

Big data in the age of the telegraph

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Daniel McCallum's 1854 organizational design for the New York and Erie Railroad resembles a tree rather than a pyramid. It empowered frontline managers by clarifying data flows.

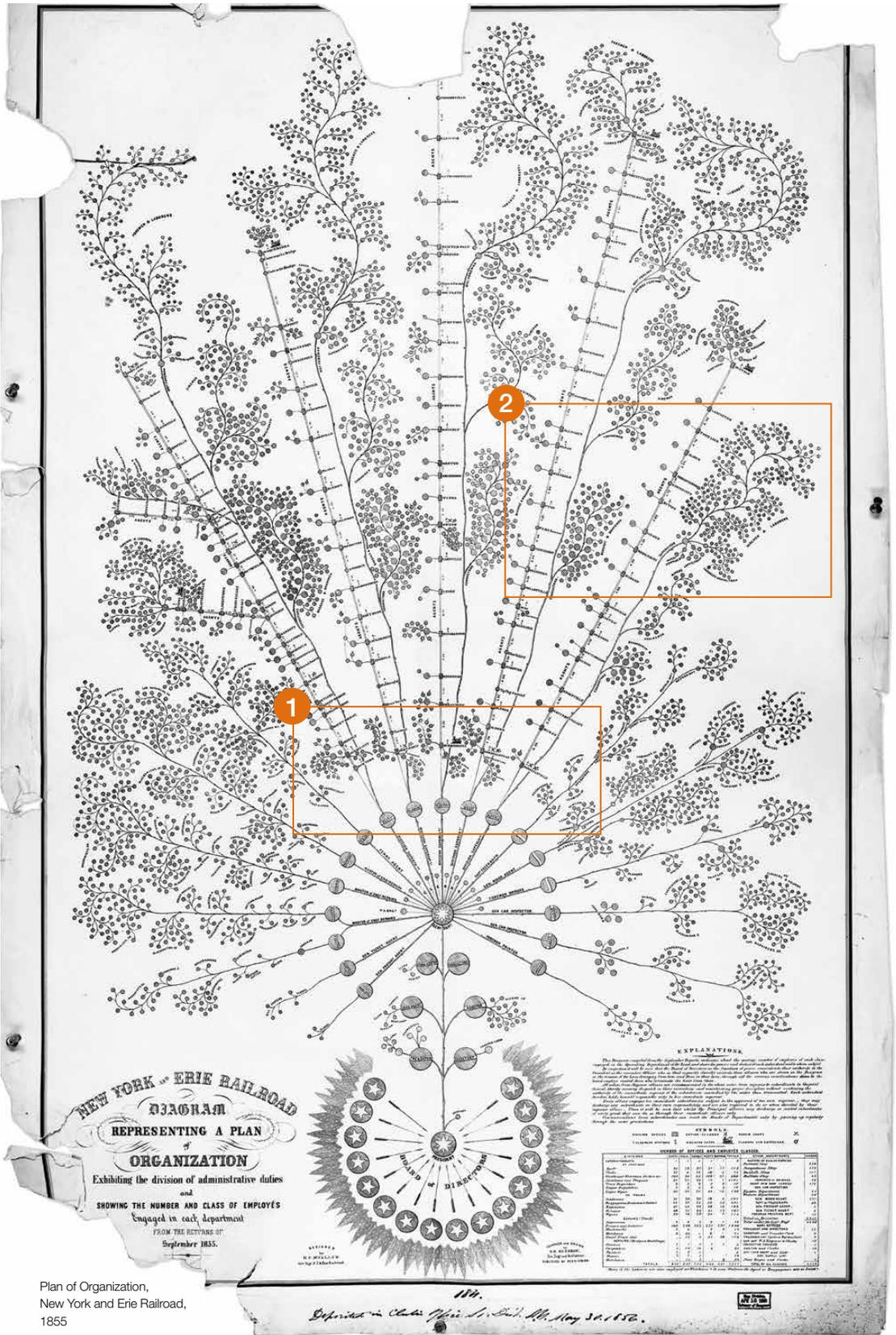
In 1854, Daniel McCallum took charge of the operations of the New York and Erie Railroad. With nearly 500 miles of track, it was one of the world's longest systems, but not one of the most efficient. In fact, McCallum found that far from rendering operations more efficient, the scale of the railroad exponentially increased its complexity.¹

The problem was not a lack of information: the growing use of the telegraph gave the company an unprecedented supply of nearly real-time data, including reports of accidents and train delays.² Rather, the difficulty was putting that data to use, and it led McCallum to develop one of the era's great low-tech management innovations: the organization chart. This article presents that long-lost chart (see exhibit, "The first modern organization chart"; and sidebar, "Tracking a missing org chart") and shows how aligning data with operations and strategy—the quintessential modern management challenge—is a problem that spans the ages.

'Big data,' then and now

Just as information now floods into companies by the tera-, peta-, and exabyte, during the mid-19th century, governments, businesses, and universities produced and grappled with what one historian has called an "avalanche of numbers."³ To be sure, McCallum's rail lines may not have generated even a megabyte of information. But this was indeed big data for him and his senior deputies, who were managing a system of unprecedented proportions. Although the telegraph's speed made more information available, organizing and acting on it became increasingly difficult. One delayed train, for example, could disrupt the progress of many others. And the stakes were high: with engines pulling cars in both directions along a single set of rails, schedule changes risked the deadly crashes that plagued 19th-century railroads.

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Plan of Organization, New York and Erie Railroad, 1855

Courtesy of the Geography and Map Division, Library of Congress.

Exhibit

The first modern organization chart

Daniel McCallum created the first organization chart in response to the information problem hobbling one of the longest railroads in the world. In surprising contrast to today's top-down organization pyramids, in McCallum's chart the hierarchy was reversed: authority over day-to-day scheduling and operations went to the divisional superintendents down the line, who oversaw the five branch lines of the railroad. The reasoning: they possessed the best operating data, were closer to the action, and thus were best placed to manage the line's persistent inefficiencies.



Each superintendent was responsible for the physical geography of the tracks and stations and for the men who moved along the rails: conductors, brakemen, and laborers. Coordinating activities between these two branches, the superintendents managed both the fixed depots and the rolling stock that moved between them.



As McCallum reflected, “A superintendent of a road 50 miles [long] . . . may be almost constantly upon the line engaged in the direction of its details.” But on railroads like his, which stretched for hundreds of miles, no individual manager could be responsible for all of the necessary schedule changes.

Reversing the information hierarchy

In crafting the organizational plan, McCallum sought to improve the way the railroad used information. Through 21st-century eyes, the chart looks both antiquarian and surprisingly modern. Far from the static, hierarchical pyramids that we today associate with such charts, his was modeled after a tree. McCallum drew the board of directors as the roots, himself and his chief officers as the tree’s trunk, and the railroad’s divisions and departments as the branches.

Critically, McCallum gained control by giving up control, delegating authority to managers who could use information in real time. He put what we would call the organization’s C-level at the ground level, supporting the railroad, not directing its operations. Following one of McCallum’s key precepts—“a proper division of responsibilities”—authority over day-to-day scheduling went to the divisional superintendents down the line.

Most of the chart spans the domains of these superintendents: the railroad’s five branch lines. Each superintendent was responsible for two subbranches of

the tree. The first was a straight branch representing the physical assets of tracks and stations, the second a winding branch consisting of the men who moved along the rails, from the conductors and brakemen on the trains to the laborers who maintained the tracks. The divisional superintendents were responsible for coordinating these two branches—the depots and the rolling stock, and the employees who moved between them.

Even as McCallum decentralized decision making along the railroad, he also insisted that targeted metrics had to be reported back to its board of directors. That data flowed down from the branches of the tree to its roots, where McCallum and the board could use the information for oversight and long-term decision making. Here, McCallum’s goal was prioritization: assuring that the board, with its finite capacity, received relevant and actionable data. As “interesting as this information is,” he reflected, it is only in its “practical application . . . that its real value consists.” McCallum therefore designed a system of hourly, daily, and monthly reports that enabled him to calculate practical metrics, such as cost per ton-mile and average load per car. By comparing the profitability and efficiency of different routes, the board could identify opportunities for improvement.

A message for today’s leaders?

Modern managers, of course, have more sophisticated tools than McCallum did. Top executives can now access detailed

Tracking a missing org chart

Former Harvard Business School professor Alfred Chandler (1918–2007), who helped establish business history as a rigorous academic discipline, described the momentous impact of managerial innovations, such as the organization chart. Chandler identified Daniel McCallum as the originator of the New York and Erie's pioneering plan and describes the chart in tantalizing detail in several of his books. I began searching for it during my doctoral studies at Harvard, writing to archives in New York and Ohio and even combing through Chandler's personal papers. In the course of my search, I learned that Chandler himself had never seen the chart and based his description on a detailed advertisement in the *American Railroad Journal*.¹

I was almost ready to give up on my search when the unexpected happened at an academic conference: Peter Knight, a professor of American studies at the University of Manchester, handed out a series of images on the history of capitalism, and I immediately recognized that one was the missing organization chart! I was astonished to learn that Peter had found it in the Library of Congress. With the help of its reference librarians, I located another copy

at St. Lawrence University, in upstate New York.² The discovery came in time for the chart to be included in my doctoral dissertation, completing a quest Chandler began when researching his own dissertation on the pioneering financial analyst Henry Varnum Poor.

Chandler continued writing about McCallum and the chart in many foundational business-history studies, including his Pulitzer Prize winner, *The Visible Hand: The Managerial Revolution in American Business* (Harvard University Press, 1977), as well as *Strategy and Structure: Chapters in the History of American Industrial Enterprise* (MIT Press, 1962), which is widely viewed as a seminal book in the development not just of business history but also of strategic thought.

¹ Chandler explains that he had not seen the chart himself (at least as of 1988), in Alfred Chandler, "Origins of the organization chart," *Harvard Business Review*, 1988, Volume 66, Number 2, pp. 156–57.

² In addition, Charles Wrege and Guidon Sorbo Jr. located the chart and discuss it in "A bridge builder changes a railroad: The story of Daniel Craig McCallum," *Canal History and Technology Proceedings*, 2005, Volume 24, pp. 183–218.

data, often in real time. Today's powerful battlefield-management systems, for instance, give generals the ability to direct combat missions at the microlevel, which was invisible to the board of the New York and Erie.

But while cheaper storage space and bandwidth will make such granular management options increasingly tempting, will they be optimal? Executive attention spans are already stressed, and many

leaders report that they are overwhelmed by copious data flows.⁴ A more fruitful approach might begin with McCallum's low-tech reflections on organizational structures and priorities. Within today's organizations, emerging social networks—often married to sources of big data—have a certain kinship with McCallum's logic. These networks too provide opportunities for greater information sharing and collaboration at relatively low levels in the organization, and they too

can improve operations, customer service, and innovation. Curiously, digital mappings of these social interactions bear a resemblance to the nodes and branches of McCallum’s chart.

Drowning in the details of operations, Daniel McCallum stepped back and redesigned the railroad’s organization. His insights on how to meld local authority with information gave his managers better operating tools—which are just as relevant in the age of the Internet as they were in the age of the telegraph. ○

¹ This article’s details on the railway’s operations and organizational thought come from Homer Ramsdell and D. C. McCallum, *Reports of the President and Superintendent of the New York and Erie Railroad to the Stockholders, for the Year Ending September 30, 1855*, New York, NY: Press of the New York and Erie Railroad Company, 1856.

² Tom Standage quotes contemporaries who called the telegraph the “highway of thought” in *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century’s On-line Pioneers*, first edition, London, UK: Weidenfeld & Nicolson, 1998. An excellent recent account of the telegraph’s impact is Richard John, *Network Nation: Inventing American Telecommunications*, first edition, Cambridge, MA: Harvard University Press, 2010.

³ The phrase “avalanche of numbers” comes from Ian Hacking, writing on the spread of probabilistic and statistical reasoning, in *The Taming of Chance*, first edition, Cambridge, UK: Cambridge University Press, 1990.

⁴ Steve LaValle et al., “Big data, analytics and the path from insights to value,” *MIT Sloan Management Review*, 2011, Volume 52, Number 2, pp. 21–32.

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