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TEACHING NOTE

# SpaceX

## Case Overview

The case is set in September of 2017 and it begins with CEO Elon Musk contemplating current industry and other issues associated with making humans an interplanetary species. While technical and other issues remain, a major concern involves lowering space launch costs. The case introduction ends with Elon Musk looking at the stars asking: How we can we get there?

The second section of the case provides a brief history of SpaceX as the first company (before Tesla and SolarCity) Elon Musk founded after selling PayPal to eBay for $1.5 billion. Elon Musk formed SpaceX after realizing the raw material costs for a rocket were a small part (~3 percent) the cost of rocket launch, when his desire to land a greenhouse of plants on Mars (i.e., Mars Oasis) was thwarted by high costs. SpaceX has achieved several notable "firsts," including the first private company to: reach orbit with a liquid rocket (2008), resupply the International Space Station (2012), place a satellite into geosynchronous orbit (2013), and reuse a rocket to place a satellite into orbit (2017). Additional SpaceX milestones are provided in a later summary of firms competing in commercial space launch. The summary of SpaceX ends by alluding to the challenges associated with competing in space launch.

The third section of the case summarizes the five different segments of the space launch market based on altitude. Spaceflight began with *suborbital flight*, or objects that reach space (~62 miles above Earth), but do not make a full orbit. Two new entrants, Virgin Galactic and Blue Origin, plan to offer suborbital spaceflight to paying customers as early as 2018. The next segment involves *Low Earth Orbit* (LEO) or the area roughly between 100 to 1,200 miles above the Earth. While space begins at 62 miles, atmospheric drag makes satellite orbit below 100 miles difficult. With the exception of the Apollo moon missions, all human activity in space has been limited to LEO and the protection the Earth's magnetic field provides from space radiation. Communication satellites are sometimes placed in LEO as it provides the shortest delay due to distance, but this also requires multiple satellites to provide coverage of the Earth's surface. (Details on the inclination of orbits and elliptical are not discussed in the case.) For example, the Iridium satellite phone system operates with a constellation of 66 satellites. The third segment of space launch involves placing satellites into *Medium Earth Orbit* (MEO), or a distance of roughly 1,200 to 22,000 miles above the Earth's surface. Navigation satellites, such as the Global Positioning System (GPS) with 31 satellites, operate in MEO because it enables multiple satellites to be in view of any point on Earth to allow triangulation of the position of GPS receivers on the ground and in the atmosphere. The fourth segment places satellites into *High Earth Orbit* (HEO),

or beyond 22,000 miles above the Earth's surface. The most common application involves putting communication, weather, or other satellites in geosynchronous orbit 22,236 miles above the equator where satellites orbit at the same speed as the Earth's surface enabling them to stay above the same line of longitude above the ground. For example, DIRECTV® satellites operate in geosynchronous orbit. Separately, this means that a person in the northern hemisphere can easily tell which direction faces south by finding which way satellite TV receivers are facing (south toward the equator). The final segment for space launch involves *Beyond Earth Orbit* (BEO), and this is needed to enter lunar orbit or to visit other planets and objects within the solar system and beyond.

Other information relevant to the third section of the case is covered in **Exhibits 1**, **2** and **3**, summarizing different organizations and their rockets aimed at suborbital spaceflight (**Exhibit 1**), and LEO and HEO (**Exhibits 2** and **3**). **Exhibits 2** and **3** also list the first and second stage rocket engines used in different space launch systems, and this is significant for two reasons. First, the engines provide different purposes with the 1st stage providing the bulk of thrust to reach space, and the 2nd stage guides its payload to its final destination in orbit (or beyond). Second, United Launch Alliance (ULA), the established competitor, has outsourced its engine, ensuring its costs are higher.

The fourth section represents the bulk of the case, and it summarizes the different competitors in the space launch industry. Before reviewing the 21st century competitors of established firms and newer entrants, a brief review of the initial "space race" from the 1950s and 1960s is provided.

Established competitors in space launch largely involve United Launch Alliance (ULA) and Arianespace.

- **United Launch Alliance** (ULA) was formed in 2006 as a joint venture between Boeing and Lockheed Martin with the support of the Department of Defense. Following its formation, ULA had a monopoly on U.S. government space launch for a decade, and this provided limited incentive to lower launch costs and innovate. ULA has since been impacted by new entrants that have forced it to restructure and sanctions against Russia that limits the continued use of Atlas V rockets that depend on the RD-180 engine. Previously, improved Post-Cold War relations with Russia, the need for reliability of launches, and the small market for HEO launches resulted in the decision to use an existing rocket. However, changing geopolitical circumstances and anticipated expansion in the space launch market has led ULA to develop a Vulcan rocket with a reusable 1st stage engine with competing designs being developed by Blue Origin and Rocketdyne. While ULA has advantages of prior experience with over 1,000 launches and a history of high reliability, its move into HEO and ceding LEO launches to competitors, such as SpaceX, is only increasing the cost of HEO launches from the spreading of overhead costs across fewer launches.
- **Arianespace** is a French multinational corporation that largely created commercial space launch when it was founded in 1980. In 2014, Arianespace claimed 60 percent of the commercial launch market, but that has eroded with competition from new entrants. Again, this is driving the development of a new launch program (Arianespace 6) that incorporates reusable components to reduce costs. Arianespace operates LEO launch and HEO separately with a partnership with Russia and a Kazakhstan launch facility, and its own Guiana facility in South America, respectively.

Newer entrants in space launch are numerous and roughly summarized in the order they entered the space launch market.

- **International Launch Service** (ILS) was formed in 1995 as a joint venture between Khrunichev (Russia) and Lockheed Martin (U.S.), but Lockheed Martin divested its ownership in 2006, when it formed ULA with Boeing. ILS offers launch services from Kazakhstan using Russian rockets.
- **SpaceX** was founded by Elon Musk and the firm designs, builds, and launches rockets and space capsules. SpaceX has demonstrated significant accomplishments in the last decade (see case page 4), and it has plans to launch rockets every few weeks and has signed a private contract to send two people to orbit the moon in 2018. SpaceX primarily uses Cape Canaveral, FL for its rocket launches.
- **Orbital ATK** was formed from a merger between Orbital Science Corporation and Alliant Techsystems in 2015, and, in 2017, Northrop Grumman announced plans to acquire it. During the 1990s, Orbital Science Corporation formed a launch services group based on its Pegasus rocket that is launched from a wide body aircraft. While Pegasus has not been frequently used, Microsoft co-founder, Paul Allen, has developed a massive Stratolaunch aircraft designed to launch three Pegasus rockets. Orbital ATK also has Minotaur rockets that combine Pegasus upper stages with re-purposed MX Peacekeeper intercontinental ballistic missile (ICBM) rocket engines to launch satellites. However, the U.S. government does not allow the Orbital ATK to use Minotaur rockets for commercial launch. Orbital ATK uses multiple locations to launch its rockets.
- **Blue Origin** was formed in 2000 by Amazon CEO Jeff Bezos who also funds Blue Origin operations by selling Amazon stock. Blue Origin has applied an incremental approach to developing rockets and it began with its New Shepard rocket and capsule to demonstrate technology and provide suborbital space travel. From this foundation, Blue Origin is developing its New Glenn (BE-4) rocket that is also planned for use by ULA in its Vulcan rocket system. The first fully assembled BE-4 rocket was completed in 2017 and Jeff Bezos plans to pursue putting people on the moon. Blue Origin operates launch facilities for suborbital flight in SpacePort America, NM and orbital launch from Cape Canaveral, FL.
- **Virgin Galactic** was founded by Richard Branson in 2004. His vision was to provide commercial space travel, resulting in a spacecraft powered by a rocket (SpaceShipTwo) that is launched from an aircraft (WhiteKnightTwo). SpaceShipTwo began testing in 2012 and experienced its first rocket test in 2013. However, the initial SpaceShipTwo was destroyed when its reentry system prematurely deployed in 2014. Testing of a second SpaceShipTwo restarted in 2017 and, in 2018, they plan to take their first commercial passengers to space. Virgin Galactic also operates an orbital launch capability under a separate subsidiary called Virgin Orbit that plans to send satellites into orbit using rockets (LauncherOne) fired off a Boeing 747. Virgin Galactic operates its suborbital launch from Van Horn, TX, and its satellite launch from Long Beach, CA.
- **Rocket Lab** celebrated 10 years as a company in 2016, but it only experienced reaching space with its Electron rocket in 2017. To overcome the entry barrier of a launch facility, Rocket Lab built its own in Mahia, New Zealand where it has a license to launch satellites every 72 hours for the next 30 years.

The fifth and final section of the case summarizes a handful of the most salient issues associated with companies pursuing opportunities in space, including:

- **Space Law** is governed by a 50-year-old United Nations treaty that largely was written without considering private companies operating in space. The main elements of the treaty ban military installations and any claims of sovereignty in space. This poses problems for potential mining of minerals in space and for how any space colony would be governed. Attempts to update the treaty are being resisted by countries that fear it would only benefit wealthy countries and corporations.
- **Militarization of Space:** While military installations are banned, satellite navigation, communication, and surveillance all have military applications. Additionally, multiple countries have demonstrated an ability to destroy satellites.
- **Politics:** Legal and military issues combine to drive political activity. For example, ULA and SpaceX both spend millions on lobbying. Additionally, Orbital ATK is currently restricted from offering commercial space launch with its rockets using decommissioned M-X Peacekeeper ICBM, and sanctions against Russia are driving ULA to develop a new rocket system that does not depend on a Russian RD-180 rocket engine. While government spending on space has been inefficient, it has maintained the ability for space launch for national security and skilled labor needed by commercial firms. In other words, it has created the ability of commercial firms to be profitable from cutting costs.
- **Substitutes:** Multiple alternatives to satellites exist. For example, only a small fraction of communication is handled by satellites with the world being wrapped by fiber optic cable. Existing technology could provide Internet and communication using high endurance drones (i.e., Facebook) or high altitude balloons (i.e., Google). Meanwhile, a Canadian company has obtained a patent for a space elevator.
- **Space Debris:** The growing popularity of space is also making it more cluttered, and the high velocities involved can make objects as small as paint chips dangerous. The U.S. government tracks objects larger than two inches in LEO and objects longer than a yard in HEO. Meanwhile, even smaller objects could still cause catastrophic damage, but we do not have the technology to track them. Additionally, neither the technology nor plans for removing objects from space exist.
- **Human Limits:** Life on Earth has evolved over thousands of year to live in gravity, and a lack of gravity causes multiple problems. Additionally, with the exception of the Apollo moon missions, all human activity in space has been limited to LEO where the Earth's magnetic field protects people from space radiation that can cause cognitive decline and increased risk of cancer. Further, behavioral and other health concerns result from living in a small closed environment. Finally, the farther people are sent from Earth the longer the delay in communication. Under the best of circumstances, it would take over 20 minutes to communicate with Mars, and a lot can go wrong in less than 20 minutes. Human limits also create problems in combination as travelling faster to limit space radiation also increases problems associated with bone density loss as it would require significant acceleration and deceleration.

The case then concludes by returning to Elon Musk contemplating these problems against the imperative to populate another planet for humans to survive as a species.

## Key Concepts

- External Analysis
- Competition
- Vision and Mission
- Strategic Leadership
- Core Competencies
- Strategic Positioning
- Entry Barriers
- Innovation
- Technology
- Strategic Alliances, Mergers & Acquisitions
- Implementation of Strategic Initiatives

## Suggested Discussion Questions

1. **Evaluate the competitive forces for the space launch industry to identify the forces controlling its profitability (e.g., Five Forces analysis). Is SpaceX positioned for long-term profitability?**

2. **Compare the impact of the value chain decisions for United Launch Alliance (ULA) and SpaceX. Which firm is more likely to experience a competitive advantage?**

3. **Compare the competitive position of established space launch firms (e.g., ULA and Arianespace) with newer space launch competitors. What strategic groups exist?**

4. **Apply PESTEL analysis to identify the general environment trends impacting space launch. What are the most important to SpaceX's strategy?**

5. **Explain how experience from increased launches can help SpaceX achieve a low cost strategy.**

## Suggested Answers

**1. Evaluate the competitive forces for the space launch industry to identify the forces controlling its profitability (e.g., Five Forces analysis). Is SpaceX positioned for long-term profitability?**

Porter's Five Forces analysis (see figure) is designed to describe rivalry in an industry, and this represents the significant change in space launch in the last two decades. Rivalry between the established firms was low and ULA enjoyed a monopoly on U.S. government space launches. This situation contributed to high costs and low innovation in space flight, creating an opportunity for new entrants to be profitable if they could reduce costs.

**New Entrants:** It is the promise of high profitability and vision of entrepreneurial founders that have led to the founding of new entrants to space launch. Still, the threat of entry is limited by the high technical complexity, high cost (~$2 to 4 billion), and the need for a launch facility. For example, Rocket Lab built its own launch facility in New Zealand.

**Bargaining Power of Buyers:** The space launch market is divided among government, commercial, and potentially personal travel. The bargaining power of the government is highest, as it represents a single buyer with regulatory power that controls profits. However, this encouraged government providers (i.e., ULA) to raise costs to increase revenue. This created an opportunity for new firms to lower costs and experience higher profits. SpaceX also successfully disrupted ULA's monopoly on U.S. government space launches by suing and then settling to launch for GPS satellites. With additional options, commercial space launch potentially has some bargaining power, but the number of options is more limited once the size and planned orbit of a satellite are considered. Also, there are currently no substitutes for space launch once a company goes to the expense of building or buying a satellite. For commercial space travel, it is anticipated there will be two options but both will cost over $200,000, or initially, space travel will not be price sensitive therefore limiting bargaining power. See **Exhibit TN-1** for a depiction of Porter's Five Forces Model.

**Threat of Substitutes:** Even at the anticipated low-end of LEO launch (Rocket Lab = $5 million; Virgin Galactic = $10 million), substitutes may be a cheaper option. If used for communication, the Iridium satellite system uses 66 satellites, or would require at least $330 million and significant time to put into place. A system of cables or cell phone towers, or a fleet of drone aircraft or balloons, may be a less expensive option. Even better, a communication company could simply lease satellite or cell phone coverage from existing providers. This is what Google does for its wireless service.[1]

**Bargaining Power of Suppliers:** Skilled personnel likely have increased bargaining power as more firms need the capabilities they provide. However, SpaceX limits supplier bargaining power by building almost everything it needs in-house. Meanwhile, ULA is dependent on suppliers for its 1st and 2nd stage rocket engines, as well as avionics. As a result, ULA has to share profits with these powerful suppliers, and increased competition from SpaceX led ULA to reduce its supplier costs by 36 percent. However, if ULA picks the Blue Origin (BE-4) engine, then it guarantees that Blue Origin will have greater profits and lower costs from enjoying a larger production quantity. It is also possible that its suppliers could forward integrate. For example, Rocketdyne offered $2 billion to acquire ULA in 2015.[2]

**2. Compare the impact of the value chain decisions for United Launch Alliance (ULA) and SpaceX. Which firm is more likely to experience a competitive advantage?**

See **Exhibit TN-2** (A Generic Value Chain: Primary and Support Activities).

**ULA** focused on reliability (design and final assembly), as well as customer service (i.e., program management, payload integration, telemetry, etc.) and interface with its primary customer, the U.S. government. This created a more bloated management infrastructure that contributed to higher launch costs, and ULA cut its management ranks by 30 percent following SpaceX's entry. ULA has also outsourced the manufacture of its 1st and 2nd stage rocket engines. This has created problems as sanctions (and high costs) have driven ULA to design the Vulcan rocket without Russian RD-180 engines. However, it will likely depend on 1st stage engines provided by either Blue Origin or Rocketdyne, and it may remain dependent on Russian RD-180 engines through 2028.

**SpaceX** was founded, in 2002, after Elon Musk realized the raw material costs of a rocket were only three percent the cost established space launch firms were charging. As a result, SpaceX has focused on reducing cost in rocket design, and minimizing its suppliers. The design of SpaceX's Falcon 9 and Dragon space capsules has incorporated reusability to lower costs. For example, while there will still be refurbishment costs, refueling a "flight proven" Falcon 9 rocket only costs a fraction ($250K) of building a new rocket ($16 million). SpaceX also works to keep costs under control by doing most of the work in-house, or minimizing its reliance on suppliers.

Based on its design and company structure focused on reducing costs, SpaceX is more likely to experience competitive advantage versus ULA. The dependence of ULA on external suppliers for its 1st stage rocket engines likely puts it at a competitive disadvantage. This is reinforced with ULA having to design a new rocket (~$2 billion expense), because of sanctions against Russia intended to remove a reliance on the RD-180 rocket engine.

**3. Compare the competitive position of established space launch firms (e.g., ULA and Arianespace) with newer space launch competitors. What strategic groups exist?**

## *INSTRUCTOR BACKGROUND INFORMATION*

**Competitive Position:** Three steps are used to map the competitive position of different firms in an industry:

1. Identify a list of competitive factors for the market.
2. Select two factors to map competitors. Cost Structure is generally put on the y-axis and another factor on the x-axis, and, in the example, number of routes is used.
3. Use the characteristics of firms competing in the industry to map their location. This identifies strategic groups that compete on similar characteristics. *Note*: The size of the circle is based on revenue or market share.

For an example, see **Exhibit TN-3** (Strategic Groups and Mobility Barrier in U.S. Domestic Airline Industry).

## *SPACE LAUNCH*

To develop a map of the competitive position of firms in the space launch industry, price is an obvious factor as the high price of established firms encouraged new entrants, and price is used on the y-axis. There are multiple other options for market characteristics to use for the x-axis (e.g., reliability/human flight, market segment, payload, etc.); however, different market segments served may be most useful to identify strategic groups. Information on these characteristics is used to map (see **Exhibit TN-4**) competitors on these dimensions with information coming from the case exhibits. The bottom segments of suborbital and firms only competing in LEO are well-defined. However, the top segment is less defined with multiple competitors and price points. For example, it is unclear whether Orbital ATK belongs in this group, when it is restricted from government launch. The observed competition among these companies also reflects the make-up of the top segment is ill-defined.

*Note*: Many of the new entrants are private companies, so financial information on revenue and other metrics to map size is not available.

From graphing the cost and market segments, three different strategic groups emerge. First, it is clear that suborbital flight is a separate strategic group. This can begin to explain Virgin Galactic creating a separate subsidiary for space launch called Virgin Orbit. A second strategic group also exists for low cost launch to LEO with the primary competitors involving Virgin Galactic and Rocket Lab.

The third strategic group involves the established spaced launch firms of ULA and Arianespace, as well as more recent entrants of Blue Origin, SpaceX, and ILS. Orbital ATK is at the border of this group and may not belong on the chart, as it is limited to U.S. government launch customers. Within this group, the closest price competition appears to be between SpaceX and Arianespace.

Further, it is clear that firms in the third group will likely compete to serve the BEO market segment. While SpaceX has a contract to send two people into a lunar orbit, none of the existing firms has a clear position and different strategies are being pursued. For example, ULA will likely depend on government contracts for any BEO missions. Meanwhile, SpaceX and Blue Origin will likely use government and other contracts to subsidize their plans to reach Mars and the moon, respectively. It is unknown how mineral extraction from the moon or asteroids will develop, and there are legal questions that require resolution.

**4. Apply PESTEL analysis to identify the general environment trends impacting space launch. What are the most important to SpaceX's strategy?**

Information in the case relates to important changes in the general environment of the space launch industry shown in **Exhibit TN-5**.

In **Exhibit TN-6**, representative trends are summarized in the format of PESTEL analysis to identify opportunities and threats from the perspective of SpaceX.

In considering the most important trends for SpaceX's strategy, they likely reflect technology is the most significant trend. Significant advances are required and multiple companies are pursuing them.

It is highly likely that all the technology needed to reach other planets will not be held by a single firm. SpaceX will likely need to create alliances or lobby for the creation of patent pools. This suggests that the political and legal trends will be other important trends for SpaceX's strategy.

**5. Explain how experience from increased launches can help SpaceX achieve a low cost strategy.**

Learning curves lead to lower costs from learning and economies of scale.

Learning during manufacturing was first identified in the manufacture of aircraft[3], and they can have significant effects. For example, during the manufacture of the first B-1 bomber, over one million-man hours were required and this fell to only 150,00 hours by the fifteenth bomber.[4] In manufacturing, learning rates range between 70 to 90 percent, and this relates to cost being reduced five to 30 percent every time production doubles.[5] This reflects increased efficiency from performing repetitive tasks and standardization, as well as improved design and manufacturing techniques. Firms with faster rates of learning can achieve competitive advantage, and learning effects are part of first mover advantages, see **Exhibit TN-7**.

Economies of scale also decrease cost as SpaceX builds more rockets. For example, the fixed cost of R&D is brought down through economies of scale by spreading it across more rockets making the next rocket's total cost cheaper than the prior rocket. Additionally, as scale increases more efficient use of labor is possible. For example, the first prototype of a rocket is likely built by the PhDs that design it, and later rockets can be produced by less expensive skilled labor. There is also generally less waste of resources as economies of scale is achieved.

## Additional Resources

### 1. Articles

- CNN "SpaceX Makes History: It Launched a Used Rocket and Then Landed It In The Ocean," http://money.cnn.com/2017/03/30/technology/spacex-launch-ses-10-reused-rocket/, last modified March 30, 2017, (includes 1:43 min video).
- C. Dillow, "The Great Rocket Race," *Fortune*, last modified October 26, 2016, http://fortune.com/spacex-ula-lockheed-boeing-rocket-race/.

### 2. Websites

- Asteroid Rank, a website listing the value of different asteroids: http://www.asterank.com/
- List of current articles on space launch; *Florida Today*: http://www.floridatoday.com/space/
- Stuff in Space, or real time tracking of objects in Earth orbit: http://stuffin.space/

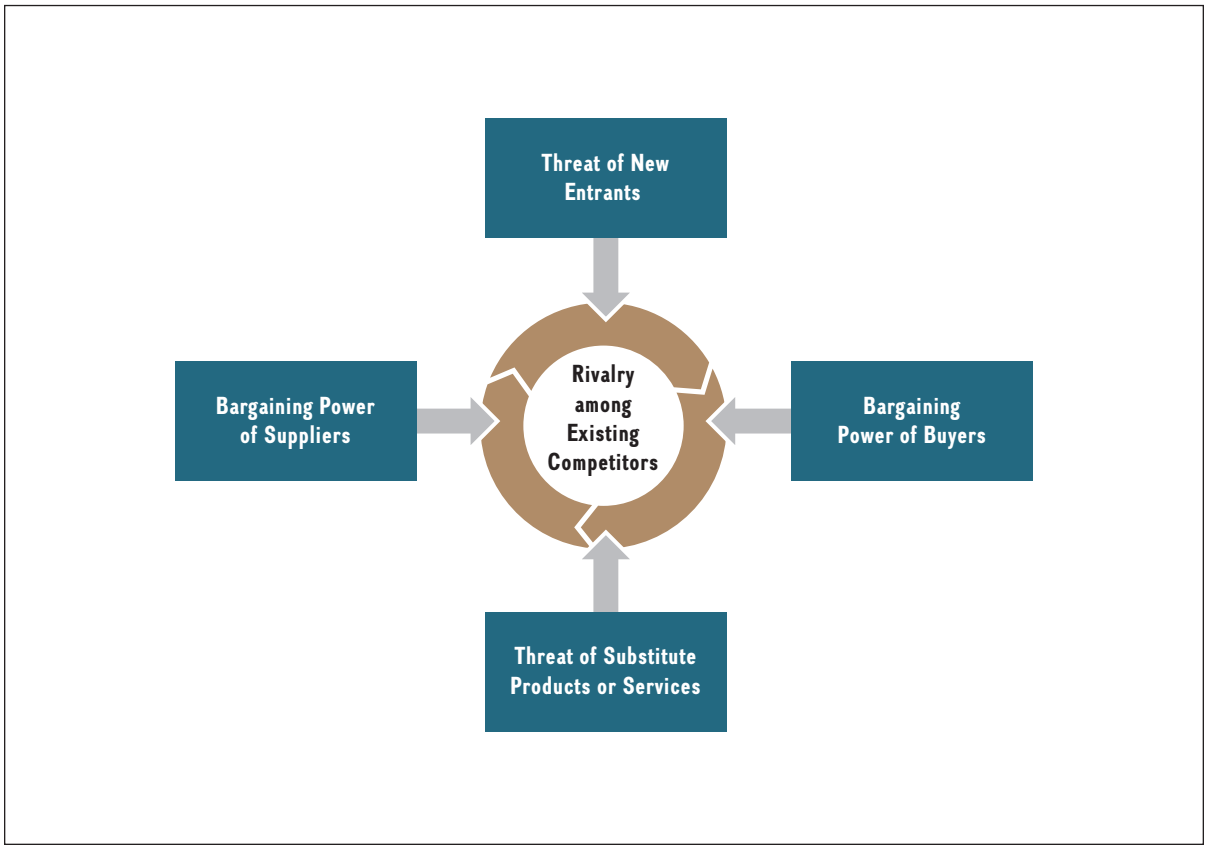
### 3. Videos

- Limits of Humanity (May 12, 2016) [7:44 min]: https://www.youtube.com/watch?v=ZL4yYHdDSWs
- Changing Space Race Economist (April 23, 2017) [2:12 min]: https://www.youtube.com/watch?v=wihUvbrzxlo&feature=youtu.be&ab_channel=TheEconomist
- SpaceX YouTube channel: https://www.youtube.com/user/spacexchannel
    - 2013: "Elon Musk: The Case for Mars," 9 July [1:02]: https://www.youtube.com/watch?v=Ndpxuf-uJHE
    - 2015: "Slow Motion Video of the Falcon 9 Explosion," 28 June [2:04 min]: https://www.youtube.com/watch?v=fTom8xVzFdo
    - 2016: "First Stage Landing on Droneship" April 29, 2016 [0:38 min]: https://www.youtube.com/watch?v=KDK5TF2BOhQ_
    - 2016: "SpaceX Rocket Explodes on Launchpad" [1:01]: http://www.latimes.com/local/lanow/89761677-132.html
    - 2016: "SpaceX Interplanetary Transport System," September 27 [4:21 min]: https://www.youtube.com/watch?v=0qo78R_yYFA
    - 2017: "Watch SpaceX Launch its First Truly Reusable Rocket" March 30 [53:02 min] https://www.youtube.com/watch?v=xsZSXav4wI8
    - 2017: "SpaceX Milestones" April 9 [4:00 min]: https://www.youtube.com/watch?v=CSi95I6OK_U
    - 2017: SpaceX Launch of First Spy Satellite "NROL-76 launch" May 1 [22:10]: https://www.youtube.com/watch?v=EzQpkQ1etdA
    - 2017: SpaceX Launch of X-37B Test Vehicle and Recovery of 1st stage rocket [22:23]: https://www.youtube.com/watch?v=9M6Zvi-fFv4
    - 2017: "SpaceX blooper reel" showing failures behind its progress [2: 08] https://www.youtube.com/watch?v=Lrn1c6N0phw
- Blue Origin:

    2015: Historic Rocket Landing [3:13 min]: https://www.youtube.com/watch?v=9pillaOxGCo

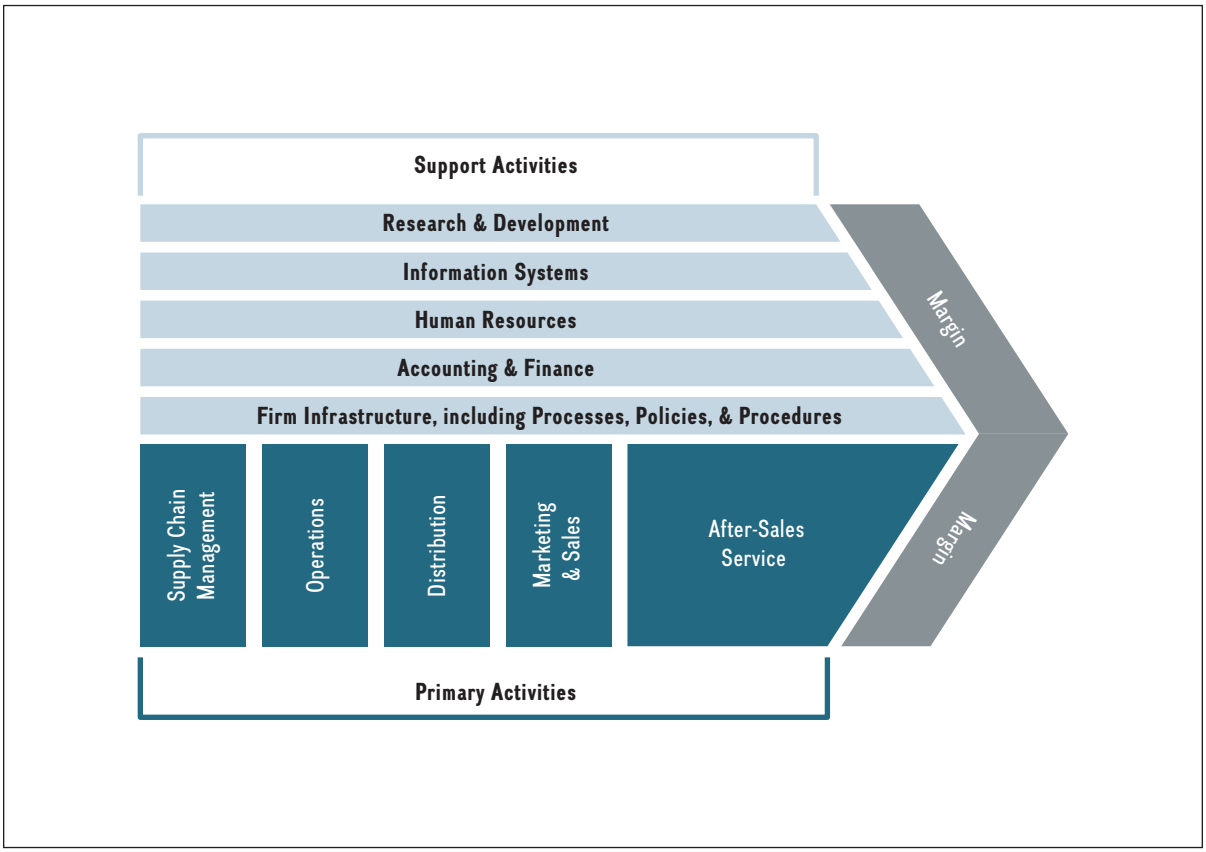
    2017: Introducing New Glenn [1:32 min]: https://www.youtube.com/watch?v=BTEhohh6eYk
- Virgin Galactic
    - "Overview" of Earth from Space: https://player.vimeo.com/video/55073825 [19:02 min]
    - LauncherOne [1:58]: https://www.youtube.com/watch?v=L2OT8Fvo1zw
- RocketLab: Making Space Affordable [2:33]: https://www.youtube.com/watch?v=LwBLE0Nbnao
- 2017: "Making Life Multiplanetary" Elon Musk presentation on plans to colonize Mars [43:47 min] https://www.youtube.com/watch?v=S5V7R_se1Xc&feature=youtu.be

**EXHIBIT TN-1** Porter's Five Forces Model



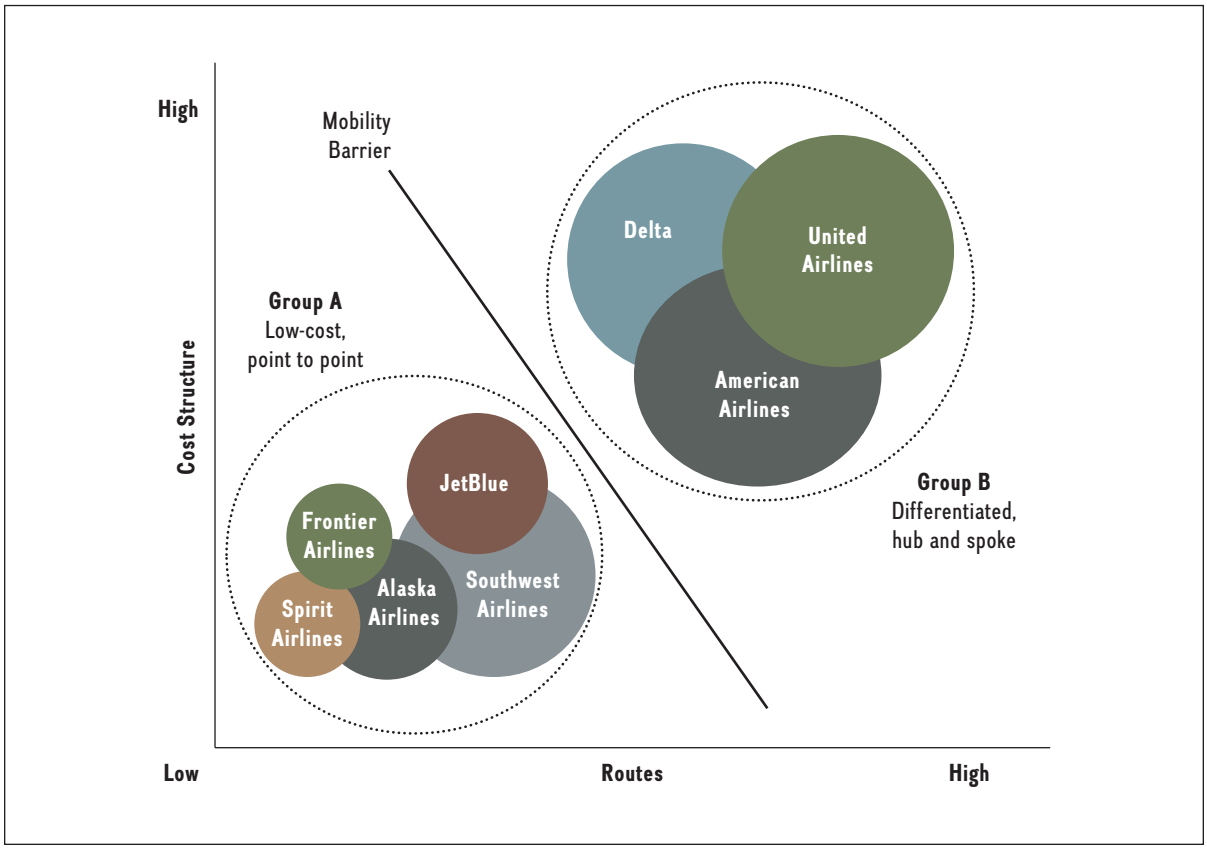

Source: Rothaermel, F.T. (2018), Strategic Management, 4th edition. Burr Ridge, IL: McGraw-Hill.

**EXHIBIT TN-2** A Generic Value Chain: Primary and Support Activities



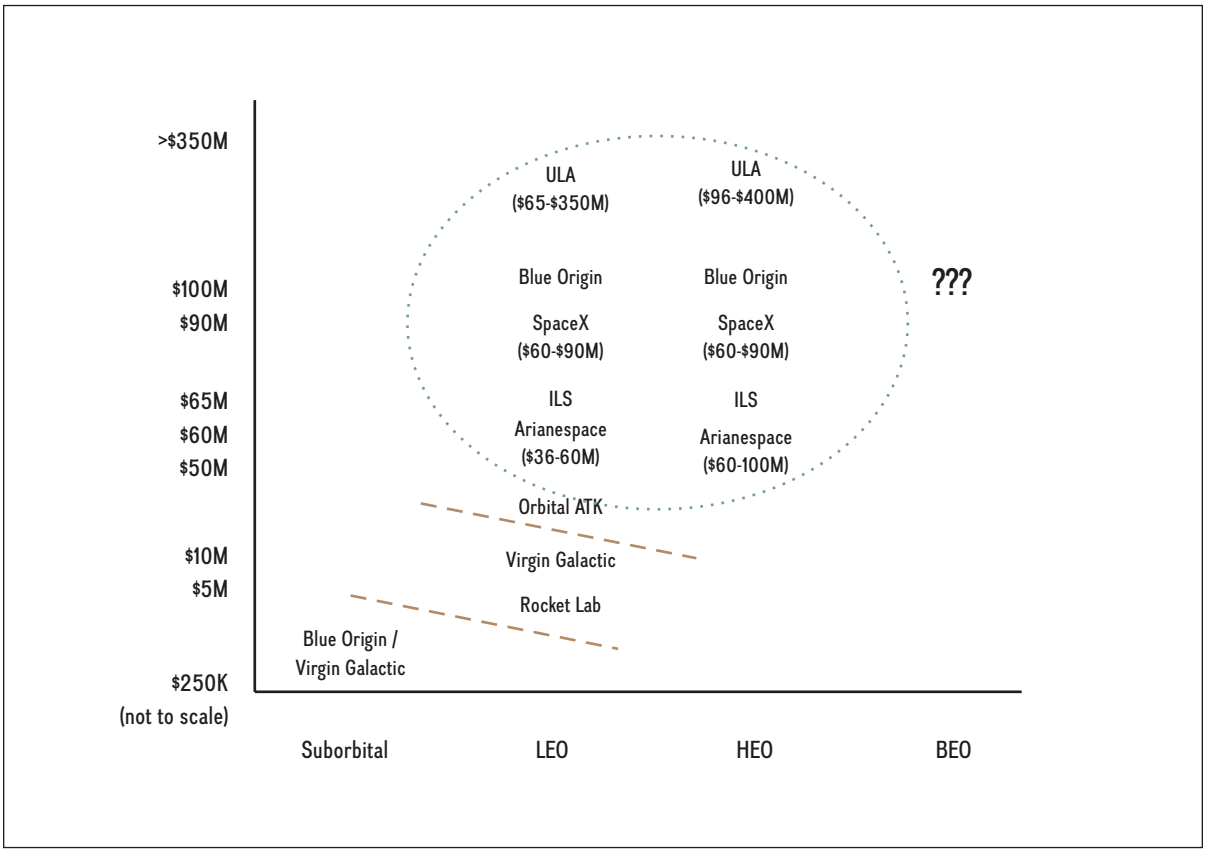

Source: Rothaermel, F.T. (2018), Strategic Management, 4th edition. Burr Ridge, IL: McGraw-Hill.

**EXHIBIT TN-3** Strategic Groups and Mobility Barrier in U.S. Domestic Airline Industry



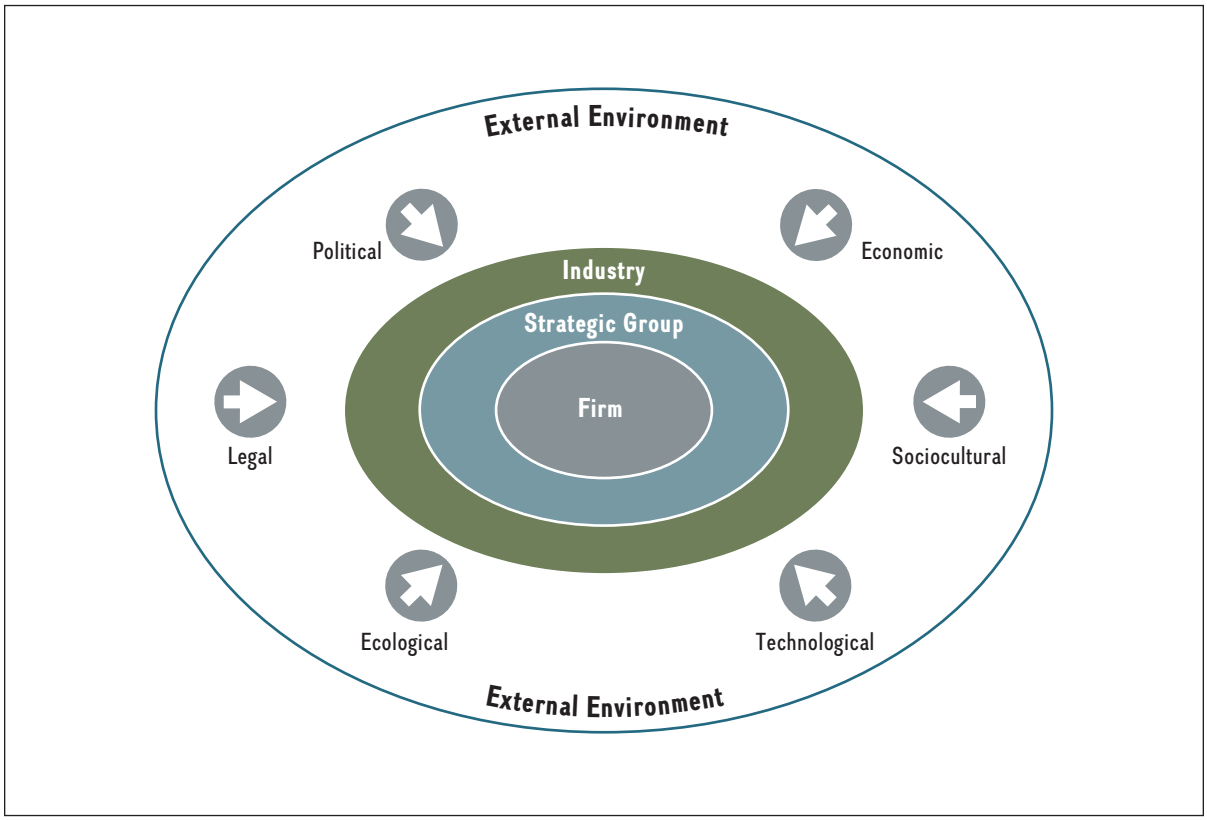

Source: Rothaermel, F.T. (2018), Strategic Management, 4th edition. Burr Ridge, IL: McGraw-Hill.

**EXHIBIT TN-4** Map of the Competitive Position of Firms in the Space Launch Industry




Source: Courtesy of D.R. King.

**EXHIBIT TN-5** The Firm within Its External Environment, Industry, and Strategic Group, Subject to PESTEL Factors



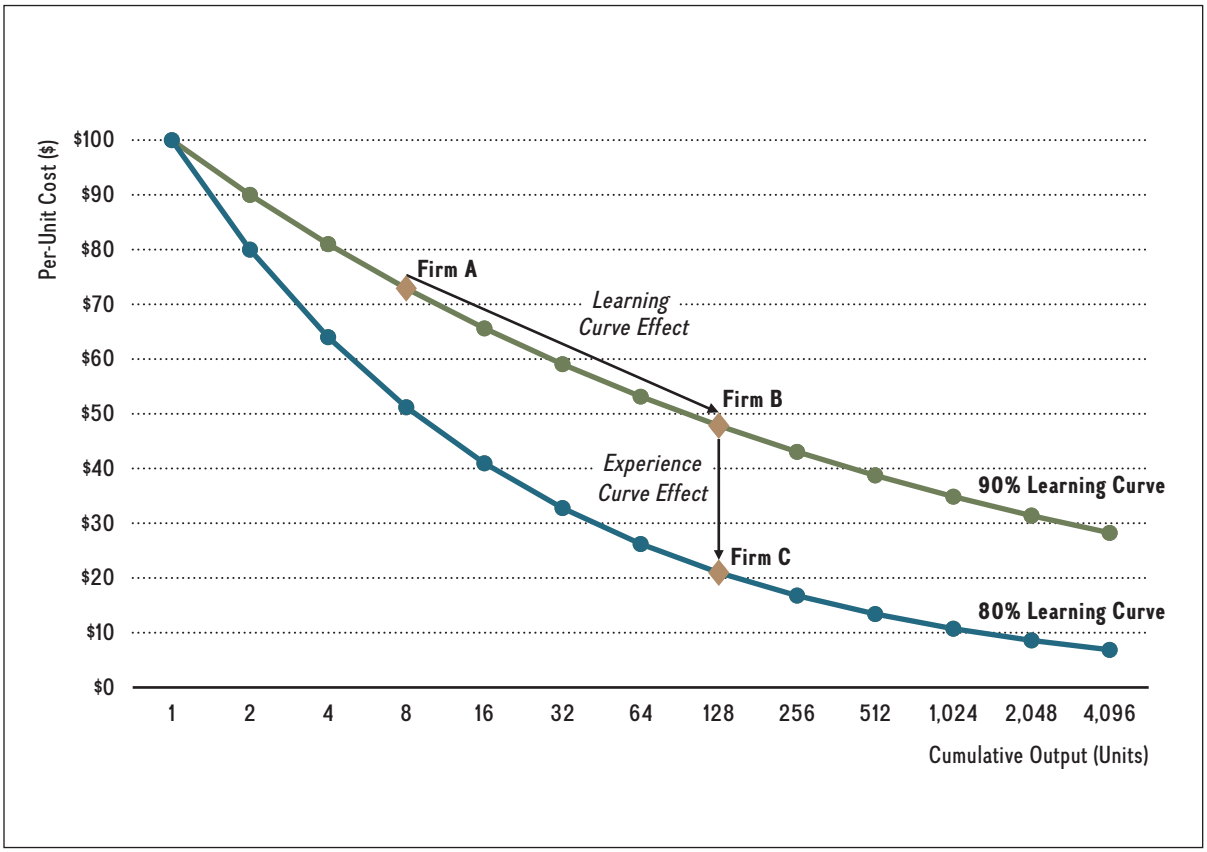

Source: Rothaermel, F.T. (2018), Strategic Management, 4th edition. Burr Ridge, IL: McGraw-Hill.

**EXHIBIT TN-6** PESTEL Analysis to Identify Opportunities and Threats from the Perspective of SpaceX

| Trend | Opportunity | Threat |
|---|---|---|
| Political | • Access to government contracts<br>• Emphasis on domestic launch<br>• Ability to influence policy through lobbying | • Government emphasis on reliability and history of success<br>• Potential for increased competition if political restrictions decrease<br>• High cost of lobbying and lobbying by other firms<br>• Commercial success also threatens government spending for space travel |
| Economic | • Growing economy and demand for space travel | • Potential for economic disruption |
| Sociocultural | • Potential interest in commercial space travel<br>• Military conflict could either increase or decrease demand | • Demand for commercial space travel will likely be sensitive catastrophic failure events<br>• Military conflict could either increase or decrease demand |
| Technological | • Technology progress is needed, but technology is also advancing rapidly | • High cost for R&D<br>• Technology advances will likely be covered by patents and needed technology may be restricted or financially exorbitant |
| Ecological | • Stephen Hawking has projected humanity has less than 100 years to populate another planet to survive as a species<br>• Less waste with reusable aircraft | • Liquid and solid rocket fuel is dangerous and harms the environment, and this may gain greater attention if space travel increases<br>• More activity in space has created space debris that represents a threat to additional activity |
| Legal | • SpaceX was able to access U.S. government space launch contracts with the threat of legal action | • SpaceX needs to protect its technology increased competition and high reward for success<br>• SpaceX will likely need to protect its patents |

Source: Courtesy of D.R. King.

**EXHIBIT TN-7** Gaining Competitive Advantage through Leveraging Learning-Curve and Experience-Curve Effects




Source: Rothaermel, F.T. (2018), Strategic Management, 4th edition. Burr Ridge, IL: McGraw-Hill.

## Endnotes

1 Google, accessed September 17, 2017, https://fi.google.com/about/.

2 Mike Gruss, "Aerojet Rocketdyne Makes $2B Offer for United Launch Alliance," SpaceNews, last modified September 8, 2015, http://spacenews.com/aerojet-makes-2-billion-offer-for-united-launch-alliance-sources/.

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