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# The Revolutionary Armed Forces of Colombia (FARC) and the Development of Narco-Submarines

Michelle Jacome Jaramillo

*START Center, University of Maryland, [mjacome@umd.edu](mailto:mjacome@umd.edu)*

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# The Revolutionary Armed Forces of Colombia (FARC) and the Development of Narco-Submarines

## Author Biography

Michelle Jacome is a Senior Researcher in the Unconventional Weapons and Technology Division at the National Consortium for the Study of Terrorism and Responses to Terrorism (START). Prior to her position at START, she worked for the United Nations Development Program in Ecuador. Her research includes transnational criminal organizations, illicit trafficking, terrorism, the crime-terror nexus, counterterrorism, and the adoption of new emerging terrorist technologies, particularly with regard to the use of unconventional weapons. She has carried out field research on these topics across Latin America. She completed her Master of Science in Development Management at the American University in Washington, D.C.

## Abstract

The Revolutionary Armed Forces of Colombia (FARC) have been one of the world's most consistently formidable violent non-state actors over the last forty years. Unsurprisingly, the group has provided one of the most compelling and concerning examples of the level of technical sophistication attainable by sub-state organizations. Over the last two decades the group has carried out an iterative and innovative process that, in reaction to improved detection capabilities, has brought them from depending on disposable go-fast boats to transport drugs to possessing fully submersible and reusable covert vessels for transportation. The following case study will discuss the development of narco-submarines and the underlying motivations behind the pursuit of this complex engineering task. The case study will outline the different phases of the narco-submarine development and highlight FARC's determination to overcome the challenges present in each design. This discussion will show how FARC's systematized acquiring of information and expertise has resulted in the accomplishment of fully submersible vessels, capable of transporting more than 10 tons of illicit product.

## Disclaimer

*Editor's Note:* This article forms part of a series of related case studies collected in this Special Issue and should be viewed in the context of the broader phenomenon of complex engineering by violent non-state actors. Readers are advised to consult the introductory and concluding papers for a full explanation and comparative analysis of the cases.

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## Introduction

Since the early 1980s, the Revolutionary Armed Forces of Colombia (FARC) has found alternate methods to land-based border crossings for the transportation of illicit drugs. These methods evolved from small aircraft landings on clandestine airstrips to the use of go-fast boats for delivery along the coasts of Mexico and the U.S. As detection efforts were bolstered in both the countries of origin and destination, FARC led a pioneering effort to develop a furtive method of transportation that could convey a large amount of cocaine to the U.S. By 1990, FARC had designed and constructed the first known “narco-submarine” used for the transportation of drugs.

FARC provides one of the most compelling examples on how violent non-state actors (VNSAs) use transformational technologies to adapt and overcome challenging dynamics. The innovative capacity of FARC is derivative of its blend in ideology, desire for self-sufficiency, financial potential and commitment to organizational learning and strength.<sup>1</sup> The iterative process in the development of narco-subs by FARC is illustrative of the long-term commitment VNSAs with resources can devote to innovative projects that facilitate their strategic objectives. The broader implication being that clandestine organizations are willing to undertake complex engineering tasks in their efforts to overcome defensive technologies implemented by state actors. Brian Jackson, et al., states that groups like these are “acutely aware of government efforts to deploy such countermeasures and actively see ways to evade or counteract them.”<sup>2</sup>

While the development of weapons and the cultivation of other martial technologies by state actors have been comprehensively addressed by military and technological historians,<sup>3</sup> processes of innovation and the engagement in complex engineering efforts such as the narco-submarine on the part of violent non-state actors remain understudied phenomena. The origin and diffusion of innovations in weapon development, according to

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<sup>1</sup> Román D. Ortiz, “Renew to Last: Innovation and Strategy of the Revolutionary Armed Forces of Colombia (FARC)” in *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, Maryland: Rowman and Littlefield, 2006), pp. 205-222.

<sup>2</sup> Jackson, Brian et.al, *Breaching the Fortress Wall: Understanding Terrorist Efforts to Overcome Defensive Technologies*, (Santa Monica: RAND, 2007).

<sup>3</sup> For information on military history and the advent of military technology adoption please refer to: Max Boot, *War Made New: Technology, Warfare, and the Course of History, 1500 to Today*, (New York, NY: Gotham Books, 2006); Martin Van Creveld, *Technology and War: From 2000BC to the Present*, (New York, NY: The Free Press, 1991).

Ackerman, has only really blossomed in the past four decades.<sup>4</sup> As a result, most of the debate in this topic has been limited to conventional warfare (within a post-World War II paradigm) and determining to what extent technological developments may influence both the onset and outcome of war between state actors.<sup>5</sup> As the introduction to this special issue states, there remain large gaps in the understanding of the dynamics of VNSA innovation in terms of complex engineering tasks, as well as some question as to what observable instances of new technology adoption can further enrich the understanding of the pursuit of complex engineering efforts by groups like FARC. This historical case study outlines the evolution of an initial attempt to construct a narco-submarine. The adoption of this novel technology by FARC analyzes two key aspects important for counter-smuggling and terrorism efforts: 1) provides relevant data on FARC's ability to engage in a complex effort and 2) takes into account the organizational limitations and constraints that may influence the technical capabilities and activities of this clandestine organization. The following sections detail the undertaking of this complex engineering effort by FARC in an era where technological innovation is no longer a one-sided game.

Narco-submarines,<sup>6</sup> also referred to as 'narco-subs', are custom-made, self-propelled maritime vessels intended to smuggle illicit goods to the United States from South and/or Central America.<sup>7</sup> The earlier designs of narco-submarines consisted of semi-submersible vessels. These vessels are capable of controlling their running depth but cannot fully submerge. More recent designs include vessels that are submersible. They are equipped with sophisticated radar and navigational technology and are capable of full submersion to be virtually undetectable. These vessels also possess self-propulsion capabilities allowing them to travel longer distances.<sup>8</sup>

According to a written statement to the Subcommittee on Border and Maritime Security House Committee in 2012, maritime drug smuggling

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<sup>4</sup> Gary A. Ackerman, "More Bang for the Buck: Examining the Determinants of Terrorist Adoption of New Weapons Technologies" (Unpublished Doctoral Dissertation, King's College London 2013).

<sup>5</sup> Ibid.

<sup>6</sup> The term narco-submarines is commonly used to describe all types of vessels (low profile vessels, self-propelled semi-submersibles and fully submersibles). Even though the early iterations of the vessels discussed in this study did not have full submersion capabilities, this study uses narco-subs to maintain consistency with the sources used.

<sup>7</sup> Robert J. Bunker and Byron Ramirez, "Narco-submarines: Specially Fabricated Vessels Used for Drug Smuggling Purposes," *Foreign Military Studies Office*, May 2014: 9, available at: <http://fmso.leavenworth.army.mil/Collaboration/Interagency/Narco-Submarines.pdf>.

<sup>8</sup> Ibid.

accounted for over 80 percent of the total illicit drug flow from the Andean region to Honduras, Mexico and other mid-way transportation regions prior to entry into the United States.<sup>9</sup> The Drug Enforcement Administration (DEA) estimates that approximately 30 percent of the maritime flow utilizes narco-submarines.<sup>10</sup> Since narco-subs have become increasingly difficult to detect and seize due to the sophisticated innovations in radar shielding techniques and navigation equipment, the United States continues to have little interdiction success.<sup>11</sup> Approximately 74 percent of suspected maritime drug trafficking goes unpursued.<sup>12</sup>

The success of narco-submarines can be attributed to the iterative evolution in design and development of the vessels. The engineering and technology employed in the construction of these vessels have improved since the first interdiction of a semi-submersible in 1993 near the San Andres Islands in Colombia. By 2011, law enforcement had destroyed construction sites along the Colombian Pacific coastline and had seized numerous models and versions of these vessels, among them Low Profile Vessels (LPV), Self-Propelled Semi-Submersibles (SPSS), Submersible/Fully Submersible Vessels (FSV) and narco containers/torpedoes.<sup>13</sup>

## Decision

Craigin, et al., addresses the adoption and diffusion of technology through organizational theory and terrorism. Even though diffusion of technology is beyond the scope of this case study, the initial analytical framework of this theory is relevant as a counter-veiling example on how terrorist groups make the decision to absorb new technology. The underlying assumption of technology diffusion is that “potential users of a new technology will absorb it when and if they learn of its existence, as long as barriers to the uptake do not exist.”<sup>14</sup> Furthermore the theory states the technology will be acquired by the

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<sup>9</sup> Rear Admiral Charles Michel, Director Joint Interagency Task Force South, “Hearing on Border Security Threats to the Homeland: DHS’s Response to Innovative Tactics and Technique,” Written statement before the Subcommittee on Border and Maritime Security House Committee on Homeland Security, *U.S. House of Representatives*, June 19, 2012, 3, available at: <https://homeland.house.gov/files/Testimony-Michel.pdf>.

<sup>10</sup> “Inside Cocaine Wars: Narco Sub Mystery,” *National Geographic Channel*, 2013, available at: <http://www.youtube.com/watch?v=aO3hikt5H3k>.

<sup>11</sup> Byron Ramirez, “Colombian Cartel Tactical Note #1,” *Small Wars Journal* (February 2014): 1-5.

<sup>12</sup> Rear Admiral Charles Michel, “Hearing on Border Security Threats to the Homeland: DHS’s Response to Innovative Tactics and Technique.”

<sup>13</sup> Ramirez, “Colombian Cartel Tactical Note #1.”

<sup>14</sup> Kim Craigin et.al, *Sharing the Dragon’s Teeth: Terrorist Groups and the Exchange of New Technologies*, (Santa Monica: RAND, 2007).

sharing of information between current and new potential users.<sup>15</sup> In the case of FARC, this is only partially applicable. FARC had two primary motivations behind the decision to undertake this complex engineering effort: 1) to counteract improved detection / interdiction efforts and 2) financial gain. These drivers have similarly led to the adoption of new techniques by other criminal organizations in Colombia. With the adoption of new radar and communications technologies in the 1990s, law enforcement's detection capabilities improved significantly.<sup>16</sup> Therefore, the decision to engage in the development of narc-submarine vessels was not in fact triggered by the availability of this already existing military technology; it was triggered by the new challenge it faced with new improved counter-smuggling efforts.

Technology adoption by FARC was an active decision intended to solve the group's current problem. Technology adoption theory indicates that organizations make the active decision to pursue new technology "under conditions of uncertainty."<sup>17</sup> Since traditional transportation no longer proved effective in the face of these newly acquired law enforcement detection capabilities, the use of "innovative logistical tool[s]" was necessary to reduce the risk of interdiction and capture.<sup>18</sup> Even though the adoption of narco-submarines was a potential solution to the risk of interdiction, it also translated into latent risks of misjudgments about the technology and the overall failure of adoption that included all the added costs of the new technology and none of the benefits reaped.<sup>19</sup> In spite of these conditions, the final decision to undertake the development of narco-subs for FARC was motivated by the tactical advantages over other forms of transportation.<sup>20</sup>

FARC's decision-making structure is a combination of centralized political leadership and decentralized operational units. The centralized leadership consists of the general secretariat which provides political direction.<sup>21</sup> The operational units, however, are decentralized, which allows each unit to

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<sup>15</sup> Ibid.

<sup>16</sup> Bunker and Ramirez, "Narco-submarines: Specially Fabricated Vessels Used for Drug Smuggling Purposes."

<sup>17</sup> Cragin et.al, *Sharing the Dragon's Teeth*.

<sup>18</sup> Byron Ramirez, "Narco-Submarines: Applying Advanced Technologies to Drug Smuggling," *Small Wars Journal* (March 8, 2014): 1-6.

<sup>19</sup> Cragin et.al, *Sharing the Dragon's Teeth*.

<sup>20</sup> It is important to note that the motivation was not a tactical move related to their political ideology. Donald B. Davis, "The Submersible Threat to Maritime Homeland Security," (Master Thesis: Naval Postgraduate School, September 2013), available at: [http://calhoun.nps.edu/bitstream/handle/10945/37609/13Sep\\_Davis\\_Donald.pdf?sequence=1](http://calhoun.nps.edu/bitstream/handle/10945/37609/13Sep_Davis_Donald.pdf?sequence=1).

<sup>21</sup> Angel Rabasa and Peter Chalk, *Origins and Development of the Guerillas in Colombian Labyrinth* (Arlington: Rand, 2001).

operate with autonomy and focus on specialized activities. Specifically, the organization is divided into six different commands, each composed of at least five fronts that represent different geographic territories.<sup>22</sup> The Joint Western Command, the most profit-driven and least politically inclined bloc of FARC, claims responsibility for most of the group's semi-submersible operations in the Pacific region.<sup>23</sup> Economic activities led by the Joint Western Command results in approximately 65 percent of the group's total revenue.<sup>24</sup>

The level of participation by each front in the decision-making process to adopt the development of narco-sub is unknown. However, given the organizational structure discussed above, the decision to first engage in this activity most likely involved the central leadership of FARC. Both the general secretariat, the ultimate deciding body of the organization, and the Joint Western Command, were thus most likely actively involved and provided approval in the initial pursuit of this new venture.

It had become evident by the late 1990s that other sea and air-based methods lacked the ability to carry large quantities of drugs in a single shipment and there had been a series of interdictions of vessels belonging to FARC.<sup>25</sup> Moreover, ground transportation resulted in lengthy, high-risk trips while go-fast boats had a 50 percent interdiction rate.<sup>26</sup> Furthermore, FARC's traditional methods for counteracting modern detection capabilities and facilitate narcotics operations, which included bribery and/or coercion of officials, concealment of merchandise in cargo containers, and use of underground tunnels, became less attractive as the possibility of carrying larger quantities in narco-submarines became available.

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<sup>22</sup> Ibid.

<sup>23</sup> The Joint Western Command controls numerous fronts in the southern and midwestern areas of Colombia.

<sup>24</sup> Armando Hernandez, Rick A. Galeano, and Mario Escobar, "The Semi-submersible Network," (Master Thesis: Naval Postgraduate School, December 2012), available at: [http://calhoun.nps.edu/bitstream/handle/10945/27844/12Dec\\_Hernandez\\_Galeano\\_Escobar.pdf?sequence=1](http://calhoun.nps.edu/bitstream/handle/10945/27844/12Dec_Hernandez_Galeano_Escobar.pdf?sequence=1).

<sup>25</sup> "Colombia halla 'narcosubmarino' supuestamente de FARC en frontera con Ecuador," *El Universo*, October 2014, available at: <http://www.eluniverso.com/noticias/2014/10/22/nota/4135331/colombia-halla-narcosubmarino-supuestamente-farc-frontera-ecuador>.

<sup>26</sup> Ivan P. Arias Vergara, "Inspeccion, Analisis, Trabajos de Completamiento y Reflotamiento del Primer Narcosumergible Encontrado en el Ecuador," (Master Thesis: *ESPOL*, 2013), available at: <https://www.dspace.espol.edu.ec/bitstream/123456789/25046/1/INFORME%20NARCOSUBMARINO%20IVAN%20ARIAS.pdf>; Ramirez, "Colombian Cartel Tactical Note #1; "Colombian Narcosubs," *Vice.com*, February 15, 2011, available at <http://www.vice.com/video/colombian-narcosubs>.



As a result, Narco-submersibles became an increasingly frequent method of covert transportation for FARC by the early 2000s.<sup>27</sup> Even though authorities have not been able to attribute the construction of these submersibles to a specific front or obtain information regarding the decision-making process, it can be presumed that each operational unit (if more than one is involved) has the capability and discretion to decide when to engage in the development of narco-submersibles in its territory. The fronts in the southern Pacific border of Colombia<sup>28</sup> are more likely to make this decision, given that the difficult terrain and mangroves of the region provide the traffickers with the ideal conditions to establish rudimentary construction sites that are difficult for law enforcement to reach and have access to the sea. Regardless of the autonomy provided by the decentralized structure, however, the high estimated costs for construction of the vessels as well as the large quantity of shipments intended to be carried, likely required at least some coordination between central leadership and operational units, in order to disburse the resources and schedule transportation of the illicit product to open-sea loading areas.<sup>29</sup>

According to the testimonies of incarcerated narco-submersible crew members, decision making at sea is made remotely by the leader of the front, who in turn receives guidance from the Joint Western Command. For example, if a vessel were to suffer interdiction, the captain of the submersible is responsible for immediately notifying the leader of his front via satellite communication, who then must give the order to sink and/or abandon the vessel.<sup>30</sup> This system is partially attributed to the overall checks and balances instituted by FARC's central leadership to keep tabs on drug profits as well as each front's operating procedures.

Even though risk about the decision-making process of adopting a new technology is addressed above, the risk assumed during the process of innovation can also provide an important perspective of the criminal

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<sup>27</sup> Ramirez, "Narco-Submersibles: Applying Advanced Technologies to Drug Smuggling."

<sup>28</sup> Erich C. Saumeth, "Narco-Semi-Sumergibles y Sumergibles," *Universidad de Federal de Juiz de Fora*, 2011, available at: <http://www.ecsbddefesa.com.br/defesa/fts/NSS.pdf>.

<sup>29</sup> Loading of the illicit product was usually carried out in the open sea. The added weight of the shipment would not allow the vessel to navigate outside the construction estuaries if the drugs were loaded at this location. "Colombian Narcosubs," *Vice.com*.

<sup>30</sup> According to Colombian law, if there is no evidence of illicit activities (no product is found), the interdiction becomes a rescue mission and the drug traffickers cannot be prosecuted. Vergara, "Inspeccion, Analisis, Trabajos de Completamiento y Reflotamiento del Primer Narcosumergible Encontrado en el Ecuador;" "Narcosubmarinos," *Discovery Channel*, 2010, available at: [http://www.dailymotion.com/video/xw6h6n\\_discovery-channel-narcosubmarinos\\_tech](http://www.dailymotion.com/video/xw6h6n_discovery-channel-narcosubmarinos_tech).

organization's behavior. Open source literature does not make direct reference to the risk tolerance of FARC during the development of the narco-sub, however the group is widely known to engage in dangerous operations while operating in a high-risk environment. Previous activities have demonstrated that the organization does not shy away from innovation. For example, the group reached out to the Provisional Irish Republican Army (PIRA) to receive training in the use of explosives,<sup>31</sup> it has dabbled in the potential trafficking of RN materials,<sup>32</sup> and has engaged in violent behavior, including the kidnapping high-level officials and keeping prisoners for leverage in negotiations.<sup>33</sup> Despite FARC's penchant for high-risk confrontation, in the case of the narco-sub, the group appears to have attempted to minimize risk and has successfully mitigated interdiction by selecting clandestine locations for construction; the sites are on shallow-river systems, difficult for law enforcement to transverse, and with vast mangroves providing necessary camouflage.<sup>34</sup>

FARC's development of narco-sub has constituted a long-term endeavor in terms of planning and execution. After the initial decision to pursue the development of narco-sub, FARC continued to innovate and improve on the initial designs. This became evident to law enforcement during seizures. The evolution of the vessels proceeded from rudimentary designs to sophisticated aerodynamic vessels equipped with telecommunication systems.<sup>35</sup> According to a former drug-trafficker, "Looking back, it appears to be that the Colombian cartel was honing their skills in preparation for their ultimate goal—the construction of a long-distance vessel that could dive and surface on command."<sup>36</sup> The implication is that the evolution of the vessels and the immediate benefits from successful smuggling trips using the early designs serviced the long-term technical and developmental goals of the group. It is

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<sup>31</sup> Andy Oppenheimer, "How terrorists acquire technology and training: lessons from the IRA," *New Security Learning*, 2009, available at: <http://www.newsecuritylearning.com/index.php/feature/123-how-terrorists-acquire-technology-and-training-lessons-from-the-ira>.

<sup>32</sup> "El Uranio de las FARC," *El Espectador*, 2008, available at: <http://www.elespectador.com/impreso/cuadernilloa/judicial/articuloimpreso-el-uranio-de-farc>

<sup>33</sup> "Las FARC liberan rehenes y piden cambiar reglas del proceso de paz," *El Observador*, 2014, available at: <http://www.elobservador.com.uy/las-farc-liberan-rehenes-y-piden-cambiar-reglas-del-proceso-paz-n293141>

<sup>34</sup> Armando Hernandez, Rick A. Galeano, and Mario Escobar, "The Semi-submersible Network."

<sup>35</sup> "Colombian Narcosubs," *Vice.com*.

<sup>36</sup> Jim Popkin, "Authorities in Awe of Drug Runners' Jungle-Built Kevlar-Coated Supersubs," *Wired.com*, 2011, available at: [http://www.wired.com/2011/03/ff\\_drugsub/all/1](http://www.wired.com/2011/03/ff_drugsub/all/1).

evident from this timeline and evolution in design that FARC did in fact invest in a long-term development program to optimize its narco-sub's designs.

The initial investment in this new technology was expected to be extremely high.<sup>37</sup> FARC invested significant financial and human resources to develop and improve designs. According to a report released by the Drug Enforcement Agency (DEA) and the Colombian National Police, some narco-sub crew members have been graduate engineers of SENA (the National Learning Service) in Colombia.<sup>38</sup> It remains unclear, however, whether these experts were sent expressly to acquire the necessary skills for this engineering feat or received this training before engaging with the organization. "This ability to invest and take on long-term, high-value projects is a warning of the traffickers' high level of resources and organization."<sup>39</sup> This commitment also signals an overarching aptitude for organizational learning, which is evident in the practices surrounding the decision-making process and later on in the implementation phases of the adoption of this new technology. FARC's openness and willingness to learn from study and experience alike allowed the group to spread tactical and operational knowledge to its members and also enabled them to identify their most apt followers for the development of this technology.<sup>40</sup> The evident change in behavior and modification of operational practices that resulted as a response to this new knowledge and experience could have facilitated the decision and adoption of this new long-term strategic objective and investment.<sup>41</sup>

Indeed, the amount invested in the construction and development was negligible in comparison to the profits expected from the drug sales per shipment.<sup>42</sup> It is estimated that the cost of construction of a vessel capable of transporting eight tons of narcotics is less than 2 million dollars with a net return of over \$200 million.<sup>43</sup> There have also been reports that FARC sold or

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<sup>37</sup> Ramirez, "Colombian Cartel Tactical Note #1."

<sup>38</sup> Ana Maria Saavedra, "La tecnología de los submarinos al servicio del narcotráfico," *El Pais*, 2011, available at: <http://www.elpais.com.co/elpais/judicial/noticias/nautilus-servicio-mafia>.

<sup>39</sup> Hannah Stone, "Rawfeed: The Evolution of the Drug Submarine," *InSight Crime*, 2011, available at: <http://insightcrime.org/news-analysis/the-evolution-of-the-drug-submarine>.

<sup>40</sup> Michael Kenney. "How Terrorists Learn" in *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, Maryland: Rowman and Littlefield, 2006), pp. 33-51.

<sup>41</sup> Kenney, Michael, *From Pablo to Osama: Trafficking and Terrorist Networks, Government Bureaucracies, and Competitive Adaptation* (University Park, PA: University of Pennsylvania Press, 2007).

<sup>42</sup> Ramirez, "Narco-Submarines: Applying Advanced Technologies to Drug Smuggling."

<sup>43</sup> Ramirez, "Colombian Cartel Tactical Note #1."

rented narco-submersibles and their designs to other collaborating organizations which not only diversified FARC's source of income but also increased its margin of profit.<sup>44</sup> This latter point illustrates the broader implication of the development of this new technology and how it may facilitate smuggling efforts for criminal organizations, not only for other violent non-state actors in Colombia, but potentially in Mexico as well.

## Implementation

Reports indicate that the Joint Western Command of FARC is responsible for most of the organization's semi-submersible operations.<sup>45</sup> Even though the precise role played by the operational units remains unclear to authorities, individuals who have been arrested have revealed that narco-sub operations are carefully carried out by a tactical team, assumed to be in close coordination with the leadership. Construction camps established in the southern Pacific coastline consist of approximately 30 low-level members responsible for securing the campsite and carrying material, as well as the technicians responsible for building the vessel.<sup>46</sup> Additionally, the organization is also known to have used and hosted Russian, Sri Lankan, and Pakistani naval engineers to assist in the design and construction of narco-submersibles, not only demonstrating their commitment to the adoption of this new technology but also taking advantage of technological diffusion<sup>47</sup> across actors.<sup>48</sup> Additional reports from the Colombian National Police state that the group may have occasionally subcontracted out construction of the submersibles to a professional service unaware of what the ultimate purpose of the vessels was.<sup>49</sup> Authorities have also discovered that the construction process is carried out across several phases, involving different locations and different subcontractors.<sup>50</sup>

Not all those involved in construction and deployment of the vessels do so on a voluntary basis, however. In 2008, Colombian authorities interdicted a vessel with four crew members.<sup>51</sup> These individuals, who had been previously

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<sup>44</sup> Kirk Semple, "The Submarine Next Door," *New York Times*, 2000, available at: <http://partners.nytimes.com/library/magazine/home/20001203mag-semble.html>.

<sup>45</sup> Hernandez, Galeano, and Escobar, "The Semi-submersible Network."

<sup>46</sup> "Colombian Narcosubs," *Vice.com*.

<sup>47</sup> Cragin et.al, *Sharing the Dragon's Teeth*.

<sup>48</sup> Vergara, "Inspeccion, Analisis, Trabajos de Completamiento y Replotamiento del Primer Narcosumergible Encontrado en el Ecuador;" Ramirez, "Colombian Cartel Tactical Note #1;" Armando Hernandez, Rick A. Galeano, and Mario Escobar, "The Semi-submersible Network."

<sup>49</sup> Semple, "The Submarine Next Door."

<sup>50</sup> Saumeth, "Narco-Semi-Sumergibles y Sumergibles."

<sup>51</sup> Ana Maria Saavedra, "La tecnologia de los submarinos al servicio del narcotráfico."

identified as trained naval engineers,<sup>52</sup> informed authorities that they had been kidnapped and taken to one of these sites and were coerced into collaborating in the construction of a vessel.<sup>53</sup>

The areas of expertise and knowledge required for the development of narco-submarines include technical design and construction (i.e., engineers, welders, electricians, fiberglass installers), experts in maritime equipment (primarily for navigation), and experienced seafarers to serve as crewmembers.<sup>54</sup> With the rapid evolution in the sophistication of narco-subs, the level of technical expertise required naturally increased.<sup>55</sup> The need for naval engineers and trained navigators has pushed FARC to seek out experts from the Colombian navy, offering large sums of money in exchange for their skills. According to Roman Ortiz, FARC's ability to recruit university students and send members to higher education institutions across the country to study science and engineering, exponentially increases its potential for technological sophistication.<sup>56</sup> FARC's notable capacity for learning is evident through its training camps and programs that often provide members with information on how to utilize new weapons and become familiar with guerilla warfare tactics.<sup>57</sup> Additionally, the group has not shied away from using violence and coercion, forcing individuals with the needed skillsets to assist them in the development of the narco-subs, as described above and testified to by arrested group members.<sup>58</sup>

The complexity of narco-sub technology has inherent limitations and risks which FARC had to face during the implementation phase. The successful adoption of this new technology was dependent on the characteristics of the technology itself and the ability of FARC to absorb the knowledge required to build and operate the vessels. According to Cragin, in order for the new technology to be effective, the implementing organization must have the "appropriate knowledge to use the technology successfully."<sup>59</sup> As discussed above, FARC diversified the acquisition of technology through explicit

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<sup>52</sup> Ibid.

<sup>53</sup> Ibid.

<sup>54</sup> Saumeth, "Narco-Semi-Sumergibles y Sumergibles."

<sup>55</sup> Bunker and Ramirez, "Narco-submarines: Specially Fabricated Vessels Used for Drug Smuggling Purposes."

<sup>56</sup> Román D. Ortiz, "Renew to Last: Innovation and Strategy of the Revolutionary Armed Forces of Colombia (FARC)" in *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, Maryland: Rowman and Littlefield, 2006), pp. 205-222.

<sup>57</sup> Ibid.

<sup>58</sup> Vergara, "Inspeccion, Analisis, Trabajos de Completamiento y Replotamiento del Primer Narcosumergible Encontrado en el Ecuador;" Ramirez, Byron, "Colombian Cartel Tactical Note #1".

<sup>59</sup> Cragin et.al, *Sharing the Dragon's Teeth*.

knowledge (e.g. design drawings of vessels) and tacit-knowledge<sup>60</sup> (e.g. “how-to” skills), many times achieved through coercion, deceit, or bribery. FARC’s ability to absorb explicit and tacit knowledge has been evident through past operations and collaborations with other criminal organizations. For example, in 1997 FARC sought out explosive expertise from the PIRA to further promote its ideological causes through urban terrorism.<sup>61</sup> The stalemate between the Colombian government and the group placed an enormous amount of pressure on the leadership, which had not been able to move forward with the group’s demands. As a result, there was a change in strategy that required more weapons and explosive technologies. FARC requested the assistance of PIRA, who excelled in the use of sophisticated mortars and other weapons. It was not long after that three mortar-bomb experts from PIRA were brought to Colombia to train FARC members.<sup>62</sup> The strategic acquisition of knowledge from other groups for FARC is a viable and relatively easy solution considering their network and resources.

When it comes to collaboration with external entities for the development of the narco-sub, early reports do indicate that the Cartel Norte del Valle might have been the organization that initially came up with the idea of narco-sub; however, this group did not have the resources or skills to act on it.<sup>63</sup> The majority of sources indicate that FARC has primary control over the development of narco-sub in Colombia. However, authorities believe that with the numbers of narco-sub suspected of being in operation ballooning, it is likely that FARC is not the only drug trafficking organization (DTO) involved in this kind of enterprise.<sup>64</sup> It is important to note that, even though Colombian authorities have evidence of collaboration between Colombian and Central American DTOs in smuggling operations, no direct connection has been made with regard to any collaboration on narco-sub development.

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<sup>60</sup> Classes of knowledge adapted from Jeffrey L. Cummings, *Knowledge Transfer Across R&D Units: An Empirical Investigation of the Factors Affecting Successful Knowledge Transfer Across Intra- and Inter-Organizational Units*, unpublished doctoral dissertation, Washington, D.C.: School of Business and Public Management, George Washington University, (2002); Gunnar Hedlund, “A Model of Knowledge Management and the N-Form Corporation,” *Strategic Management Journal*, Vol. 15 (Special Issue), Strategy: Search for New Paradigms, 1994; Rogers, Everett M., *Diffusion of Innovations* (New York, NY: The Free Press, 1995) and Bernard Simonin, “Ambiguity and the Process of Knowledge Exchange in Strategic Alliances,” *Strategic Management Journal*, Vol. 20, No. 7, 1999.

<sup>61</sup> Martin Hodgson, Henry McDonald, and Peter Beaumont, “IRA Blunder in the Jungle Sparks US Rage,” *The Observer*, August 19, 2001, available at: <http://www.theguardian.com/uk/2001/aug/19/northernireland.ireland>.

<sup>62</sup> Jeremy McDermott, “Colombian Attacks ‘Have Hallmark of IRA,’” *BBC News*, August 11, 2002, available at: <http://news.bbc.co.uk/2/hi/americas/2186244.stm>.

<sup>63</sup> “Narcosubmarinos,” *Discovery Channel*.

<sup>64</sup> *Ibid.*

With regard to other sources of collaboration, authorities have reported the use of professionalized services (individuals and/or groups) that are not linked to drug trafficking networks. For example, there is one known civilian contributor that has assisted in the crafting of narco-submersibles—Enrique Portocarrero aka “Captain Nemo.”<sup>65</sup> He has designed and built as many as “20 fiberglass submarines, designed to resemble sea creatures, for drug traffickers to haul cocaine from Southern Colombia to Central America and Mexico.”<sup>66</sup>

FARC is known to have meticulously maintained operational security during the development of narco-submersibles. To avoid detection, workers completed much of the construction of these vehicles under the protection of thick jungle canopy.<sup>67</sup> The daily tidal fluctuations of the mangroves also limit and prohibit access via boat.<sup>68</sup> In addition, “local muscle” armed with automatic rifles and grenades provided increased security.<sup>69</sup> FARC members are also known to have preventative measures in place to avoid prosecution in the case of an interdiction at sea.<sup>70</sup>

In terms of safety of the crew members, the group has been less cautious. FARC lacked concern for the well-being and safety of the personnel involved in the construction and journey phases. The treacherous environment of the mangroves entailed poor living conditions in construction sites.<sup>71</sup> Furthermore, the submersibles themselves are known to have had extremely cramped living quarters.<sup>72</sup> Crewmen traveled long distances with limited food and

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<sup>65</sup> Watkins, Lance J., *Self-Propelled Semi-Submersibles: The Next Great Threat To Regional Security and Stability*. Naval Postgraduate School, 2011, available at: [http://edocs.nps.edu/npspubs/scholarly/theses/2011/June/11Jun\\_Watkins.pdf](http://edocs.nps.edu/npspubs/scholarly/theses/2011/June/11Jun_Watkins.pdf).

<sup>66</sup> Watkins, *Self-Propelled Semi-Submersibles: The Next Great Threat To Regional Security and Stability*.

<sup>67</sup> Hernandez, Galeano, and Escobar, “The Semi-submersible Network.”

<sup>68</sup> Ibid.

<sup>69</sup> Jim Popkin, “The High Seas: How a high school-educated drug smuggler built a fleet of submarines—in the middle of the jungle—to ferry cocaine to the United States,” *Slate*, 2013, available at:

[http://www.slate.com/articles/news\\_and\\_politics/foreigners/2013/10/mauner\\_mahecha\\_s\\_drug\\_submarines\\_inside\\_a\\_high\\_tech\\_south\\_american\\_narco.html](http://www.slate.com/articles/news_and_politics/foreigners/2013/10/mauner_mahecha_s_drug_submarines_inside_a_high_tech_south_american_narco.html).

<sup>70</sup> The captain is instructed to sink the vessel and turn the interdiction into a rescue mission. “Colombian Narcosubs,” *Vice.com*; Vergara, “Inspeccion, Analisis, Trabajos de Completamiento y Replotamiento del Primer Narcosumergible Encontrado en el Ecuador.”

<sup>71</sup> Vergara, “Inspeccion, Analisis, Trabajos de Completamiento y Replotamiento del Primer Narcosumergible Encontrado en el Ecuador;” Ramirez, “Colombian Cartel Tactical Note #1;” Hernandez, Galeano, and Escobar, “The Semi-submersible Network.”

<sup>72</sup> “Colombian Narcosubs,” *Vice.com*.

without sleep or running water. While inside the narco-submersibles, they were confined to a loud capsule often filled with engine fumes.<sup>73</sup> Finally, in the case of an impending interdiction, the front leader would often willingly sink the vessel, leaving the crewmembers adrift at sea.<sup>74</sup>

Appendix A provides a detailed description and images of the historical evolution of the narco-submersibles. The following section describes the general construction process from start to finish of the most complex vessel developed: the submarine.

Experts have divided the evolution of the design of the submersible vessels into three distinct phases:

1. **1992-2004:** This phase consisted of experimentation through trial and error. The vessels were constructed using fiberglass material and were usually between 30 to 50 feet in length.
2. **2005-2006:** This phase reflected rapid prototyping with increased capability and the use of self-propelled technologies. Vessels incorporated wood to the fiberglass previously used and varied in range and capacity.
3. **2007 to the present:** This current phase incorporates mature designs and greater standardization.<sup>75</sup> The vessels are faster and have a higher carrying and storage capacity. Some designs include the use of steel with specialized lead shielding to avoid detectors. Additionally, these vessels incorporate the use of advanced navigation systems, GPS and other anti-radar features.<sup>76</sup>

Overall, the emphasis FARC placed on research and development resulted in a series of improvements, ranging from semi-submersibles intended only to last one trip to submarines with sophisticated navigation equipment and

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<sup>73</sup> “Narcosubmarinos,” *Discovery Channel*.

<sup>74</sup> Vergara, “Inspeccion, Analisis, Trabajos de Completamiento y Replotamiento del Primer Narcosubmersible Encontrado en el Ecuador;” Ramirez, “Colombian Cartel Tactical Note #1.”

<sup>75</sup> Terrance G. Lichtenwald, Mara H. Steinhour, and Frank S. Perri, “A Maritime Threat Assessment of Sea Based Criminal Organizations and Terrorist Operations,” *Homeland Security Affairs* 8:13 (2013), available at: <https://www.hsaj.org/articles/227>.

<sup>76</sup> Phases extracted from Bunker and Ramirez, “Narco-submersibles: Specially Fabricated Vessels Used for Drug Smuggling Purposes.”



communication technologies capable of transporting over eight tons of material and making numerous trips.<sup>77</sup>

According to numerous sources, the first step in the construction process is to identify a location to carry out the construction of the vessel. The location is selected based upon the feasibility of the site for bringing in construction materials via the river systems, accessibility to the ocean, and ability to operate covertly throughout the construction process. Thick mangrove vegetation provides an excellent cover for construction sites and is difficult for law enforcement to patrol due to its sheer density.<sup>78</sup> Building submersible sites close to the ocean is also a prerequisite because, upon completion, these underwater vehicles must have a navigable route downstream to estuaries where they can begin their voyage into the Pacific Ocean.<sup>79</sup> Typically, these vessels are built near the Pacific coastline of Colombia, in or near the regions of Sanquianga and Buenaventura.<sup>80</sup>

Concurrent with the identification of the construction site, personnel are selected according to their expertise. Following the fulfillment of these two requisite goals, the initial infrastructure needed for the construction effort is built. The materials needed for the sites are transported via river systems along the Pacific coastline of Colombia. These rivers are only accessible at certain times of the day, depending on tidal cycles.<sup>81</sup> According to the testimony of detainees (predominantly naval engineers), the construction is carried out in phases.<sup>82</sup> The exact process of construction remains largely unknown to authorities, however, many of the seized vessels have been evaluated and experts claim that the methods used to construct the narco-submersibles are organized, compartmentalized and specialized.<sup>83</sup> In one instance, a vessel captured in the northern region of Ecuador was evaluated within the framework of the expanded ship work break structure (ESWBS).<sup>84</sup> Through

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<sup>77</sup> Bunker and Ramirez, "Narco-submarines: Specially Fabricated Vessels Used for Drug Smuggling Purposes," 12.

<sup>78</sup> *Ibid.*

<sup>79</sup> Hernandez, Galeano, and Escobar, "The Semi-submersible Network."

<sup>80</sup> *Ibid.*

<sup>81</sup> Popkin, "The High Seas: How a high school-educated drug smuggler built a fleet of submarines—in the middle of the jungle—to ferry cocaine to the United States."

<sup>82</sup> Saumeth, "Narco-Semi-Sumergibles y Sumergibles."

<sup>83</sup> The ESWBS is a system of project management instituted by the Project Management Institute and often used in training to compartmentalize the different systems needed in the submersibles. Vergara, "Inspeccion, Analisis, Trabajos de Completamiento y Reflotamiento del Primer Narcosumergible Encontrado en el Ecuador."

<sup>84</sup> The ESWBS is a set of guidelines used by the United States Navy to identify the different components of the structure and systems needed in the construction of submersibles. It is also used as a project management practice by the Project

this evaluation, it became evident that the vessel’s construction had followed similar guidelines; shining light on the sophisticated nature of the systems, not only in the vessel and its construction, but also the procedures and planning that had been undertaken.<sup>85</sup> Even though it is unclear whether this formal framework is used at all construction sites, it has provided authorities with a blueprint of the general process of construction of narco-sub.

<b>General Construction Process<sup>86</sup></b>	
<b>Process</b>	<b>Description</b>
<i>General Hull Structure</i>	<ul style="list-style-type: none"> <li>• Construction of the main hull and all the structural divisions (bulkheads), platforms, frame reinforcements of the bow and stern, and bases for equipment.</li> <li>• Welding of all compartments and unions, ballast tanks, masts, service platforms, trapdoors and cabins.</li> </ul>
<i>Propulsion Plant</i>	<ul style="list-style-type: none"> <li>• Installation of energy converters, propulsion gears, twin engines, generators, cooling and fuel systems, oil services, and water recycling systems.</li> </ul>
<i>General Electric Plant</i>	<ul style="list-style-type: none"> <li>• Backup generators and air conditioning systems (when available). The overall electric source and conduits that provide power to all the systems.</li> </ul>
<i>Command and Surveillance</i>	<ul style="list-style-type: none"> <li>• Installation of satellite, radar, sonar, GPS (and overall communication) technologies.</li> </ul>
<i>Auxiliary System</i>	<ul style="list-style-type: none"> <li>• Installation of systems that provide fresh water, and lubrication. (This system is only occasionally included as it is primarily to provide comfort to crewmembers.)</li> </ul>
<i>Outfit and Furnishings</i>	<ul style="list-style-type: none"> <li>• Paint jobs, stowage, working spaces, living quarters.</li> </ul>
<i>Armament</i>	<ul style="list-style-type: none"> <li>• None. The storage spaces traditionally designated for armaments serve as additional room for narcotics</li> </ul>

Management Institute and often used in training to compartmentalize the different systems needed in the submersibles. Vergara, “Inspeccion, Analisis, Trabajos de Completamiento y Reflotamiento del Primer Narcosumergible Encontrado en el Ecuador.”

<sup>85</sup> Saumeth, “Narco-Semi-Sumergibles y Sumergibles.”

<sup>86</sup> Processes of construction of a submersible interdicted in Ecuador in 2011 as described by: Vergara, “Inspeccion, Analisis, Trabajos de Completamiento y Reflotamiento del Primer Narcosumergible Encontrado en el Ecuador.”

	and other illicit goods being transported by the vessel.
<i>Integration and Engineering</i>	<ul style="list-style-type: none"> <li>• Training of crewmembers, inspections, trials, schematics. Processes to ensure the viability of the trip.</li> </ul>

Recent vessel seizures illustrate further evolution in narco-sub design capabilities. In contrast to the early semi-submersible vessels found in Colombia, fully submersible vessels have been found since 2011 that are 30 meters long and three meters wide, and “can carry four crew members in an air-conditioned interior, which even features a small galley. Perhaps most importantly, it can carry eight tons of cocaine, dive eight meters underwater, and make the long voyage to the coast of Mexico with only a periscope remaining above the surface.”<sup>87</sup>

The implementation process was not without hurdles, however. The group faced different obstacles throughout the evolution of the narco-sub. Initially, they encountered flaws in design, essentially utilizing the basic go-fast boat structure with a wraparound hull. Even though these vessels resulted in a higher rate of successful trips (predominantly due to the vessel’s camouflage at sea), these semi-submersibles were still detectable by air because they could not fully submerge. Additionally, due to design constraints and inexperience in this engineering feat, vessels could only be used once and could not carry more than 2 to 4 tons.<sup>88</sup> Regarding more sophisticated designs, the group took over twenty years to perfect the fully submersible model. FARC’s perseverance is evident, as it did not abandon efforts to build a fully submersible vessel. The main obstacles to achieving the most recent design had to do with acquiring the necessary expertise to incorporate the most complex systems utilized by these vessels. These included systems related to the full submersion capability and satellite communications systems. Additionally, many of these systems had to be manufactured in-house, which extended the construction time period.<sup>89</sup>

## Analysis and Conclusion

While the main motivations behind the decision to develop narco-sub are described above, it is important to point out why FARC made the decision to

<sup>87</sup> Stone, “Rawfeed: The Evolution of the Drug Submarine.”

<sup>88</sup> Bunker and Ramirez, “Narco-submarines: Specially Fabricated Vessels Used for Drug Smuggling Purposes.”

<sup>89</sup> Ibid.

construct these vessels in-house and to continue pursuing this technology despite the difficulties. The reasons FARC undertook this complex engineering effort therefore include:

1. *Avoiding Detection*—As an illicit enterprise, FARC seeks to remain clandestine. As such, the adoption of narco-submersibles prolonged its ability to operate under the radar. This is especially true now that FARC has successfully constructed fully submersible vessels, which are almost impossible to detect.<sup>90</sup> The adoption of GPS and satellite technology by Colombian law enforcement dramatically improved smuggling detection efforts. To counteract this, the group invested in engineering and technological measures to persist and keep the competitive advantage in drug smuggling.<sup>91</sup>
2. *Profit*—The organization is profit-driven, which is one of the key reasons why narco-submersibles in particular were selected. As previously mentioned, the cost to construct these vessels was low relative to the profit gained from successful smuggling journeys. Colombian authorities estimate that with one successful trip with a vessel carrying seven tons of cocaine, FARC would earn approximately \$175 million dollars.<sup>92</sup>
3. *Long-term Development*—Evidence suggests that, in spite of the obstacles present in this complex engineering task, FARC persevered in acquiring a true narco-submersible capability because it foresaw the advantages of eventually succeeding in having a fleet of fully functional submarines. FARC was prepared to tolerate setbacks along the way in order to achieve this ultimate goal. Moreover, as designs evolved, the vessels increased in storage capacity, thus increasing the profit margin of each trip.

The organization ultimately succeeded in its goal of acquiring fully submersible vessels. This can be attributed primarily to:

1. *Financial and human resources*—The group invested vast resources over the span of 20 years to perfect the submersible design. FARC's

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<sup>90</sup> Davis, "The Submersible Threat to Maritime Homeland Security."

<sup>91</sup> Bunker and Ramirez, "Narco-submersibles: Specially Fabricated Vessels Used for Drug Smuggling Purposes."

<sup>92</sup> "Colombian Narcosubs," *Vice.com*

resources facilitated the acquisition of the necessary skills and materials (albeit sometimes by using coercion).

2. *Influence*—The dominant influence of FARC in the areas where the development of the narco-submersibles occurred highly impacted the success of this engineering task. This provided the group with access to individuals with the necessary skills, ranging from members of the Colombian navy to local fishermen. In addition, the Joint Western Command instilled fear in neighboring towns and villages. Surrounding populations were warned against discussing the nature of the Command's operations with authorities.<sup>93</sup> As a result, activities carried on more smoothly and with less chance of discovery.
3. *Safe Havens*—The areas of operation along the Pacific coastline of the numerous fronts engaged in the construction of the narco-submersibles are largely beyond the reach of Colombian authorities. This contributed to the successful development of the narco-submersibles because construction was allowed to continue without disruption.
4. *Culture of learning*—FARC's organizational learning capabilities were exceptional. The time and effort that were devoted to each member's training and schooling exhibited a wide spectrum of learning that facilitated the trial and error approach during the development phases of the narco-submersibles. FARC undertook several development phases, each of which built on the phases that had gone before. This iterative process absorbed lessons learned in each phase to improve the next, ultimately leading to the successful development of a fully submersible vessel.

FARC's evolution since 2006, or some might even argue devolution in ideology and the improvement in Colombia's security environment, created a challenging context for VNSA technological innovation.<sup>94</sup> After the 9/11 attacks, the international security arena changed. As international criminal and terrorist groups were targeted by law enforcement, FARC suffered financial losses, leadership arrests, and desertion. Nevertheless, the group has continued to develop narco-submersibles as demonstrated through their last standardization and maturity phase in 2007. Even though the adoption



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<sup>93</sup> "Narcosubmarinos," *Discovery Channel*.



<sup>94</sup> Román D. Ortiz, "Renew to Last: Innovation and Strategy of the Revolutionary Armed Forces of Colombia (FARC)" in James Forest (ed.), *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, MD: Rowman & Littlefield, 2006).

of this new technology was intended to facilitate drug transportation, the designs of the vessels themselves are now an in-house capability and new commodity which FARC can communicate to other criminal or terrorist organizations for the right price in these times of need. The diffusion of narco-submarine technology to other criminal or terrorist groups is of concern to counter-smuggling and terrorism efforts in the region, particularly if the vessels were to be used for more nefarious purposes than drug trafficking. This illustrates how technology adoption and diffusion intended to facilitate operations can itself become yet another stand-alone resource for terrorists and potential collaborators.

The mixed nature of FARC's ideology, coupled with its openness for ideas and vast resources, provides a fascinating example of how violent non-state actors explore innovative technologies to overcome challenging dynamics. FARC's need for strategic autonomy bolstered the group's desire for innovation. This fear of dependency molded the organizational norms, as well as decision-making processes and practices, gearing them towards self-sufficiency in all their operations. The iterative process in the development of narco-subs is demonstrative of the long-term commitment VNSAs with resources can devote to innovative projects that facilitate their long-term strategic objectives.

<b>Appendix A. Evolution of the Narco-Sub (1970s-Present)<sup>95</sup></b>		
<b>Years</b>	<b>Phase</b>	<b>Description</b>
1970s through early 1990s	 <p style="text-align: center;">Go-fast boats</p>	<p>Fiberglass material. Deep “V” offshore racing hull - usually 30 to 50 feet (10 to 15 m) long, narrow in beam, and equipped with two or more powerful engines, often with more than 1,000 combined horsepower. The boats can typically travel at speeds over 80 knots (150 km/h) in calm waters, over 50 knots (90 km/h) in choppy waters, and maintain 25 knots (47 km/h) in the average five to seven foot (1.5 to 2 m).</p>
Early 1990s through 2004	 <p style="text-align: center;">‘Narco-sub’ Experimentation Phase</p>	<p>Fiberglass and wood; low horse power engines; Many different designs used; Limited in range and capacity.</p>

<sup>95</sup> Table extracted from Bunker and Ramirez, “Narco-submarines: Specially Fabricated Vessels Used for Drug Smuggling Purposes.”

<p>2005 - 2006</p>	 <p>'Narco-sub' Prototyping Phase [semi-submersibles]</p>	<p>Similar vessels seized [semi-submersibles]; Increased engine power; increased capabilities such as greater stealth, better operational performance, and increased speed and size; Introduction of low-profile vessels (LPVs).</p>
<p>2007 - present</p>	 <p>'Narco-sub' Standardization and Maturity Phase</p>	<p>Faster (up to 11 mph); Some made from steel; Capable of carrying bigger loads of drugs than earlier models; Two-diesel engines; Engines up to 350 hp; Upper lead shielding; Advanced navigation systems; GPS; Anti-radar features; water-cooled mufflers.</p>