UAM Geomatics, Inc.
A NEXA Capital Company

NEXA Series White Paper No. 24-1
August 2021

This white paper examines the exciting opportunity for new mobility solutions for the State of Ohio, bringing innovation, incremental revenues, economic growth, and job creation in the emerging Advanced Air Mobility (AAM) Sector.

Advanced Air Mobility Business Case Assessment: State of Ohio

Emerging Aerospace Technologies to Deliver Profitable Transportation Operations and 15,000 Permanent Jobs

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Ohio's Transportation Challenge

The State of Ohio faces both opportunities and challenges regarding future transportation systems and mobility options. The future needs and expectations of Ohio residents include a heightened emphasis on sustainability, affordability, efficiency, and environmental impact. Technological innovations and new business models offer potential for innovative approaches to passenger and cargo mobility.

Advanced Air mobility (AAM) is a concept of air transportation that moves people and cargo between places not conveniently served by surface transportation or underserved by aviation, bringing urban and regional mobility into the third dimension. Aircraft can be driven by electric propulsion and battery technologies (Figure 1). AAM utilizes primarily eVTOL (electric Vertical Takeoff and Landing) aircraft, which includes passenger aircraft, cargo aircraft, and sUAS (Small Unmanned Aerial Systems, also known as drones.

Figure 1 - Hyundai multi-rotor eVTOL air taxi design.

Ohio is keenly aware that an American state that starts transforming itself now into an AAM center will reap first-mover benefits—top talent and wide-ranging investment opportunities. In addition, investment will provide significant benefits to its taxpayers, including reduced congestion, an energized technology sector, thousands of jobs, robust economic activity, and a larger tax base.

ODOT intends to facilitate full-scale AAM development for the safe, efficient, and equitable transportation of goods and people throughout the state. AAM is also considered a strategic growth area for Ohio's aerospace sector, which has already made significant contributions to the research, development, and integration of AAM.

NEXA Engagement:

Driven by the economic and societal promise of AAM, the Ohio Department of Transportation (ODOT) commissioned this analysis for advanced autonomous aircraft technologies in Ohio. The overall goal of this project was to forecast the business and economic benefits of these groundbreaking new aircraft systems and services through the year 2045.

NEXA Capital is proud to have been among the team chosen for this work, joined by Crown Consulting and the University of Cincinnati.

Assessing Ohio's AAM Opportunity: Methodology

Our team followed a multi-step plan designed to deliver benefit estimates that account for technology and regulatory realities, emphasizing interaction among team experts in economics, cargo, eVTOL, and sUAS programs.

The first stage of the project was to gather industry perspectives on eVTOL and sUAS modes, technology readiness, and gaps in industry research by conducting a series of interviews and surveys with the most relevant and key stakeholders.

The second stage of the investigation phase required critical infrastructure to be identified, categorized, and mapped using ArcGIS, a geospatial mapping and analysis tool. Relevant data layers important to the implementation of AAM were researched, geospatially compiled, and loaded into the ArcGIS software to be mapped for the State of Ohio.

The information obtained through the interviews, coupled with the analytical ArGIS data, was used to develop the most impactful use cases and were fed into the AAM Business Case Model to determine the region's ability to adopt and sustain AAM operations. ArcGIS infrastructure data was paired with over 100 other inputs to produce operating expenses (OpEx) and capital expenditures (CapEx) for ground infrastructure, development of infrastructure for Providers of Services for Unmanned Air Vehicles (PSU), total electric eVTOL aircraft expenditures, and operator revenues for passenger, cargo, and emergency medical use cases. Concurrently, the sUAS cases were separately analyzed to forecast and qualify the efficiency, safety, productivity, and societal benefits of these services.

Outputs from the AAM Business Case Model were then used as inputs to the AAM Economic Impact Model, calculating the total impact of AAM on the Ohio economy at three levels: the direct level (jobs gained directly from AAM), the indirect level (jobs gained indirectly by the supply-chain industries supporting AAM), and the induced level (the subsequent jobs gained from induced spending in all sectors of the economy), providing job growth forecasts and GDP estimates, in addition to tax revenues at the state and local levels.

Infrastructure through ArcGIS

Concurrent with the interviews, team members assessed and inventoried existing transportation infrastructure available throughout the State of Ohio using ArcGIS. This geospatial mapping and physical inventorying tool provided unique capabilities for applying location-based analytics. Contextual tools are also able to visualize and analyze geospatial data via maps, datasets, algorithms, and reports. The team documented more than 35 layers of information that will become indispensable when designing and operating new airborne systems within the State of Ohio. These layers, shown in Figure 2, were researched, compiled, and loaded into the ArcGIS software to be mapped onto the State of Ohio.

35+ Data Layers	
Demographic Information Overlay	Colleges and Universities
General Aviation Airports	Water and Shipping Ports
Commercial Airports	Military Bases and Airports
Roadways	Agriculture Zoning
Highways	Laboratories
Waterways	Fire Stations
Political Boundaries	Police Stations
Hospitals	Noise Measurement TIMS
Cargo Rail Stations	Towers/Antennae
Ports	Helipad Confirmation
Part 135 Operator Fleets and Lists	Passenger Rail Stations
Airport O/D, A/D, Fleet, FBO Data	Power Grid
Logistics Centers	Air-Based Cargo Hubs @ Airports
Manufacturing Plants	Major Shopping Centers
Headquarters of Fortune 1000 corporations	Major Music Venues
Major Local Employers	Government Facilities—Federal, Local
Major Sports Venues	MSA Demo Layer
Ohio Bridge Database	

Figure 2 - ArcGIS geospatial data layers inventoried for Ohio Project.

As a foundation for the 25-year forecasts, the team used the following macro assumptions while estimating the cost and schedule for AAM ground infrastructure:

- A large percentage of existing public, private, and unregistered heliports are first remediated to provide a baseline to support early eVTOL services before expansive new construction is undertaken.
- A certain number of heliports and vertiports are built or retrofitted to provide hybrid aircraft refueling, electric charging, or fuel cell charging on a city-by-city basis. The estimated costs of such charging facilities or services are rolled into the ground infrastructure costs.
- All airports within a given city's economic catch basin, whether commercial air transport or general aviation/business aviation, will receive investment in vertiport facilities and AAM traffic management services to permit safe passenger handling and eVTOL traffic volume.

Figure 3 provides a graphic representation of the many layers of ArcGIS data information available during our analysis.

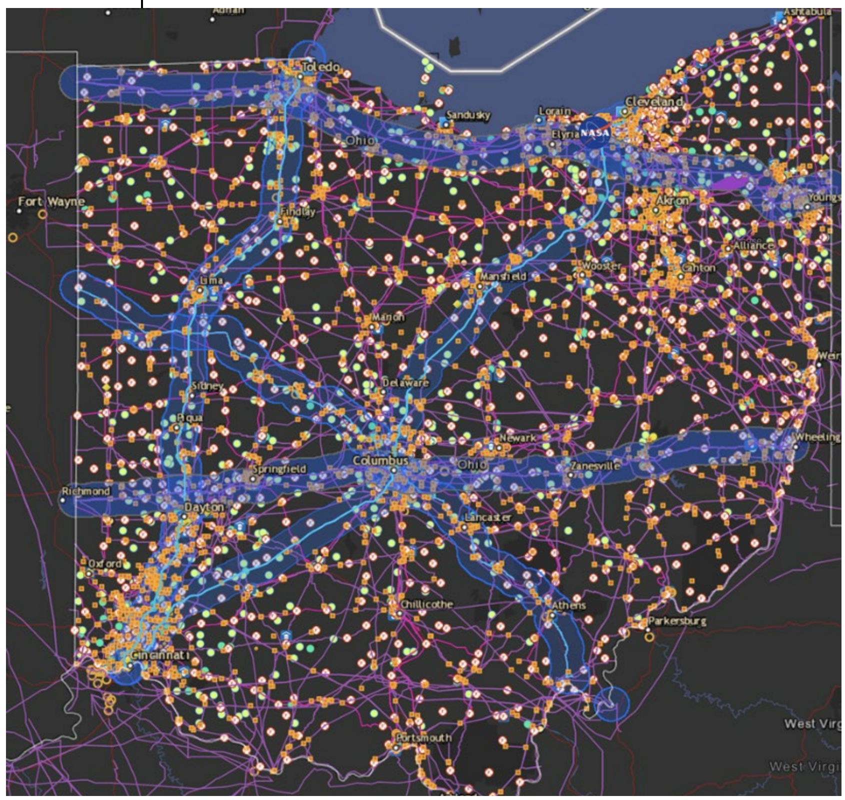

Figure 3 - Ohio showing certain ArcGIS data layers and five major logistics corridors.

The statewide infrastructure mapping effort provided the inputs for the AAM Business Case Model. Ohio is already well positioned for the implementation of AAM, as there are more than 270 helipads and 500 runways within the state. Cargo eVTOL operations will benefit from the 112 manufacturing centers and 138 logistics centers across the state, allowing eVTOL operations to swiftly integrate into existing freight transportation modes. With more than 1,100 fire departments and 171 hospitals, Ohio will have a high demand for eVTOL medical use cases, such as Medevacs and patient transfers.

All the 35+ layers included in the ArcGIS data sets helped to determine a specific city's ability to adopt and implement AAM. These metrics were used as inputs in the Business Case Model to calculate a city's demand for eVTOL services over the 25-year period.

Business Case Methodology

In addition to the geo-coded datasets, the Business Case Model analysis makes use of more than 100 additional sources of information necessary to perform demand and costing analysis, and to aid in estimating capital and operating costs for AAM ground facilities and UTM (Urban Air Mobility Traffic Management) facilities.

Key to this analysis tool are the three business case models. The tool accepts assumptions used for input drivers of each model:

- Aircraft Operators: Airport shuttle, on-demand air taxi, regional transport,

corporate campus to destination, medical/emergency services, and cargo.
- Public/Private/Partnership model for AAM ground infrastructure.
- Public/Private/Partnership model for PSU infrastructure.

By modelling these three classes of stakeholders, we were able to analyze and confirm long-term profitability on all fronts. The costs of these three entities are all accounted for when calculating ticket price. This allows for reasonable return horizons on the infrastructure, as well as profitability in the case of the operators.

Figure 4 - Beta Technologies eVTOL for United Parcel Services.

We posited the following investment thesis: for a city market or, in the case of Ohio, a region, to reach sustainable AAM revenue activities, operators and infrastructure investors must achieve profitability break-even success or, as a better outcome, a profitable bottom line.

Passenger demand is one of the most important inputs for the model, and for this forecast, the study team carefully developed supply and demand assumptions based on a dynamic range of ticket prices, both elastic (price sensitive, as in the case of consumer choices) and inelastic (less sensitive, as in the case of Medevac). There are, however, some fundamental questions that cannot be answered through financial and economic analysis. For example:

- Will Ohioans embrace these new services, finding sufficient value from improved AAM, thereby offsetting ticket prices?
- Will an extensive network operation involving dozens of aircraft flying above residential areas, generating some noise and visibly daunting, find acceptance?

Business Case Outputs

NEXA's proprietary AAM Business Case model produces:

- Operator Revenues for Passenger, Emergency Medical, and Cargo use cases
- Capital Expenditures and Operating Expenses for Ground Infrastructure and UTM
- Vehicle Purchases from OEMs

Over the 25-year period to 2045, our Business Case model estimates (Figure 5):

- Over 7.2M Passengers/Year by 2045
- Over $1B in Ground Infrastructure CapEx and OpEx
- Nearly $500M in UTM CapEx and OpEx
- Over $9B in Operator Revenues across both Passenger and Non-Passenger use cases
- Over $2.2B in Vehicle Purchases

Due to the regulatory hurdles of AAM passenger operations, using eVTOLS for emergency services and medical air ambulance operations will be one of the first use cases to begin generating revenue. While annual passenger counts are low, emergency services "ticket" costs, or cost per use, are very high, producing high revenues in the early years. Cargo operations are also likely to occur early on as eVTOLs will improve just-in-time deliveries for manufacturers, including timely on-demand delivery, reducing warehouse costs and keeping inventory low.

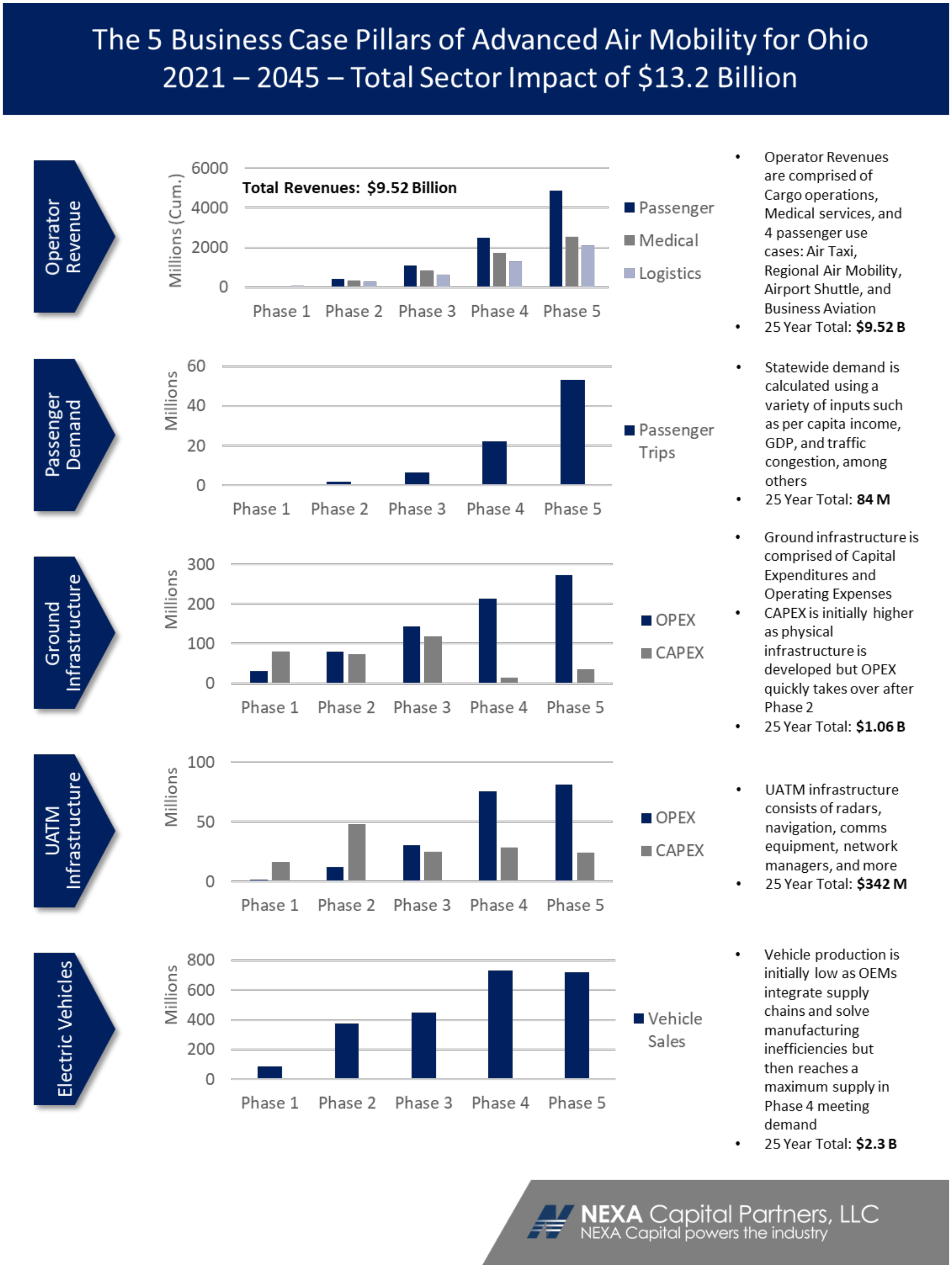

Figure 5 - Business Case Analysis Produced Strong Operational Revenues from Passenger Demand for Ohio

These statewide outputs prove AAM to be a profitable business over the 25-year period, which is crucial to the development of initial infrastructure that could be funded by government initiatives, private sector investments, or a combination of the two through a public private partnership model. Our team concluded that with a profitable long-term business model, investors can safely provide funding for AAM development knowing they will receive their returns in the future.

Cargo Use Case Methodology

To determine the revenue potential of Ohio's eVTOL cargo market (Figure 4 shows the new UPS liveried eVTOL aircraft to be manufactured by Beta Technologies), we obtained existing air freight and trucking data from the Bureau of Transportation Statistics' Freight Analysis Framework 4 tool. The FAF4 tool provides both historical and projected freight movement data for the United States, categorized by commodity.

Both air freight and truck freight projections were used as inputs for the eVTOL cargo market model. These initial inputs were distilled to the eVTOL cargo market potential by three different filters, based on our stated assumption, which is that AAM aircraft will transport cargo that is:

- Time sensitive,
- Within payload capacity, and
- High Value.

First, the inputs were sorted by commodity codes and filtered by only time-sensitive commodities. Of the initial Standard Classification of Transported Good (SCTG) codes, the commodity categories relevant to eVTOL operations were Precision Instruments, Electronics, Machinery, Pharmaceuticals, and Perishables.

Next, the subcomponents of each of the five commodity categories stated above were assigned to a weight class. Commodities that were over 1,000 lbs. or under 50 lbs. were not considered. Each weight class corresponded to a market share percentage for each SCTG Code subcomponent. These percentages based on weight class were applied to Ohio's freight projections to further sort for the eVTOL cargo market potential.

Finally, subcomponents were filtered by value classes. We assumed that eVTOL cargo operations would cater to high value, given the cost of eVTOL use compared to traditional freight modes. SCTG Code subcomponents were assigned a value class and a corresponding market share percentage that was applied to the inputs.

After sorting by time-sensitive and high-value goods between 50-1,000 lbs., we arrived at the eVTOL cargo market potential. To understand what share of this total market potential cargo eVTOL operators could capture, we applied five different exogenous factor constraints over the 25-year period to reach a conservative estimate of the annual eVTOL cargo market share. This market share was then distributed among five Ohio logistics corridors based on current and projected freight flow percentages along those routes. The five logistics corridors were defined around four interstate highways (I-70, I-71, I-75 and I-80) and U.S. Highway 33. As mentioned, Figure 3 presents an ArcGIS representation of the five Ohio corridors.

Cargo Use Case Outputs

The analysis shows that the total eVTOL cargo market share over the 25-year period would move more than 1.2 million tons of commodities valued at more than $5.5 billion. Revenues over the 25-year period total more than $2.1 billion, growing from $76 million in Phase 1 to $820 million in Phase 5. Our analysis shows that a majority of eVTOL cargo flows will follow the I-71 corridor, as this corridor connects Ohio's three largest cities: Cincinnati, Cleveland, and Columbus. In Phase 5, the I-71 corridor will see more than $325 million in revenue during that five-year period.

Over the entire 25-year period, I-80 increases its share of the eVTOL cargo market. Connecting Cleveland to Toledo and eventually Chicago, we anticipate increased interstate freight operations as cargo eVTOL technology advances, allowing for more revenue along the I-80 Corridor in the later phases.

Economic Impact Analysis

In economics, an input/output ("I/O") model is a quantitative methodology that represents the interdependencies between different branches of a national economy or of regional economies. The I/O model depicts inter-industry relationships, showing how output from one industrial sector may become an input to another industrial sector. In the inter-industry matrix, column entries typically represent inputs to an industrial sector, while row entries represent outputs from a given sector.

This format shows how dependent each sector is on every other sector, both as a customer of outputs from other sectors and as a supplier of inputs. This inter-industry relationship is expressed in the form of industry coefficients, or multipliers, that depict the rate of change of output among a set of interdependent industries, from a one unit increase in output by one industry.

In this study, NEXA used IMPLAN, an Input/Output economic modeling system used by the U.S. Government for economic forecasting. Our team analyzed the business case for Combined Statistical Areas (CSAs) around six cities across the state, with each "city" comprising their Metropolitan Statistical Area (MSA) and proxy counties.

Together, the six CSAs capture every county in the state, allowing distribution of the outputs for the state as whole. As a result, the IMPLAN industry multipliers used in this scenario are state averages, with total impact represented at the state level.

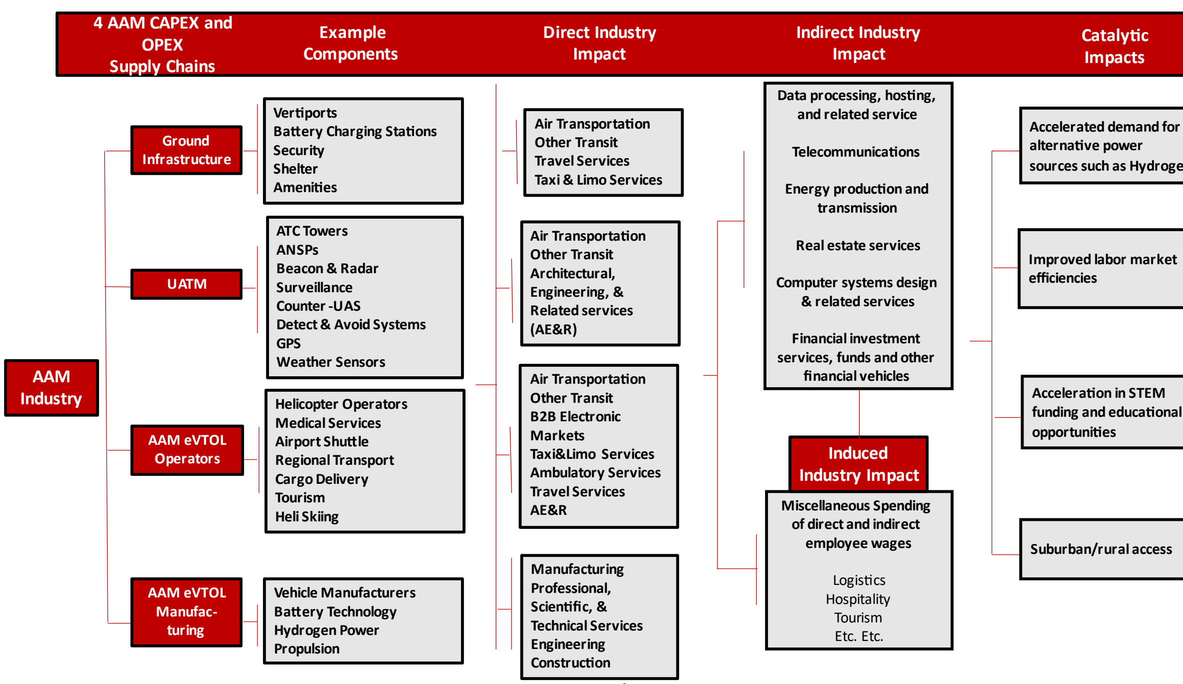

Figure 6 - UAM Geomatics econometric model showing impacts driven by four supply chains.

In combining the business case totals, the team produced consolidated operational expenses (OPEX), capital expenses (CAPEX), and revenues along the four supply chains discussed previously, with OPEX and CAPEX for ground infrastructure, PSU, and aircraft, in addition to revenue for the operators. These totals, or economic outputs, have been forecasted for each phase of AAM's development in Ohio until 2045. The flow of the analysis is represented in Figure 6. The model examines and calculates direct, indirect, and induced economic impact. Catalytic impacts (those arising from general connectivity and more difficult to quantity) are then considered separately.

Economic Impact Analysis: GDP

GDP, or gross domestic product, is defined as the total value of all domestic final goods and services produced within a specified period (typically a year). It is also known as value added, which according to IMPLAN, is defined as the difference between total output and the total value of intermediate inputs throughout an economy during a specified period. It is the total output minus intermediate inputs. In the case of AAM, total output over 25 years calculated using the business case analysis model, is $12.9 billion.

IMPLAN calculated the value added of this output at $11.4 billion for the State of Ohio (Figure 7). $4.6 billion is attributed to the direct impact; $2.9 billion is attributed to the indirect impact, and $3.8 billion is attributed to the induced impact.

Economic Impact Analysis: Jobs

Jobs were calculated first in terms of employment, which IMPLAN defines as including both part-time and full-time annual employment. In this study, the total employment in the State of Ohio was derived from the total output produced by AAM at the direct, indirect, and induced levels. Since the employment count does not differentiate between type of employee, a conversion to full-time equivalent (FTE) is necessary to capture a tangible estimate of the labor count. IMPLAN provided a conversion sheet to identify the corresponding FTE count.

The job numbers in Figure 5 reflect cumulative jobs gained year over year. As the value of AAM increases every year, so does the labor required to support it. This means that by 2030, the value of AAM at the direct, indirect, and induced levels will require roughly 5,000 jobs to support it. In 2045, that number reaches just above 15,000. Note that this job forecast does not account for jobs that could be replaced by AAM jobs.

Economic Impact Analysis: Taxes

IMPLAN captured tax revenues at the local, state, and federal level. The local level represents totals for townships, cities, and counties for the entire state. Increased government revenues generally translate into additional government expenditures, which offers the state more investment opportunity into state infrastructure, economic and social programs, and so forth. Figure 8 depicts these revenues at the local, state, and federal levels over each phase of growth. These estimates are

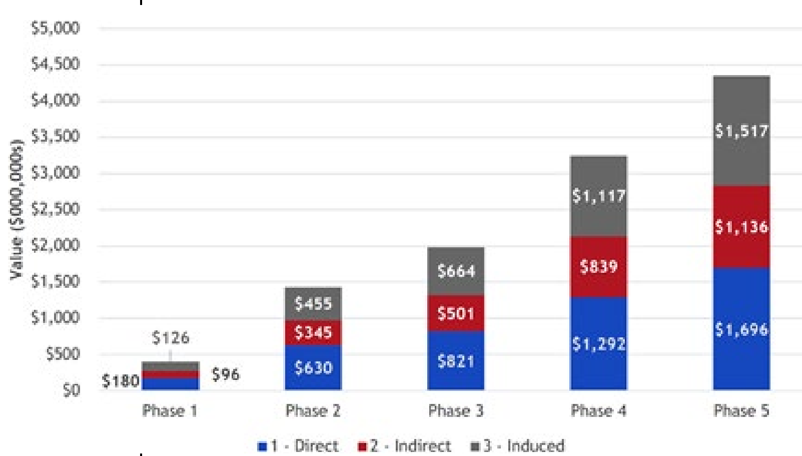

Figure 7 - IMPLAN Estimated GDP Growth for Ohio Due to AAM

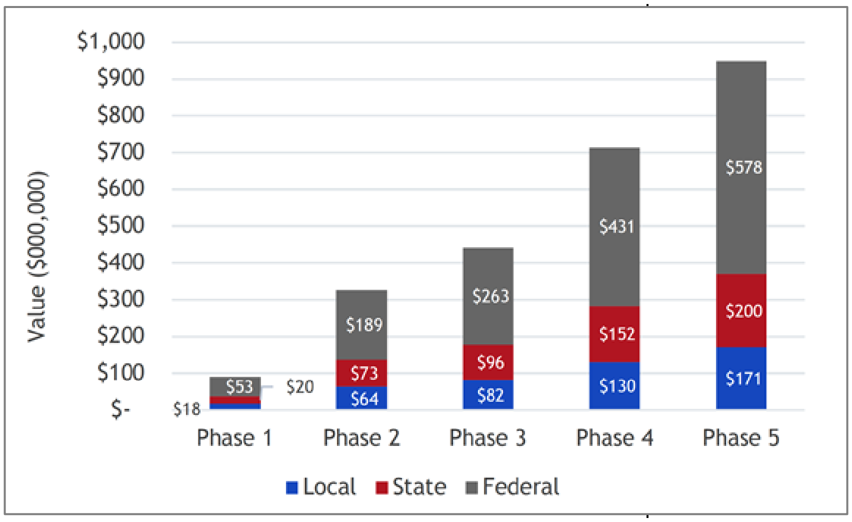

Figure 8 - IMPLAN Produced AAM Tax Revenues at Local, State and Federal Levels

additive, with total revenue of $2.5 billion gained over 25 years. The local and state governments account for $464 million and $542 million in revenue, respectively, totaling approximately $1 billion. Federal revenues account for about $1.5 billion.

This industry ripple effect will touch nearly all sectors of a city or regional economy; however, the impacts across these industries at all levels will vary according to the unique economic makeup of the case study. The industry multipliers for each city or region will be different, resulting in different impacts across the board, every time. Thus, the number and types of jobs created, the industries impacted, and tax revenues gained will also be different.

Catalytic Impacts

Economic catalytic impacts are commonly studied when assessing air transport systems, and advanced air mobility is no exception. By definition, an "economic catalyst" is an event that (Figure 9):

- Has two or more groups of customers;
- Who need each other in some way;
- Who can't capture the value from their mutual attraction on their own; and
- Rely on the catalyst to facilitate value reactions between them.

Modern economists claim that in air transport, catalytic effects are even greater than the direct and indirect effects. For example, catalytic impacts arise from connectivity and interaction benefits, among other things, and social benefits that lift communities with the jobs and spending that create new businesses.

Potential Catalytic Impacts Arising From AAM Services, and Subject to Separate Economic Analysis
• Access to goods and services to underserved or disconnected populations
• Urban decongestion and its effects on economies and quality of life
• Increased Investment in STEM education
• Reduced carbon footprint
• Boost to tourism
• Increased intracity and intercity trade, including international
• Growth in adjacent industries and technologies

Figure 9 - Ohio AAM Catalytic Impacts

Conclusion

Advanced Air Mobility is what is known as a disruptor, an invention that changes everything for almost everyone. Think the invention of writing. Or the printing press. Or the Internet. AAM will reinvent how we go places, and how products come to us.

As our urban areas become more congested, as more people and businesses demand access to convenient mobility, the only space available is up. With advanced technology, underutilized space above cities will provide that mobility with quiet, safe, green aircraft that not only offer new transportation options but will provide numerous social benefits to large metropolitan areas such as energizing businesses, universities, and students in technical fields; assisting disadvantaged communities; and saving lives with rapid, efficient medical transportation.

For the State of Ohio, we foresee a thriving new industry providing some $13 billion in economic activity between now and 2045, some $2.5 billion in local, state, and federal tax revenue, and some 15,000 FTE jobs. As this increased prosperity is only for one state, we can only imagine the figures resulting from modeling these forecasts for the entire U.S.

Disruptors change society, change how businesses operate and what we do as individuals to navigate our world. The next disruptor—AAM—is well on its way and will be here soon.


Infrastructure to Support Advanced Autonomous Aircraft Technologies in Ohio

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Prepared for:
The Ohio Department of Transportation,
Office of Statewide Planning & Research

Project ID Number: 111453
June 2021
Final Report

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AIR MOBILITY. ADVANCED.
NEXA Capital Partners, LLC
NEXA Capital powers the industry
University of CINCINNATI
RESEARCH
U.S. Department of Transportation
Federal Highway Administration

Figure 10 - The Full Report Can be Downloaded at https://www.dot.state.oh.us/Divisions/Planning/LocalPrograms/LTAP/Documents/2021_05_26_PID_111453_Final_Deliverable_-_RDR_5-26-21_V1.pdf

About UAM Geomatics Inc.

UAM Geomatics, Inc. is a NEXA Capital company. New infrastructure will be key to Advanced Air Mobility viability: vertiports, UATM infrastructure services, passenger facilities, lighting and weather systems, airspace planning, and certification. Our extensive work in Advanced Air Mobility has resulted in the development of world-class geospatial mapping tools and business case investment analytics laying groundwork for AAM urban airspace design. UAM Geomatics, Inc. has identified and mapped these capital expenditures for 84 metro areas globally. UAM Geomatics is also an official "Partner" of ESRI with its ArcGIS tools being made available to the AAM industry through the UAM Geomatics portal. Go to www.nexa-uam.com for more.

Michael Dyment

Michael is the Managing Partner of NEXA Capital Partners, a Washington DC based investment banking and corporate finance advisory firm, with a focus on aerospace sector clients and programs. NEXA has a record of successful project finance in aerospace, having completed securitizations for major programs such as FAA ADS-B and Iridium Aireon. NEXA Advisors, a NEXA subsidiary, recently completed a business intelligence study called ***Urban Air Mobility—Infrastructure and Global Markets***, which provides 25-year market and economic forecasts for 84 of the world's largest metropolitan areas. NEXA established UAM Geomatics, Inc. in response to the overwhelming success of the study, providing global geo-coded information and big data analytics to accelerate city-by-city UAM development and investment. Prior to NEXA, Mr. Dyment was a partner or national director with PricewaterhouseCoopers, Arthur Andersen LLP, AT Kearney, and Booz Allen Hamilton. He holds a Master of Science in Aeronautics and Astronautics from the Massachusetts Institute of Technology, and a B.Sc.Eng. in Geomatics Engineering from the University of New Brunswick.

Chase Leeby

Chase joined the NEXA team in 2019 and currently serves as a Director and Senior Financial Analyst responsible for aerospace market and industry research, developing financial models, conducting business case analysis and performing M&A due diligence. Chase has co-authored Advanced Air Mobility white papers and economic impact studies for the city of Vancouver and the state of Ohio, in addition to NEXA's groundbreaking ***Urban Air Mobility: Infrastructure and Global Markets*** study. Highly skilled in geospatial analysis he is one of NEXA's most proficient ArcGIS and ESRI platform users. Before joining the NEXA team, Chase worked as an intern to the CFO of Adecco Australia in Melbourne and as an accounting intern for Beeline in London. He has experience in the investment banking industry working as an intern with Nomura Securities on both the Valuations and Debt Trading and the Mergers and Acquisitions teams. Chase received his M.Phil. in Oriental Studies from the University of Oxford and holds a B.A. with Honors in History and Economics from Washington and Lee University. He lives and works in Washington DC.