Labor Movements: From the Specifications of the Panama Canal to Robotic Patents

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Abstract

This paper is part of an ongoing collaboration between architecture faculty and students. The paper highlights two student projects from a recent research studio focused on the link between regulatory documents (specifications, laws, codes, patents, etc.) and the political territories that connect building technology with the movements of construction labor. Each project interconnects two types of movement: (1) physical movements of people, materials, and machines (2) political movements and colonial structures of power. The former are visible and have limited durations, while the latter are seemingly invisible but with enduring consequences. The contemporary effects of these movements are latent in the underexamined histories of written regulatory documents.

In the first project, these two types of movement intersect in the construction of the Panama Canal. The strategy for this analysis is based on visualizing concrete specifications, sanitation laws, and construction images collected from the Nichols Notebook Archive. These documents juxtapose unpredictable site conditions, yellow fever and the movement of people, with the pursuit of material predictability, such as engineered concrete. These two scales collide at the margins of the oceanic trade route, stressing the tensions between exploitative imperialist bodies and the bodies of local and migrant workers. Overlapping with the timeline of the Panama Canal construction, the second student project connects the language of twentieth century U.S. Labor Acts with the evolution of KUKA Robotic Patents. The influx of twenty-first century industrial construction robots highlights the political implications of choreographing movement on the worksite. Both projects resulted in a series of strategies used to visualize the movements of labor, arguing that labor conditions are central to technological processes, yet peripheral to traditional architectural discourse. Examining postcolonial theory and automation discourse through the study of written regulations makes a case for expanding transdisciplinary knowledge across multiple scales of visible and invisible movements.

Keywords: pedagogy, history, labor, construction, specifications, patents, robots

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Introduction

“We can see and feel the waste of material things. Awkward, inefficient, or ill-directed movement of men, however, leave nothing visible or tangible behind them. Their appreciation calls for an act of memory, an effort of the imagination.”[1]

In the introduction to “The Principles of Scientific Management” (1911), the engineer Fredrick Winslow Taylor lamented over the wasted energy of workers and the inefficiency of their “ill-directed movements”. Behind this statement was the ambition to engineer the movements of twentieth century factory workers in order to maximize industrial production. For a national, capitalist economy that was founded on resource extraction, “workers were increasingly treated as disposable machine parts and machines were treated

as organisms with an internal life that needed to be preserved."[2] Instrumental to the emergence and ensuing peak of the industrial age, Scientific Management was rooted in patterns of material production that are present in ongoing colonization practices. These patterns exploited the bodies and movements of people and materials to sow infrastructural conditions that could sustain the capitalist, economic surge of the twentieth century. In the twenty-first century, the dominant structures of power are still dependent on the extraction of natural resources, their subsequent transformation into raw materials, and ultimately, their manifestation as architecture or large-scale infrastructure. Capitalist alchemy is always a display of power disguised as unavoidable growth. Undergirding these power structures are forms of movement. This paper does not present a comprehensive history of movement or interrogate the intellectual provocations associated with the humanist study of "the body". Instead, the paper asks a series of entangled questions: How can architectural education engage notions of movement to expand the rhetoric of modernity around construction labor? What if one of the premises of teaching building technology was to interrogate environmental, social, racial, economic, and political imbalances of power? If the assembly of materials and their performance continues to dominate architectural discourse, how can we make the disassembly of processes a precondition for thinking about the assembly of materials? How do we decide what matters—who and what is remembered—when we build our imagination around buildings and technology?

Labor Movements is based on two student projects from a recent studio focused on the link between regulatory documents (specifications, laws, codes, patents, etc.) and the political territories that connect building technology with the movements of construction labor.

The work of the studio produced four research themes:

1. Labor Conditions and Global/Local Networks
2. Typological Politics and Historical Codes
3. Material Consumption and Energy Narratives
4. Disciplinary Techniques and Professional Processes

To arrive at these themes, students worked through a three-step methodology that combined precedent study, professional practice, and speculative research.

Step 1: Identify sources of regulatory documents that are connected to historical circumstances, which are relevant to the production of architecture.

Step 2: Visualize the collected documents and histories by designing graphic networks that weave different forms of evidence into well-researched arguments.

Step 3: Speculate about the influence of regulatory documents on the processes that shape buildings, sites, and cities—and question the role of archival technology.

Without making design proposals, students focused on the consequences of building to reveal the social and political patterns of technological production. The two projects presented in the body of this paper where central to the discussion of the first research theme: Labor Conditions and Global/Local Networks. Both projects connect building technology with postcolonial theory and automation discourse. From the construction specifications and health-related regulations of the Panama Canal to U.S. labor acts and robotic patents; each project uses archival sources to visualize the politics of labor and the ethics of material consumption. These visualizations are linked to two types of interconnected movement: (1) physical movements of people, materials, and machines (2) political movements and colonial structures of power.

Postcolonial Theory and the Panama Canal

A decade before the advent of Scientific Management, the documentation of the U.S.-led construction of the Panama Canal was collected during the tenure of Aurin B. Nichols, Canal Office Engineer. “From the mule trains that moved the plundered silver of Bolivia and Peru to Atlantic ports; the first railroad to cross the continental divide; the failed project to construct a sea-level canal connecting the two oceans”, the documents in the Nichols Archive mark the five-hundred-year colonial history that led to “the immense complex of locks, dams, artificial lakes, and engineered channels that constitute the Panama Canal.”[3] After opening in 1914, the canal is still defined by the role of movement, which is evident in the colonial circumstance of its territory, the racialized labor of local and migrant workers, and the site conditions defined by the connection between concrete and sanitation.

Postcolonial theory has reshaped notions of the world(s) we live in for decades. Without parsing out the differences between decoloniality, decolonization, and anticolonialism, this section of the paper highlights postcolonial theory as *sites of memory*. From Edward Said’s “Culture and Imperialism” to Anibal Quijano’s embedment of coloniality within modernity, one of the consistent demands of postcolonial theory is the “entanglement of worlds.”[4] As Achille Mbembe points out, postcolonial theory is “an intellectual constellation whose strength and weaknesses originate in its very fragmentation”.[5] Considering this fragmentation, how can postcolonial theory alter notions of technological progress to pave new pedagogical paths?

The entanglement of worlds is grounded in the plurality of sites of memory. In the context of building technology, construction sites are central to the diversity of collective memory. Beyond philosophical concerns about memory, the temporality of construction sites is defined by their deference to the finished object or building. Simply put, the resulting structure is what matters the most.

Yet, as a piece of continental infrastructure, the Panama Canal is in a perpetual state of construction. The temporal dimensions of the canal site are essential to the technocratic drive that intensifies colonialist, territorial occupation. The student project featured in the following two pages combines material specifications, workers’ health records, sanitation laws, and archive images into forms of visualization that confront the presumed ambitions of technological progress in the Panama Canal Zone. (Figure 1).

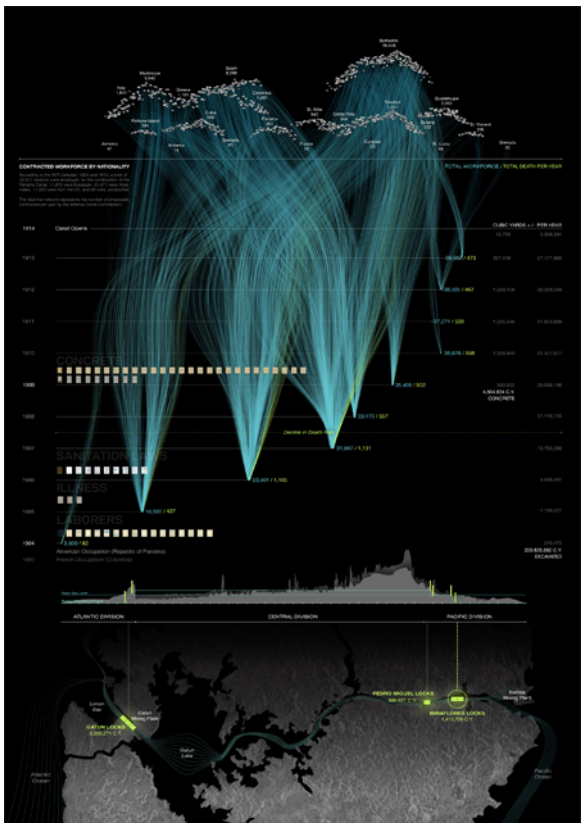


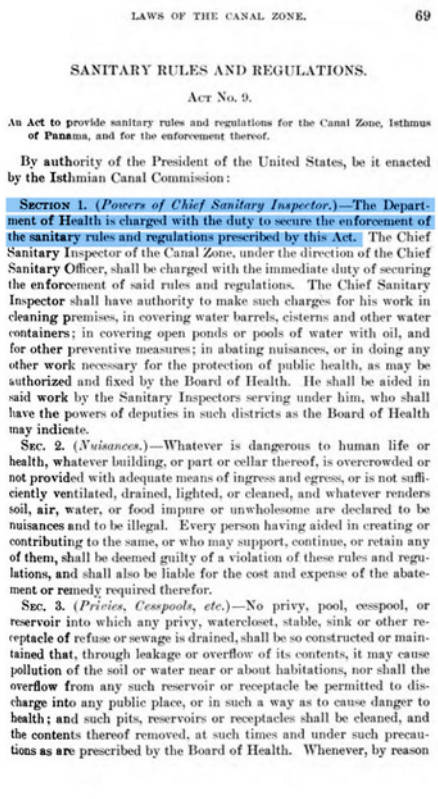
Fig. 1. Visualization connecting laborers’ movements and death, sanitation laws, concrete production, and land displacement across time. Author: B. Woytassek

Concrete Specifications and Sanitation Laws

In modern terms, specifications are written instructions from architects to contractors and other parties involved in construction. As instruments of service, they focus on the industrial distinction between "immaterial products of the mind and material products of the hand."[5] More importantly, specifications operate as written regulations that undergird the organizational hierarchy of modern labor. In the case of the Panama Canal, material specifications and sanitation laws collected in the Nichols Archive, show the collision between workers, concrete, and the outbreak of disease. These construction specifications juxtapose unpredictable site conditions, yellow fever and the movement of people, with the pursuit of material predictability, such as engineered concrete. Multiple scales of intra- and intercontinental networks are revealed through these conditions. These scales further the colonial dominance of the site, colliding at the margins of the oceanic trade route while stressing the tensions between exploitative imperialist bodies (the United States) and the bodies of on-site workers (local and migrant).

Tracing the global and local migration networks of materials and on-site workers emphasizes the correlation between the movement of people and the potential spread of diseases. Over the ten-year, U.S.-led construction, 56,307 laborers migrated from 86 countries.[6] With the influx of people, disease quickly followed and yellow fever spread among laborers while deepening racialized labor conditions. After seeing the downfall of the French canal construction operations due to yellow fever, the U.S. implemented Sanitary Laws (Figure 2) to mitigate the movement of water and people.[7] As early as 1905, confidential reports from the U.S. Public Health and Marine Hospital Service indicate the emerging concern over the spread of yellow fever:

"I wish to make a confidential report about the second case of yellow fever in this place…So far I believe there is no question but that the infection was introduced from Colon by the small steamer Orienta…I understand that Mr. R was to be taken to the hospital and screened."



LAWS OF THE CANAL ZONE. 69

SANITARY RULES AND REGULATIONS.

ACT No. 9.

An Act to provide sanitary rules and regulations for the Canal Zone, Isthmus of Panama, and for the enforcement thereof.

By authority of the President of the United States, be it enacted by the Isthmian Canal Commission:

SECTION 1. (*Powers of Chief Sanitary Inspector.*)—The Department of Health is charged with the duty to secure the enforcement of the sanitary rules and regulations prescribed by this Act. The Chief Sanitary Inspector of the Canal Zone, under the direction of the Chief Sanitary Officer, shall be charged with the immediate duty of securing the enforcement of said rules and regulations. The Chief Sanitary Inspector shall have authority to make such charges for his work in cleaning premises, in covering water barrels, cisterns and other water containers; in covering open ponds or pools of water with oil, and for other preventive measures; in abating nuisances, or in doing any other work necessary for the protection of public health, as may be authorized and fixed by the Board of Health. He shall be aided in said work by the Sanitary Inspectors serving under him, who shall have the powers of deputies in such districts as the Board of Health may indicate.

SEC. 2. (*Nuisances.*)—Whatever is dangerous to human life or health, whatever building, or part or cellar thereof, is overcrowded or not provided with adequate means of ingress and egress, or is not sufficiently ventilated, drained, lighted, or cleaned, and whatever renders soil, air, water, or food impure or unwholesome are declared to be nuisances and to be illegal. Every person having aided in creating or contributing to the same, or who may support, continue, or retain any of them, shall be deemed guilty of a violation of these rules and regulations, and shall also be liable for the cost and expense of the abatement or remedy required therefor.

SEC. 3. (*Privies, Cesspools, etc.*)—No privy, pool, cesspool, or reservoir into which any privy, watercloset, stable, sink or other receptacle of refuse or sewage is drained, shall be so constructed or maintained that, through leakage or overflow of its contents, it may cause pollution of the soil or water near or about habitations, nor shall the overflow from any such reservoir or receptacle be permitted to discharge into any public place, or in such a way as to cause danger to health; and such pits, reservoirs or receptacles shall be cleaned, and the contents thereof removed, at such times and under such precautions as are prescribed by the Board of Health. Whenever, by reason

Fig. 2. Sanitary Rules and Regulations, Act No.9. Laws of the Canal Zone, Isthmus Canal Commission, 1906

The year prior to the implementation of the sanitation laws in 1906, the number of worker deaths had risen from 427 to 1105. The nine articles of the sanitation laws outline two primary regulatory conditions: treatment of water and care for infected patients. The first condition is tied to the role of mosquitoes in spreading yellow fever, while the second includes protocols for the movement of infected people.[8]

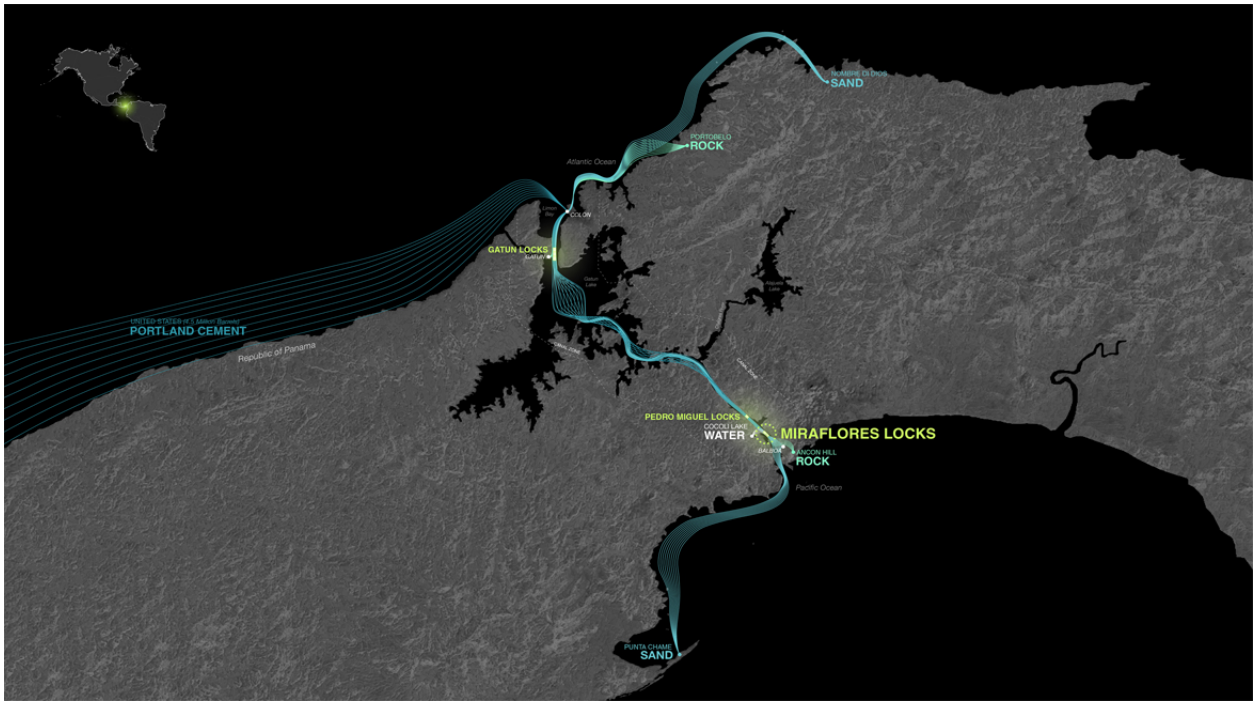


Fig. 3. Panama Canal Zone, movement of water and raw materials used for concrete production. Author: B. Woytassek

As part of these regulatory conditions, sanitary inspection protocols designated surrounding villages as sanitary districts. While these protocols prevented the spread of disease and greatly reduced worker deaths, they also tightened the colonial grip of the U.S. on the canal and its local communities—undermining indigenous practices of land stewardship in favor of delineating productive material territories. Over 5,000 workers died (not all from yellow fever) from 1904 until the canal opened on August 15, 1914.[9]

While sanitation laws regulated the movement of water, concrete specifications solidified the role of material testing at a territorial scale. With rock and sand supplied by Panama, the U.S. would need to import 4.5 million barrels of cement. To further the manufactured quality of the site, artificial lakes, namely Coccoli Lake (Figure 3), were reintroduced into the area as sources of water for the production of concrete.[10] At the end of construction, millions of cubic yards of concrete would be used in all three locations of the canal lock system.

Beyond the quantifiable predictability of concrete performance, on-site conditions of the Miraflores locks were categorized into water, concrete, and laborers. The presence of water challenged the application of sanitary regulations, making favorable conditions for mosquitos infected with yellow fever to breed and continuously threaten the lives of workers. Concrete, however, requires water as a measurable and predictable ingredient. In this circumstance, water was the tension between the material specifications and sanitation protocols. This tension challenges the colonial imagination that underlies contemporary ideas of technological progress—and its indifference towards the movements of construction labor.

Automation Discourse: Part, Body, and Assembly

Refining humans into efficient machines and making machines into more effective organisms that replace human labor was central to twentieth century Scientific Management. Automation discourse has been tied to the space between human and machine labor for over a century. At the center of this discursive space is the role of movement. Even in a postindustrial age, the industrial practices of Scientific Management have become a defining feature of capitalist societies, reasserting the "excitement about a coming age of automation that can be traced back to at least the mid nineteenth century."[11] Rapid changes in artificial intelligence, machine learning, and robotics are transforming the world of work. Alongside these rapid advances, the history of labor in the United States lays out the regulatory framework of automation discourse and its sociotechnical imaginary. The rise of patents and the establishment of labor acts are two types of documents that define a portion of this framework, yet they are largely excluded from the sociotechnical knowledge that shapes architecture education. This section of the paper centers on a student project that combines the legacy of U.S. Labor Acts (1931-2020) with emerging U.S. Kuka Robotic Patents (1986-2016).

Hannah Arendt's distinction between labor and work has become a common reference for architects interested in extending critical theory into automation discourse. *Labor* leaves no material trace, its unending cycle of invisibility stands in contrast to the material presence of *Work.*[12] Applying this distinction to the contemporary relationship between humans and robots weaves the idea of movement into the entangled worlds of labor and work. To examine these worlds, the visualizations produced in this student project stem from Frank and Lillian Gilbreth's early twentieth century, Therblig Motion studies—and connect to the analysis of language used in a select set of bricklaying labor acts, union documents, and robotic patents. The Therblig Motion studies (Figure 4), a form of scientific management, produced a language of movement resulting from the actions of various parts of the human body (e.g., the interaction of the eyes and hands looking for a brick initiates "search").[13] Extending this language to human and robotic movement, a *part* consists of a component of a whole and moves in concert with other parts. The *body* is the composition of all the parts that make up the whole or individual, and *assembly* is the congregation of discrete bodies that organize around a specific action. Ultimately, these three interconnected scales, *part, body, and assembly* form the language of the written regulatory documents that determine the movement of humans and robots on construction sites (Figure 5).

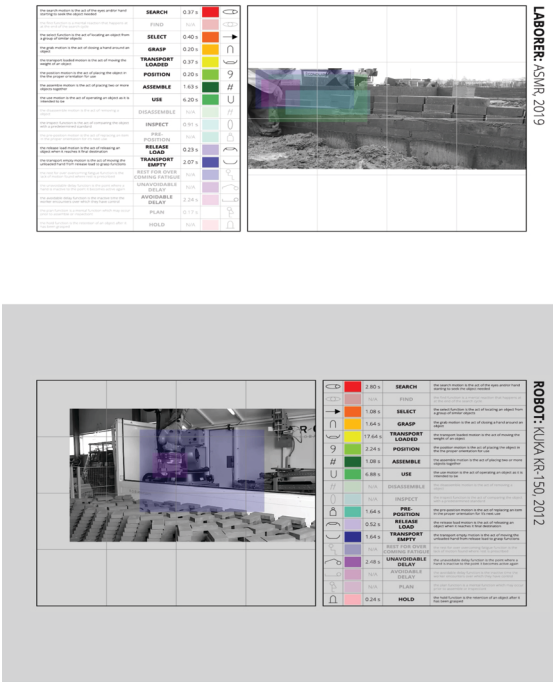


Fig. 4. Therblig motion studies and robotic arm studies based on the work of Frank and Lilian Gilbreth. Authors: J. Kenny and N. Krueger

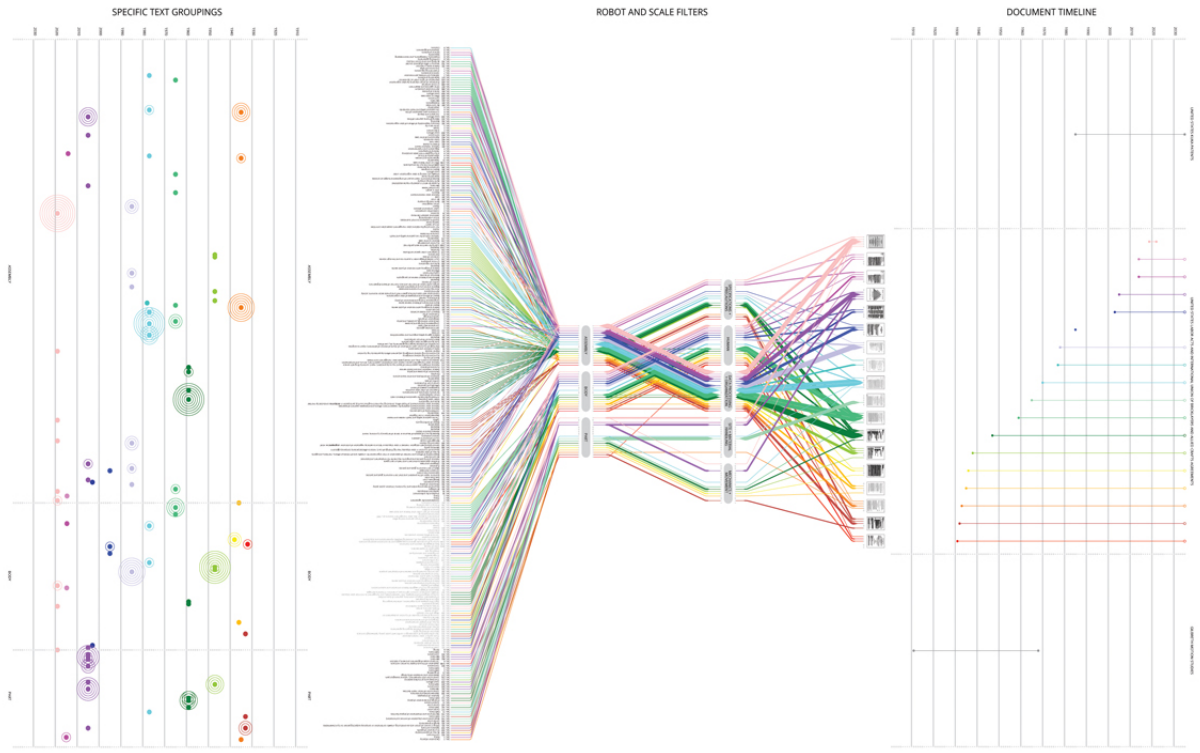


Fig. 5. Visualization of language connecting labor acts and patents to human and robotic movement. Authors: J. Kenny and N. Krueger

Labor Acts and Robotic Patents

"The work of our hands as distinguished from the labor of our bodies" suggests that robots do *work* and humans perform *labor*.[14] If we subscribe to this contemporary notion—even to resist its oversimplification—then what are the parameters that make this distinction relevant to architects' education? Among many things, automation discourse asks, how was Fredrick Taylor's interest in the exploitation of the human body analogous to the contemporary fascination with robotic bodies? Answers or more provocations surrounding these questions may lie in regulatory documents that guide labor and work on construction sites. Studied individually, the content of these documents offers a glimpse into the times and places that contextualize specific working conditions for humans and robots. But when examined as a collection, these documents unfold two questions: What are the different types of documents used to regulate human and robotic movements? At what scales are human and robotic movements regulated? To study the space between human labor and robotic work, the visualizations in this project analyze the language of fifteen labor acts, three brick-laying union documents, and eighteen robotic patents (Figure 5).

In the United States, Labor Acts mediate the site relationships between workers, unions, and the government. As regulatory documents, Labor Acts protect the rights of workers and set standards for humane working conditions. Patents, on the other hand, are documents that protect an invention or product through the use of trademarks and brand names.

Patents specify the process of creating and operating said inventions within the United States. Both Labor Acts and Patents serve as regulatory documents and are defined through comparable scales of *part, body*, *and assembly* as well as the many subcategories (sections and classes) that connect more specific details and regulations within a similar, main idea or category (Figure 5).

In this project, both types of documents were filtered through robot classifications that dealt with the body of the worker, their movement, and how they were able to organize information on site. The three scales of *part, body, and assembly* emerged as a framework for understanding how movements were being controlled according to specific labor acts. For example, the National Industrial Recovery of 1933, promoted the organization of industry "for the purpose of cooperative action among trade groups, to induce and maintain united action of labor and management under adequate governmental sanctions and supervision."[15] While the 1933 act reinforced extractive material practices, it also outlined movement regulations for construction practices, such as, the elimination of convict labor, fair wage standards and limiting weekly work hours. Comparing the labor acts that affect human labor to the patents that assert possession over robotic work, reveals the different scales of regulation that define the space between both. In the United States, human movement is historically regulated through the scale of *assembly*. Without the constant exploitation of implied or actual surveillance—one precondition for the violent subjugation of black slave labor—it is difficult, and more importantly, perverse, to control and regulate the individual movements of the human body. The collective movements of racialized labor are inscribed into U.S. labor history and continue to underlie regulatory frameworks. Labor acts mark how bodies move on site by establishing regulations that apply to the large assembly of people, affecting collective bargaining, time and wages, and the ability to withhold labor.

Robotic movement, on the other hand, is regulated through the scale of the part. Though patents became more specific over time, regulating the body at first, exact parts now dictate how robots move. Because patents establish a proprietary relationship between human and the part produced, the part qualifies as the material presence of owned work rather than the immaterial trace of labor that Hannah Arendt defines in the *Human Condition*. When it is reproduced and/or copied, the human responsible for inventing the part is protected. Considering Arendt's distinction between labor and work, a robotic part is a product of human work. Although human and robotic movements exist within the same construction sites, the types of documents that regulate human movement at the assembly scale and robotic movement at the parts scale probe at the future of human labor and robotic work.

Conclusion

Postcolonial theory and automation discourse suggest alternative forms of knowledge about modernity. Building Technology is deeply implicated in the potential to teach and learn about different visions of the world. Confronting imbalances of racial and environmental power could be a way to challenge the colonial imagination that has marginalized the history of construction labor. Much of architecture's complicity in this violent history rests in the overlooked power of regulatory documents. This paper and the outcomes from the studio highlighted in it, give students the space to visualize these power structures.

There are three primary observations about the studio pedagogy in relation to the role of movement(s):

First, the recognition of the temporality of construction sites, not just as means to an end, but rather as important places of memory. Whether it is an ongoing site of colonization, like the Panama Canal, or generic models for sites inherited from the tension between

human labor and robotic work, movement is central to capturing the temporality of construction sites. Second, the construction and maintenance of websites were the primary method of work and content delivery for the studio. Students made websites to develop and share their research throughout the semester. The websites made their work public beyond the isolation of studio reviews and the limited duration of the semester. Lastly, during a semester in which the COVID-19 pandemic restricted student and faculty movements, the studio prioritized the close reading of written, regulatory documents over the physical proximity and haptic nature of the traditional studio context. These reflections stress the potential of leveraging history to affect the future of practice while uncovering processes that continue to shape and misshape our present.

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