# An Actor Network Theory Analysis of Barriers to High-Speed Rail Expansion in the Amtrak Acela Express 2021 Program

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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**Introduction**

In August 2016, Amtrak received a $2.45 billion federal loan for the "Acela Express 2021 program." This program aimed to purchase 28 new high-speed trains and improve the current rail infrastructure to support these trains by 2021. These new trainsets would replace the existing Acela trainsets that service the Northeast Corridor (NEC) from Washington D.C. to Boston (Lord, 2017). Amtrak signed a contract with Alstom, a France-based manufacturer, to produce these trainsets. However, an October 2023 press release from the Amtrak Office of Inspector General (OIG) stated that the Acela program would face further delays with no clear completion date (Miller, 2023).

Current discourse surrounding the Acela Express 2021 program centers on the aging rail infrastructure and communication challenges between Amtrak and Alstom. However, the causes of the production delays should not be considered in isolation, as this leads to a limited understanding of how other technical and non-technical factors contributed to Amtrak's failure to meet its deadline. I argue that Amtrak failed to create a high-speed rail network due to the interrelationships among several key technical and non-technical factors, including inadequate project specifications, funding allocation issues, and problems with project management.

Actor Network Theory (ANT) offers a comprehensive lens to understand the Acela Express 2021 program. ANT states that technical systems are created by network builders who select and mobilize human and non-human actors, each playing a crucial role in shaping outcomes. To understand how Amtrak's role as a network builder led to major program delays, I will analyze Amtrak OIG reports, the U.S. Department of Transportation (DOT) waiver for the Acela Express program, scientific magazine articles, and congressional reports.

**Background**

The Acela line is an electric high-speed train service operated by Amtrak on the NEC. The first Acela Express service took place on December 11, 2000. The trains were constructed by Alstom, a France-based manufacturer that has built high-speed trains for services across Europe. Tommy Thompson, the Amtrak board chairman at the time, described the Acela as "an extraordinary and historic achievement that proves Amtrak can deliver transportation that America needs" ("Building the infrastructure for Acela Express," 2016). In 2016, Amtrak partnered with Alstom to introduce the next generation of the Acela fleet, since the original fleet needed an upgrade. These new trainsets would increase operating speeds to 160 mph from 150 mph and improve the travel experience with new onboard amenities ("New Acela fleet," n.d.).

**Literature Review**

There is limited scholarly research surrounding the specific case of Amtrak's unsuccessful "Acela Express 2021 Program" to update its high-speed train infrastructure after receiving a $2.45 billion federal loan. The scholarly literature surrounding the Amtrak Acela line takes a more general perspective. It explores the various factors that have led to the slower adoption of high-speed rail in the United States over the years when compared to other countries.

In a research article titled *Survey of Current High-Speed Rail Planning Efforts in the United States*, authors Joseph P. Schwieterman and Justin Scheidt analyzed data sets for high-speed rail (HSR) initiatives across the United States to determine what challenges different agencies, such as Amtrak, have faced. Their findings revealed that "more than 70% of proposals for high-speed routes that use existing railroad routes involve single-track lines currently used for mainline freight service" (Schwieterman & Scheidt, 1995). When passenger and freight trains have to share rails, delays and blockages happen. Freight rail is not built for HSR technology,

and this contributes to why Acela trains capable of traveling at speeds equal to or greater than 135 mph will have average trip speeds below 80 mph, which is much slower than European and Asian countries. Schwieterman and Scheidt explain that a solution to addressing capacity constraints from freight volume would be constructing dedicated HSR tracks (Schwieterman & Scheidt, 1995). While this paper does highlight the shortcomings of the existing infrastructure, it does not adequately consider the other technical and non-technical actors in the complex rail network.

Another paper, *Running off the Rails* by Tony R. Eastham explores the shortcomings of the development of the Amtrak Acela Express fleet in 2002, which was still contracted to Alstom. Like Schwieterman and Scheidt, Eastham describes a lack of adequate infrastructure as a significant obstacle. Eastham also details communication challenges between engineering teams, coupled with a lack of effective project oversight by Amtrak management. This led to numerous faulty trainsets being withdrawn due to microcracking, problems resulting from incorrect measurement specifications, and fractured brackets. Eastham contends that in retrospect, some of these problems were expected since the performance of high-speed trainset on infrastructure that was not built to support it would lead to technical issues (Eastham, 2003). Yet, this analysis still falls short because it does not recognize all actors and how their dynamics contribute to the network. Moreover, the Acela Express 2021 program is more complex than the 2002 program and introduces new human and non-human actors which factor into why the project was fundamentally unsuccessful.

This paper will contribute to a more holistic understanding of why the Acela Express program fell short of its objective to upgrade the high-speed rail infrastructure and trainsets by the 2021 deadline. Engineering failures are often due to the interplay of social and technical

factors. By employing ANT, I will identify the relevant actors in the Acela network and examine how the primary actors involved in constructing this network failed to anticipate the shortcomings of certain actors and the dynamics that led to delays.

**Conceptual Framework**

To understand the factors at play that have led to Amtrak's unsuccessful attempts to update the Acela high-speed train network, the ANT framework will be used. Developed by writers Michel Callon, Bruno Latour, and John Law, ANT states that technical systems can be viewed as a network of human and non-human actors to solve a problem or reach a goal (Cressman, 2009). ANT argues that both human actors and non-human actors, such as technology and cultural norms, play equally important roles in the construction of technology. Uncovering the nature and evolution of the relationships among these actors leads to understanding the success or failure of a network.

In ANT, the concept of translation describes how connections form between actors in the sociotechnical network. There are four stages: problematization, interessement, enrolment, and mobilization. In problematization, the primary actors or network builders, such as scientists and engineers, define and identify a problem and the actors involved. They then draw up a network of how these human and non-human actors are related. In interessement, the network builders bring the actors into the network. These actors are then assigned their roles in the enrolment stage. Finally, in the mobilization stage, the network builders bring together the network and push for action toward the technical goal (Callon, 1984).

In this paper, I will use ANT to define the actors and their relationships within the Acela network following the 2016 initiative to expand high-speed rail service. From there, I will use the concept of translation to analyze how the network builders failed to clearly outline the role of

actors, such as Alstom, in problematization. These shortcomings led to the network falling short of its goals in the mobilization stage.

## Analysis

### *Network Formation*

To utilize the ANT framework, the actors present in the network must be identified. In the case of the Acela Express 2021 program, the network builder is Amtrak. Amtrak is responsible for defining the problem and the actors involved in the network. The human and institutional actors are defined as follows: (i) Alstom, the contracted company responsible for manufacturing the new Acela Express fleet (Miller, 2023); (ii) Parts manufacturers, both domestic and international, that parts must be sourced from (Feinberg, 2015); (iii) Government Agencies, such as the Federal Rail Administration (FRA) and DOT, that have set different regulations (Miller, 2023); (iv) Freight companies who share the rail infrastructure with Amtrak (Schwieterman & Scheidt, 1995). Similarly, I have identified the non-human or technological actors as follows: (v) Regulatory standards on materials sourcing and manufacturing safety; (vi) Funding that Amtrak has received for the project in the form of a $2.45 billion federal loan; (vii) Rail infrastructure that the Acela trains must operate on; (viii) Acela trains, both the new ones that must be developed and the legacy fleet; (iv) Simulation software that verifies the safety of the train models (Miller, 2023).

The next step in the ANT analysis is to determine how the human and nonhuman actors are associated with one another. Figure 1 shows a simplified diagram of the Acela Express 2021 network and the connections between the actors. These connections will be formed by stepping through the phases of translation. During problematization, the first phase of translation, Amtrak identified the actors needed to undertake the Acela Express 2021 program. It then determined

how these actors were related in the network and what contracts or negotiations they had to make with each human or institutional actor. A 2020 Amtrak OIG report from Amtrak's assistant inspector general outlines the expectations of many of these institutional actors. Alstom is responsible for manufacturing Acela trainsets that meet regulatory standards. To verify this, Alstom's simulation software should be used. Government agencies establish regulatory standards and allocate the funding that Amtrak receives (Morrison, 2020). As established previously, freight companies share much of the rail infrastructure with Amtrak, and this rail infrastructure directly interacts with the Acela trainsets. Finally, parts manufacturers supply the parts used in Acela trainsets and interact with Alstom to ensure the compatibility of these parts.

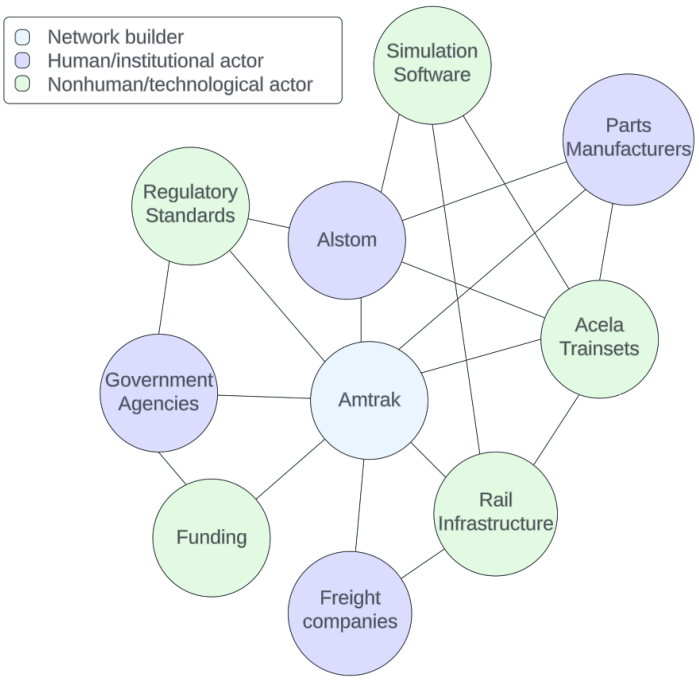


*Figure 1. Simplified Acela Express 2021 network*

In interessment, Amtrak brought the actors into the network, and in enrolment, each actor assumed its role defined by Amtrak. During mobilization, Amtrak brought the network together to work towards the technical goal of manufacturing the new trainsets and improving the supporting infrastructure. I argue that Amtrak's Acela Express 2021 program failed to establish an effective high-speed rail system due to the network builder's inability to effectively define the conditions and expectations of the project during problematization, which led to misalignment of goals during the interessment and mobilization stages among the actors in the network.

*Software Simulation*

When detailing the conditions in the contract with Alstom, Amtrak did not enforce the regulatory standards set by the FRA or account for the complexity of computer simulations, and this ambiguity led Alstom to cut corners in verifying the safety of its trainsets. A 2023 Amtrak OIG report on the Acela Express 2021 program states that federal regulation mandated that Amtrak submit FRA performance predictions, ensuring the validity and safety of Alstom's computer simulations before further testing of its trainsets. Alstom developed 14 different iterations of the simulated trainset model, but none were up to the standards of the FRA. It claimed that the track conditions were too challenging and that the requirements were too different from those in Europe, where Alstom is based. Morrison discredits the first complaint about track conditions, arguing that Alstom produced the legacy fleet in the 2000s that operated on the same tracks (Morrison, 2023).

The report subsequently revealed that Alstom proceeded with manufacturing serial trainsets without obtaining FRA approval for its computer model. More than half of the commissioned units have been constructed, and they all have various issues ranging from structural and design modifications to sealant, drainage, or corrosion corrections. As a result, the fully assembled trains are sitting, unused, in a storage yard in Philidelphia (Morrison, 2023). Lack of effective project oversight was also an issue with the 2002 Acela fleet, and this led to trainset manufacturing faults (Eastham, 2003). Amtrak has had the opportunity to learn from its previous project management mistakes but has failed to adjust its leadership effectively. In the report, Assistant Inspector General James Morrison writes that the company officials did not push back on Alstom going into production because "they were overly optimistic about the vendor's progress and believed the vendor's assurances that validation was close." He added that

company officials wanted “to help preserve the company’s relationship with the vendor and to hedge against the risk of further production delays” (Morrison, 2023). While maintaining a good relationship with a contracted company is important, certain compromises should not be made with major multiyear projects.

By prioritizing speed over attention to detail, Amtrak inadvertently introduced more delays in the production process. It is important to note that the simulations would have differed significantly from models that Alstom had for clients in Europe because, in the United States, Acela trains run on commercial freight rail (Schwieterman & Scheidt, 1995). As a result, collisions with freight trains are a possibility, and the FRA imposes more stringent safety requirements. This distinction suggests that existing simulations cannot simply be transferred over and additional development must be done to ensure accuracy. Moreover, dismissing complaints about infrastructure obstacles by pointing to Alstom's ability to manufacture trainsets for the tracks two decades ago highlights a failure on Amtrak's part as network builders. It underscores Amtrak’s oversight in recognizing how the roles of the actors have evolved since the last contract. Amtrak's complacency towards the early initiation of trainset production has led to numerous issues and delays in the manufactured trainsets. Alstom still bears responsibility for not meeting FRA regulations. However, Amtrak is equally accountable for failing to outline specific conditions in the contract and enforcing these requirements throughout subsequent stages of production.

*Funding and Domestic Rail Manufacturing*

Amtrak failed to properly account for budget constraints that would arise from complying with the Buy America plan, and this resulted in a failure to meet project deadlines. According to the FRA, the goal of Buy America is to “maximize the use of goods, products, and materials

produced in the United States" ("Buy America," n.d.). Amtrak is required to abide by the domestic spending preference. However, when it comes to constructing high-speed rail trainsets, not everything can be purchased in America. This is because the U.S. government has failed to properly invest in the domestic rail industry over the last few decades (Kim, 2023). For the parts that cannot be purchased domestically, among other exceptions, a waiver can be obtained from the DOT to import them. A waiver was issued to Amtrak for the Acela Express 2021 program, allowing eight specific components to be purchased abroad (Kim, 2023). The remaining 95 percent of components were manufactured in the United States ("New Acela Fleet," n.d.).

This highlights the dilemma Amtrak faces in implementing Buy America plans while dealing with inadequate funding. Although Amtrak has spent $1.6 billion of its $2.45 billion budget as of 2023, no fully operational trainsets have been built (Morrison, 2023). It is important to understand that the lack of government investment in the domestic rail industry has resulted in costlier domestically sourced components compared to imports. The waiver granted by the DOT for the Acela Express 2021 program demonstrates the necessity of exceptions due to limitations in domestic sourcing. However, when it comes to cost, exceptions can only be made if domestic materials increase the cost of the entire project by more than 25 percent (""Buy America" domestic sourcing guidance and waiver process for DOI financial assistance agreements," n.d.). For a program that was allocated $2.45 billion, this suggests that costs might increase by hundreds of millions of dollars before an exception for domestic material sourcing can be secured. Considering the remaining 95 percent of trainset components were manufactured in the United States, it is likely that a cost increase was sustained to adhere to the Buy America policy. The option to cut costs elsewhere to offset the increase is unfavorable because it could lead to

sacrifices in quality and safety. Unless funding is increased proportionately, the Buy America mandate is hindering the success of establishing high-speed rail in the United States.

As I have argued, so long as Amtrak is required to comply with the Buy America initiative without an increase in funding and more lenient timelines, attempts to establish a high-speed rail system will continue to be unsuccessful. However, as stated in the waiver granting Amtrak permission to source some components internationally, some commenters opposed the issuance of the waiver because they believed it would lead to more waivers. They argued that manufacturers in the United States were theoretically capable of manufacturing the requested components (Feinberg, 2015).

While it may be possible for U.S. manufacturers to adapt their production processes to satisfy a greater variety of requests, this view fails to consider that Buy America can also lead to increased costs of rolling stock procurement (Platzer & Mallet, 2015). Rolling stock refers to rail cars and buses. One analysis found that the price of public transportation buses in the United States is about double that of Japan and South Korea. Additionally, reducing the purchasing options for rolling stock limited innovation. (Platzer & Mallet, 2015). In the end, when the manufacturing cost of rolling stock increases, part of that cost increase ends up being passed on to the riders. If ridership decreases, profitability will also decrease and further hinder Amtrak's ability to receive government funding for high-speed rail projects. Thus, the Buy America requirement and a lack of funding adjustments contributed to the failure of the Acela Express 2021 program's completion.

*Communication and Management*

Despite Amtrak's acknowledgment that the Acela Express 2021 program was a high-risk program with the largest single investment the company had made, it failed to establish a proper

management system for the program leaving the various actors in the network with no clearly defined leadership. In a November 2017 report, the Assistant Inspector General of Audits Stephen Lord identified the following oversights in management and scheduling:

> In July 2017, the company designated the EPMO [Enterprise Program Management Office] as the program lead but has not formally defined its duties and authorities to manage this program. In addition, the Engineering department has not staffed a team to manage the 10 supporting infrastructure projects. Moreover, the company has not implemented key risk management tools, such as a program-wide integrated master schedule, or a list of project risks and mitigation plans for the 10 related infrastructure projects to help ensure the trainsets enter revenue service on time. (Lord, 2017)

Project management is a crucial component of a large-scale project like this and as the network builder, Amtrak is responsible for mobilizing the actors in the network to fulfill their tasks. Without establishing adequate internal leadership to oversee and facilitate communication with each actor, there is no way to implement contingency plans. As delays accumulate, any built-in flexibility to the manufacturing schedule is eliminated.

According to an Amtrak OIG report, by January 2020, additional management concerns were identified. At that point, any cushion in the production schedule had been eliminated due to the aforementioned management issues (Morrison, 2020). Critical issues emerge from this report. Firstly, Amtrak's failure to designate the EPMO with specified roles and responsibilities suggests that ineffective leadership led to accountability issues. Moreover, despite there being ten infrastructure project teams, the absence of a management team raises concerns about whether the required attention and expertise were given to each team to ensure the successful execution

of each portion of the infrastructure project. Concern also arises from the omission of project management tools or schedules. Without clear progress metrics, the program remains vulnerable to unforeseen challenges derailing a timely completion. Postponing the service with new trainsets results in a delay in revenue generation. Additionally, it requires legacy Acela trains to continue operations; these trains are roughly two decades old, and their continued use has caused performance delays (Morrison, 2023). The consequence is more than increased operational costs, but also damage to the Acela line's reputation.

When it comes to creating a network of this complexity and duration, the project should not have proceeded until proper management is established. The forecasted delays in 2017 started out being roughly three months, but in 2023, the delays have become three years. Therefore, the lack of effective management during the problematization phase directly resulted in Amtrak's inability to complete the Amtrak Acela Express 2021 program on time.

**Conclusion**

Using the actor-network theory framework to analyze the Amtrak Acela Express 2021 program, I argue that Amtrak failed to create a high-speed rail network in its role as the network builder. This can be attributed to the inadequate definition of project specifications and expectations during the problematization phase, which ultimately led to the misalignment of goals with Alstom, problems allocating funding for the project given Buy America requirements, and a lack of proper management to oversee the progress of the program. This analysis provides a more comprehensive view of how various technical and non-technical factors contributed to a three-year delay in production. Learning from Amtrak's failure is crucial for institutions and project managers to avoid comparable production delays in future complex large-scale infrastructure projects.

**References**

*Building the infrastructure for Acela Express*. (2016, February 25). Amtrak, a history of America's railroad. https://history.amtrak.com/blogs/blog/building-the-infrastructure-for-acela-express#:~:text=Amtrak%20crews%20and%20contractors%20installed,new%20signal%20system%3B%20lowered%20or

*Buy America*. (2022, November 1). United States Department of Transportation. https://railroads.dot.gov/legislation-regulations/buy-america/buy-america

*"Buy America" domestic sourcing guidance and waiver process for DOI financial assistance agreements*. (n.d.). U.S. Department of the Interior. Retrieved February 25, 2024, from https://www.doi.gov/grants/BuyAmerica

Callon, M. (1984). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St. Brieuc Bay. *The Sociological Review, 32*(1), 196-233. https://doi.org/10.1111/j.1467-954X.1984.tb00113.x

Cressman, D. (2009). A brief overview of actor network theory: Punctualization, heterogeneous engineering & translation. Simon Fraser University. https://summit.sfu.ca/item/13593

Eastham, T. R. (2003). Running off the rails. *IEEE Spectrum, 40*(1), 66–69. https://doi.org/10.1109/MSPEC.2003.1159735

Feinberg, S. (2015, November 6). *Request for waiver of Buy America requirement for components of next generation triansets*.

https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/15479/Amtrak%20Waiver%20in%20Common%20Signed%20by%20Administrator%2011.6.15.pdf

Kim, M. (2023, September 5). *Why high-speed bullet trains won't work in the U.S. right now*. Scientific American. https://www.scientificamerican.com/article/why-high-speed-bullet-trains-wont-work-in-the-u-s-right-now/

Lord, S. (2017). *Train operations: The Acela Express 2021 program faces oversight weaknesses and schedule risks* (OIG-A-2018-002). Amtrak Office of Inspector General. https://amtrakoig.gov/sites/default/files/reports/OIG-A-2018-002.pdf

Morrison, J. (2020). *Train operations: Acela 21 program continues to face significant risk of delays, warranting more contingency planning* (OIG-A-2020-004). Amtrak Office of Inspector General. https://amtrakoig.gov/sites/default/files/reports/OIG-A-2020-004%20Acela%2021%20%28REDACTED%29.pdf

Morrison, J. (2023). *Major programs: Company improved management of new Acela program, but additional delays and cost increases are likely* (OIG-A-2023-013). Amtrak Office of Inspector General. https://amtrakoig.gov/sites/default/files/reports/OIG-A-2023-013%20%28REDACTED%29%20-%20amended_1.pdf

*New Acela fleet*. (n.d.). Amtrak. Retrieved February 25, 2024, from https://www.amtrak.com/next-generation-high-speed-trains

Platzer, M. D., & Mallett, W. J. (2015). *Effects of Buy America on transportation infrastructure and U.S. manufacturing: Policy options* (Congressional Research Service). U.S. Congress.

Schwieterman, J. P., & Scheidt, J. (2007). Survey of current high-speed rail planning efforts in the United States. *Transportation Research Record: Journal of the Transportation Research Board*, *1995*(1), 27–34. https://doi.org/10.3141/1995-04