Perception, by observing a flower placed before them using all five senses and sketching the particulars of what they saw.

Then, they practiced Exact Sensorial Fantasy (Imagination). They closed their eyes and instead of observing particulars, they imagined a process that couldn’t be seen in any given moment: the growth of the plant. In people, it’s difficult to see the child in the adult. Yet plants disclose the relationship between time and growth in their very form, the plant shooting upward from its stem to the crown of leaves and flowers. The earlier stages of the plant remain present even in full flower. This practice allows participants to think beyond rigid categories and nouns, and toward verbs, systems and relationships. As individuals imagined this sequence, they made further gestural sketches attempting to portray this growth.

Then, they Encountered the Whole by returning to a fresh sheet of paper to co-create a drawing of the flower that discloses its particular characteristics and portrays gestural growth.
8. Inspiration from Goethe’s Tender Empiricism

Fig. 5 Sketch of the particulars by a workshop participant. October 6, 2019.

Fig. 6 Co-created sketch of the whole by workshop participants. Photograph by Joshua Korenblat, October 6, 2019.
Finally, we explained how this process, when repeated, can allow the subject to attempt to Become One with the Phenomenon, in the sense that the subject’s awareness has shifted to a deeper relationship with the object of inquiry. Participants shared these sketches and discussed how the earlier individual and contemplative work allowed them to co-create freely with their small groups. Participants completed a Somatic Attention worksheet, one of the Plexus Institute worksheets that help people in organizations become more bodily aware of their presence in a greater whole.

This sketching mindset can provide a complementary way of thinking and making in otherwise analytical projects. In some ways, it goes beyond systems thinking in its holistic mindset because it stays closer to the original phenomena, without transforming it into the abstractions we often see in systems diagrams and conceptual maps. Researchers working on data visualization can search for the examples
8. Inspiration from Goethe’s Tender Empiricism

of the original phenomena at the heart of their inquiry. Through writing and sketching in a notebook, they can find ways to close the distance between the subject and object of their inquiry, in all its qualities. We can hold these qualities in dialogue, with responsibility, tenderness and care, for more authentic portrayals of reality.
Goethe and Learning How to Create Data Visualizations Today

How might Goethe’s way of science provide a more practical set of insights into working with quantifiable observations today? Exploratory data processes involve classification, measurable observation, analysis, and the mapping and patterning of entities. This work requires literacy in working with numbers and making charts and graphs. Yet Goethe admitted that he was ‘by nature averse to counting and classification’, the foundations of visualization today. Goethe’s methods lead us into the phenomena, to contemplation and comprehension, rather than to the explanations we utilize in everyday actions in the world. Galileo and Descartes inform data visualization in thinking, doing, and making—we make charts on Cartesian coordinates. The mechanists have their due. But what about the Romantic poet-scientist, relegated to obscure footnotes?

To answer the question of what people working with quantifiable data can learn from poets like Goethe, we can think about how a beginning student in any storytelling course might learn to gather and understand information. For a new story, the student might typically answer the Six W’s—Who/What, How much/many, Where, When, How, and Why. In a data visualization course, the student can answer four of the Six W’s pictorially: through bar charts, for instance, we can compare the who/what and the how much/many. With a map, geographic or conceptual, we can identify the where in the story. With line charts and timelines, we can trace the when, the sequence of events. But even with a scatterplot or multivariable plot, which measures the relationships between entities, we often can’t access the how and the why. As the famous saying goes, correlation does not mean causation. Just because we might see a relationship between increased ice cream sales at the beach and shark attacks, does not mean that ice cream sales cause shark attacks, to cite one vivid example. To integrate the how and the why, the data designer must write a headline and provide guiding text so that the reader can reason through the story.

The sequential order of these questions also maps to visual perception, how we orient ourselves in any new scene through pre-attentive

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processing. To situate ourselves in a setting, we only land on the how and why after rapidly processing who/what is involved, how much/many, where, and when. Yet even in the perceiving moment, we leap to conclusions in the how and the why so that we resolve ambiguity and avoid danger. This, of course, can lead to biases and misjudgments that transform reasoning into rationalization. Goethe’s ideas can help us become more comfortable with delaying the how and the why in the experimental process of analyzing and visualizing data for an extensive period of time. Instead, we can devote more time to conversing with the observations themselves, taking time to reframe them to validate our reasoning.

Recall Goethe’s method of picture building. As Cornell University Professor Amanda Jo Goldstein writes in her book *Sweet Science*, ‘Frederick Amrine has aptly described Goethe’s empiricist methodology as the controlled development of new ways of seeing as many modes of representation as possible, or better, to cultivate the mode of representation that the phenomena themselves demand’. This process offers insight for anyone sketching with data in tools like Excel, Tableau, or R. When sketching with data on the computer, it’s important to reframe what appears on screen by asking questions. Rutgers University professor Jane Miller recommends identifying the general picture that appears, depicted by the magnitude of comparisons and directions of change. Then, the researcher can find and describe exemplary data points, and finally, exceptions or outliers. Here, the researcher alternates between focused attention and open awareness, between letting new ideas and questions appear as a workbook fills with data sketches, in sequence on worksheets and in juxtaposition on dashboards.

For Goethe, experiments were scientific only because they involved subtle modifications and tests, from multiple angles and with attention to perception. He detested Newton’s theory of light, borne out from a singular prism experiment, partially because it did not result from a process of picture building. Goethe uses the analogy of getting to know the authentic nature of a man: you can’t learn much from discrete measures of intelligence, height, and weight. But see his actions in the crucible of decisions, and you can know a lot about that man. For Goethe, one arrives at truth through a biography, not a summary.

In a conventional approach to teaching data visualization, an educator can give beginning students small, summarized sample data sets without much context, and then students work their way up to richer data sets implicated in real-world contexts. The problem with the simple to complex approach: the small sample data set lacks the ‘ecological’ context that Goethe’s tender empiricism attends to through picture building. Goethe’s approach suggests an alternate educational approach. When we learn data visualization, we can scaffold projects from the complex to the simple, rather than from the simple to the complex. Software enables students to sketch and reframe many variables almost immediately, to examine their interplay in relationship to the greater story. Students learn data visualization not from a rigid set of rules of reading, understanding, and making charts, but rather from working in complexity and multiplicity.

In a Goethean method, students begin with a more complex data set, aware of its original, situated context. I’ve tried this method in an introductory course I teach, Data Visualization, to students in graphic design and digital media journalism. Students work in three phases—although they don’t have to be performed in rigid sequential order. I’ve adapted some of these ideas from Cole Nussbaumer Knaflic, and her 2019 book *Storytelling with Data: Let’s Practice!*

First, the Big Idea: students interview a dataset to study an individual record and understand how many variables are present. They understand the type of data in each variable, the range of values, and the level of detail presented at the smallest scale. They detail what’s missing and inquire why this information is missing. To do this, students create a data biography that provides a portrait of who collected the data and why, which leads them into contextual inquiry on the topic. They begin to articulate the purpose of their inquiry: the audience, context and message, and write their purpose in a single sentence. Then, they elaborate on that sentence through writing and storyboarding to develop a visual plan, giving and receiving feedback from their peers. They’d make a big picture sketch to capture the idea in a holistic and radiant way too.

In the next phase, Details, students gradually match the visual plan and big picture sketch to appropriate charts. To do this, students identify what they’re trying to do with the chart, such as make comparisons or
show relationships. They’d select chart types that can fulfill this purpose in an accurate way. Moving onto the computer, students use software to swiftly iterate and reframe visualizations for insight, all the while reducing visual clutter and focusing reader attention on what’s most important. While making these charts, students attempt to answer the 6 W’s with descriptive headlines and annotations. Students understand the chart for themselves, and then attempt to relate their understanding to other people.

During the Story phase, students then structure this material into a narrative arc that’s appropriate for their Big Idea. In the final phase, Crafting, students make sure that abstract charts also have pictures nearby, to remind the reader of the original phenomena and what’s at stake in the story. Crafting involves attention to the visual surface of the data visualization, to make the reading experience more intuitive and to draw readers in emotionally.

Below, I’ve provided examples of this process from one student’s work in my introductory data visualization course. These projects emphasize sustainability and human-centered design principles as well.

Table 1  Emma Noyes: Data interview from Viz for Social Good: United Nations in Papua New Guinea, April 2020.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Granularity (What does a single record mean?)</td>
<td>One individual’s answer to one question</td>
</tr>
<tr>
<td>2. Rows (How many total records?)</td>
<td>186821</td>
</tr>
<tr>
<td>3. Columns (How many different variables?)</td>
<td>7</td>
</tr>
</tbody>
</table>
| 4. Types (are variables nominal, ordinal, interval, or ratio?) | Age: Ratio  
Answer: Nominal  
District: Nominal  
Gender: Nominal  
ID: Interval  
Province: Nominal  
Question: Nominal |
### Interviewing the data

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Unique Key (Is one of the variables unique?)</td>
<td>No</td>
</tr>
<tr>
<td>6. Boundaries (min &amp; max of quantitative variables)</td>
<td>Age: min 0 1 max 79927561 (I am still trying to figure out why this is...)</td>
</tr>
<tr>
<td></td>
<td>ID: min 1 1 max 7817</td>
</tr>
<tr>
<td>8. Levels (What are the values of the quantitative variables?)</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>ID: Numbered from 1 onward for each response to a particular question. Ex: 1—93 for “Do you know about the Sustainable Development Goals in Bougainville province; 94–167 for the same question asked in Central province</td>
</tr>
<tr>
<td>9. Hierarchies (Do some levels form hierarchies?)</td>
<td>Hierarchy between Province and District</td>
</tr>
<tr>
<td>10. Nulls (Are there any missing values? Why?)</td>
<td>There are missing answers to many questions. I think this is because certain questions do not apply to some people (for a question like “Where were your children immunised?” some do not have children), and/or because people just did not provide an answer.</td>
</tr>
</tbody>
</table>

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### Data Biography

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dataset Name</td>
<td>United Nations in Papua New Guinea</td>
</tr>
<tr>
<td>Goals</td>
<td>“The UN System in Papua New Guinea has worked extensively with the Government to localize the SDGs and integrate them into the national development framework. The goal is to visualize data sets related the SDGs indicators gathered from over 8,000 SMS survey participants across 22 provinces in Papua New Guinea.”</td>
</tr>
<tr>
<td>How was the data collected</td>
<td>Data was collected ”by using an innovative SMS platform.” I was unfortunately unable to find more information about this on the UN Papua New Guinea website.</td>
</tr>
<tr>
<td><strong>Data Biography</strong></td>
<td><strong>Answers</strong></td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Questions</td>
<td><img src="https://docs.google.com/spreadsheets/d/1YZMzzzs0VqmHYjuMaUzkdAosHB3sQotubm-Yh4PyO/edit#gid=693674619" alt="URL" /></td>
</tr>
<tr>
<td>Link to data source</td>
<td><img src="https://www.vizforsocialgood.com/join-a-project/2017/11/10/united-nations-in-papua-new-guinea" alt="URL" /></td>
</tr>
<tr>
<td>Link to storage source</td>
<td><img src="https://www.vizforsocialgood.com/join-a-project/2017/11/10/united-nations-in-papua-new-guinea" alt="URL" /></td>
</tr>
<tr>
<td>Notes on data quality</td>
<td>The dataset is organized quite well for data viz use... but I think that was intentionally done by someone at VFSG</td>
</tr>
<tr>
<td>Sample Size</td>
<td>8,000 people</td>
</tr>
<tr>
<td>Topic</td>
<td>Data is collected on 35 areas of SDGs related indicators as well as the overall perception on the SDGs. Each data contains information on the survey answer, province, gender, and age. *All quotes from VFSG project page: <a href="https://www.vizforsocialgood.com/join-a-project/2017/11/10/united-nations-in-papua-new-guinea">https://www.vizforsocialgood.com/join-a-project/2017/11/10/united-nations-in-papua-new-guinea</a></td>
</tr>
<tr>
<td>Variables</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>Answer</td>
</tr>
<tr>
<td></td>
<td>District</td>
</tr>
<tr>
<td></td>
<td>Gender</td>
</tr>
<tr>
<td></td>
<td>ID</td>
</tr>
<tr>
<td></td>
<td>Province</td>
</tr>
<tr>
<td></td>
<td>Question</td>
</tr>
<tr>
<td>When was the data collected</td>
<td>Not entirely clear but sometime before November 10, 2017, when the VFSG project was started.</td>
</tr>
<tr>
<td>When was the data last updated</td>
<td>Not entirely clear but sometime before November 10, 2017, when the VFSG project was started.</td>
</tr>
<tr>
<td>Who collected the data</td>
<td>&quot;The UN Communication Group, made up of UN Communication Specialists in Papua New Guinea&quot;</td>
</tr>
<tr>
<td>Who owns the data</td>
<td>The United Nations</td>
</tr>
<tr>
<td>Questions</td>
<td>Answers</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Who was included/excluded fro..</td>
<td>Because data was &quot;gathered from over 8,000 SMS survey participants,&quot; I would assume that whoever chose to not participate is excluded.</td>
</tr>
<tr>
<td>Why was the data collected</td>
<td>&quot;With 85 percent of the country's population living in rural areas with underdeveloped infrastructure, and approximately 30 percent of the population not accessing any form of media, such inaccessibility to people also limits data availability, particularly disaggregated data. As identification of the most disadvantaged is key to implementing the SDGs, the UN Communication Group, made up of UN Communication Specialists in Papua New Guinea, has undertaken a project to collect disaggregated data by using.&quot;</td>
</tr>
</tbody>
</table>
8. Inspiration from Goethe’s Tender Empiricism

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**Fig. 9a Emma Noyes: Working process examples from Viz for Social Good: United Nations in Papua New Guinea, April 2020 [Worksheet].**
Fig. 9b Emma Noyes: Working process examples from Viz for Social Good: United Nations in Papua New Guinea, April 2020 [Sketch].
Fig. 9c: Emma Noyes: Working process examples from Viz for Social Good: United Nations in Papua New Guinea, April 2020 [Final project].

Gender Equality and Family Health & Wellness in Papua New Guinea

The Sustainable Development Goals (SDGs) are a global call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. To that end, the Sustainable Development Solutions Network (SDSN) and United Nations University (UNU) have been running the SDSN Alumni Survey since 2014. The survey seeks to gather data on numerous topics related to the SDGs across the globe.

In this example, we see data from Papua New Guinea relating to gender equality and family health. The charts illustrate the percentage of responses to various questions, such as:

- Gender
- Violence

The data shows that 41% of respondents were subjected to violence by a current or former partner in 2017, and 49% received no information about family planning from a health provider in 2017.

These insights highlight the importance of addressing gender equality and family health in Papua New Guinea and the need for improved information and support systems for women.
### WHO IS YOUR AUDIENCE?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>List the primary groups or individuals to whom you’ll be communicating.</td>
</tr>
<tr>
<td></td>
<td><strong>People on the board of Global Fund for Women</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Advocates for women’s rights</strong></td>
</tr>
<tr>
<td>2.</td>
<td>If you had to narrow that to a single person, who would that be?</td>
</tr>
<tr>
<td></td>
<td><strong>Lachmaya Mapp Frett, President and CEO of Global Fund for Women</strong></td>
</tr>
<tr>
<td>3.</td>
<td>What does your audience care about?</td>
</tr>
<tr>
<td></td>
<td>The health and well-being of women all around the world</td>
</tr>
<tr>
<td>4.</td>
<td>What action does your audience need to take?</td>
</tr>
<tr>
<td></td>
<td>Spread awareness and donate to treating obstetric fistula</td>
</tr>
</tbody>
</table>

### WHAT IS AT STAKE?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What are the benefits if your audience acts in the way that you want them to? (Not current)</strong></td>
<td></td>
</tr>
<tr>
<td>More than 10,000 women annually will be treated for obstetric fistula</td>
<td></td>
</tr>
<tr>
<td>More women will be able to have safe childbirths</td>
<td></td>
</tr>
<tr>
<td>Gender inequality in African and South Asian societies will decrease</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>What are the risks if they do not?</strong></td>
</tr>
<tr>
<td>The 1,000,000 women in Africa and South Asia with fistula will continue to suffer</td>
<td></td>
</tr>
<tr>
<td>There will continue to be a lack of access to safe obstetric care</td>
<td></td>
</tr>
<tr>
<td>Social inequality will increase</td>
<td></td>
</tr>
</tbody>
</table>

### FORM YOUR BIG IDEA

It should:

1. Articulate your point of view.
2. Convey what’s at stake, and
3. Be a complete (and single) sentence.

If the Global Fund for Women does not take action to spread public awareness of obstetric fistula and donate to provide treatment for women with this injury, more than 1,000,000 women will continue to suffer and die in Africa and South Asia because of fistula and social isolation.

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Fig. 10a Emma Noyes: Working process examples from Operation Fistula, May 2020 [Worksheet].
Fig. 10b Emma Noyes: Working process examples from Operation Fistula, May 2020 [Idea board].
Fig 10c Emma Noyes: Working process examples from Operation Fistula, May 2020 [Sketch].
Obstetric Fistula: A Women's Health Crisis

Obstetric fistula is a childbirth injury that occurs when a woman experiences obstructed labor without access to the care she needs to give birth safely. Days of unrelieved labor causes holes (aka fistula) to form between the vagina and rectum or bladder walls. This detrimental condition causes unborn children to die and has severe health and societal consequences for mothers. Over 1,000,000 women are currently living with fistula, but only 15,000 are treated yearly.

More Births Unattended by Health Staff Correlates with Low Female Life Expectancy

87% of fistula countries had below average attended births and female life expectancy from 2000-2015.

Fewer Hospital Beds Correlates with Low Female Life Expectancy

96% of fistula countries had a below average number of hospital beds per 1,000 people from 2000-2015.

Fig 10d Emma Noyes: Working process examples from Operation Fistula, May 2020 [Final project].
Fig. 10e Emma Noyes: Working process examples from Operation Fistula, May 2020 [Final sketch]. The final sketch shows the plan to introduce more pictorial imagery in the final crafted project, so that abstractions do not become barriers to what is happening in lived reality.
Nina Guido, a Data Visualization student, shows the benefits of attending to all four phases—Big Idea, Details, Story and Crafting—in her makeover of the Bee Informed Partnership dashboard, which tracks honeybee colony loss in the United States.

![Image 1](image1.png)

**Fig. 11** Nina Guido: Bee Informed Partnership dashboard, before the makeover, April 2019.

**Fig. 12** Nina Guido theguardian.com/books/2016/oct/28/amitav-ghosh-where-is-the-fiction-about-climate-change:- Bee Informed Partnership dashboard makeover, April 2019.
Goethe teaches patience with his practice of careful picture building, and in this patience, we cultivate analysis by examining the particulars of a phenomenon, synthesis by scaling out to the whole, and most neglected of all, seeing with the mind’s eye. In his introduction to his *Theory of Colour*, Goethe writes, ‘The desire for knowledge is first stimulated in us when remarkable phenomena attract our attention. In order that this attention be continued, it is necessary that we should feel some interest in exercising it, and thus by degrees we become better acquainted with the object of our curiosity’. He continues to describe the working process of understanding phenomena:

During this process of observation we remake at first only a vast variety which presses indiscriminately on our view; we are forced to separate, to distinguish, and again to combine [...] to accomplish this [...] requires an unremitting and close application; and we find for this reason, the men prefer substituting a general theoretical view, or some system of explanation, for the facts themselves, instead of taking the trouble to make themselves first acquainted with cases in detail and then constructing the whole.25

A contemporary reviewer of Goethe’s way of science listed techniques that appear in the poet-scientist’s notetaking and writing. Here, I apply Goethe’s techniques to working with data today, mindful of not muting the original phenomena.26

1. Essay

*To essay* means to sift through an idea. Like a filter, this allows a reader to focus on a particular observation and appreciate it in its own right. This can be an exemplary observation from the dataset or an exceptional one. To get back to original, individual things, consider writing brief essays about your data observations. For instance, working with the original Titanic passenger manifest (a popular sample dataset that unlike other

sample sets, comes with a lot of context), a researcher can look up a family in the record and attend to them through some writing that creates a living portrait. For example, who were the Goodwin family, who appeared on the passenger manifest? By conducting some research, we can give a face to the data, a story, and remind ourselves what is at stake in the dataset.

This is also the Nature Institute’s approach in essays such as *The Flexible Giant: Seeing the Elephant Whole*. Characteristics of the elephant are described in an essay format, constantly relating the particulars—the trunk, the head and so on—to not only the whole elephant, but also its existence in an environment, which is no less a part of the elephant. By essaying and sketching our observations, we begin to go beyond object thinking and see the observation in its own interest. The elephant, or even the most minute observation, can become a ‘small world’, as Goethe puts it.

2. Organize

Some new tools, such as Palladio, by Stanford University, and the commercial app Airtable, allow researchers to see their data collections in multiple views, such as in spreadsheets or on cards. Images and links can be added to the cards, creating a rich exploratory environment unmoored from the constraints of the spreadsheet. By creating pictorial sets that can be rapidly rearranged, we discover new insights in the relationships between observations. Perhaps this is why Goethe wished he could write less and draw more.

3. Combine with Biographical Material

The researcher can acknowledge their own worldview and also the biography of whomever collected the data. By becoming mindful of the biographies involved in the data collection process, the researcher can become more aware of what biases might exist in the collection. For example, in Hans Rosling’s popular Gapminder visualizations, he measures relationships between health and wealth of countries around the world over the past two hundred years. Based on his variable selections, he paints a justifiably optimistic trend. But what if he were to...
measure an index of happiness instead on one of the axis lines? Would new shapes and inferred stories emerge? The kingdom of Bhutan, for example, measures the happiness of its people, and not just their productivity—but it is not a common question to ask in the capitalist countries. What do we miss when we make assumptions about how the world works? The same holds true for the data analyst and designer. Consider writing in the first-person voice to acknowledge that designing with data is not an objective experience.

4. Deductions and Inductions

Goethe was skeptical of both of these methods—they either lead to hypothetical proofs or toward abstractions. Yet he did rely upon deduction and induction, which involve moving from the big picture to the details and back again. To do this, consider keeping a notebook or sketchbook next to the computer. Pen and paper excel in big-picture thinking, which eventually will lead to the details; the computer excels at working with the details and building them up into a whole, the big picture. This dialectic helps the final visualization product become more human and relatable.

5. Poetic Infusion

Recall that poets can make bitter ideas sweeter to imbibe, a tradition that harkens back to Lucretius and that Goethe continued. Poetry also helps readers attend to even a humble weed with wonder. The goal of poetry: Transcend the conceptual barriers we place between ourselves and the phenomena-filled world.

6. Accessible Examples: Appropriate for Beginners

Goethe’s writing is much more accessible than many of the academic writers who write about Goethe. His literary sensibilities even allow for metaphor in writing about scientific ideas, which might seem anathema to objective, empirical descriptions. Indeed, metaphors accentuate what two entities have in common, while the metaphor risks losing sight of how the entities differ. Yet metaphors remain a primary way we reason with the world. They help us understand the unfamiliar through
familiar terms. How might we use metaphor in explaining topics, or make charts that also resemble the topic to make it more memorable, and harken back to pictorial rather than abstract experiences? For example, in Nina Guido’s geographic maps of honeybee colony loss, she chose a honeycomb shape for each state and honeyed colors, enriching our abstract reasoning with what’s at stake in the real world.

7. Share Ideas, Cooperate, Criticize, Oppose as Needed

One theory in entrepreneurship states that five people, well suited for each other, can accomplish just about anything. Several people focused on one subject can produce the most outstanding results, as Goethe understood and championed.

8. Make your Projects Remixable

Goethe documented his poet-scientist process and elaborated upon it in great detail. Through his experiments, illustrated writing and poems, he advocated for the spiritual, philosophical and practical benefits of his way of working and tried to popularize it. Craig Holdrege reflects on the Goethean approach, which begins in experiments—a conversation between the subject and the object so that the particulars of an experience are not harmed. Here, the subject is vulnerable to the object of inquiry: the object, the manifold experience we try to understand, can only be more fully grasped when one becomes humble enough to admit multiple subjects into the inquiry:

In this work you make your own observations, but you also interact with and utilize the work of others […] Here is where a research community evolves […] As Goethe writes, ‘What applies in so many other human enterprises is also true here (in science): the interest of many focused on a simple point can produce excellent results. […] I have always found working together with others so advantageous that I have every reason to continue doing so’.

From these multiple points of view, a rich and salient portrait can be created, the biography of an idea. This idea—radical collaboration—is

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often touted in systems thinking and design thinking. The most wicked problems yielded in sustainability research require the integrative perspectives of scientists, humanists, and designers. To make your data visualization projects more vivid, shareable, and credible, consider posting them to open platforms so that communities can examine and remix them with the source data. In mindset and method, this type of convivial, co-creative work corresponds with the broadened perspectives that data visualization affords.

Bibliography

Andrews, R. J., Info We Trust: How to Inspire the World with Data (Hoboken: John Wiley & Sons, 2019).


Goethe, Johann Wolfgang von, Versuch der Metamorphose der Pflanzen zu Erklären (n.p.: Ettinger, 1790).


Holdrege, Craig, Thinking Like a Plant: A Living Science for Life (Great Barrington: Lindisfarne Books, 2013).


Irwin, Terry, ‘Goethean science and design: A phenomenological approach to understanding whole forms in nature & the built/designed world’, www.academia.edu/18348890/Goethean_Science_and_Design_A_
Phenomenological_Approach_to_Understanding_Whole_Forms_in_Nature_and_the_Built_Designed_World


