UAM Geomatics, Inc.
A NEXA Capital Company

NEXA Series White Paper No. 23-1
July 2021

This white paper examines the exciting opportunity for economic growth and job creation in the emerging Advanced Air Mobility (AAM) Sector. Nations around the world are engaged in a highly competitive race to achieve technological superiority and market dominance with electric Vertical Take-off and Landing (eVTOL) aircraft. Jobs in aerospace, transportation, high technology, and hospitality, to name a few, await forward-leaning cities.

The New Economics of Advanced Air Mobility

Emerging Aerospace Technologies Deliver Revenues, Jobs, Tax Revenues and Economic Prosperity to Cities on the Move

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The Trillion Dollar Prize

Advanced Air Mobility (AAM), also known as Urban Air Mobility (UAM), involves the use of revolutionary eVTOL aircraft (Figure 1), which promise to be smaller, lighter, quieter, greener, and far more affordable than traditional aircraft. This new form of aviation offers dozens of new uses—from regional shuttles to medical delivery to on-demand air taxis—as well as the promise of less congestion—the bane of modern cities. Key technologies include lightweight composites, lithium-ion batteries, powerful multi-rotor lift, and advanced flight control systems.

THE REVOLUTIONARY AAM CONCEPTS AND SYSTEMS IN DEVELOPMENT TODAY HAVE THE POTENTIAL TO TRANSFORM OUR MODERN WORLD, BOOSTING THE LIVABILITY OF OUR CITIES, AND IMPROVING OUR WAY OF LIFE.

In 2021, Morgan Stanley forecast the size of the AAM market (2021 – 2050) at more than $9 trillion, while a more recent and widely subscribed industry study by UAM Geomatics Inc., a NEXA Capital company, identified $1 trillion in 25-year market potential within the world's 84 largest cities. (Combined, these metropolitan areas represent just 26 percent of global GDP.)

Figure 1: Archer has received financial commitments for over $1 billion in investment in 2021 through Atlas Crest (NASD: ACIC). Above is a rendering of the Archer 5-Passenger Tilt Rotor eVTOL.

Economic Impact Assessments: a Crucial Launchpad of the Advanced Air Mobility Industry

Metropolitan regions around the world are considering the introduction of Advanced Air Mobility, exploring where to construct vertiports and plan flight routes, how best to serve the public, where to obtain financing, and how to navigate regulatory hurdles. One of the most essential steps forward, however, is performing an Economic Impact Assessment (EIA.) A quantification of economic benefits to the public—new, solid, high-paying jobs, both white collar and blue collar—

serves to enhance public perception of the new technology and increases community interest. The benefits to local authorities—jobs, as well as increased tax revenues—appeal to city planners.

As a new form of air transportation, Advanced Air Mobility will create jobs, tax revenues, and increased economic prosperity in every city that introduces it. Using revolutionary new aircraft that are only just now becoming possible, AAM will expand economic opportunity by moving people and cargo between places not conveniently served by surface transportation or underserved by aviation—local, regional, intraregional, and urban. AAM uses eVTOL aircraft, both those that carry passengers and small unmanned aircraft systems (sUAS), also known as drones. The passenger aircraft will be powered by hybrid electric systems, batteries or, at some point further down the road, hydrogen fuel cells. Until quite recently, this new aviation technology was referred to as Urban Air Mobility, a name that reflected its intended uses in a congested urban environment. However, it is becoming apparent that its benefits will not be limited to cities. These aircraft may range far and wide, bringing accessibility to communities across regions. That is why we use the term Advanced Air Mobility in this paper.

The versatility in eVTOL technology—and the resulting economic manifestation—is best expressed in its myriad use-case potential. There are five major use cases that provides a cross-section of benefits for the local and regional communities impacted. The use cases include air taxi, Medevac, airport shuttle, regional air transportation, and business aviation. In summary, these use-cases improve intra and intercity commute times, save more lives at lower costs, and connect regional economies, bringing economic opportunity to underserved communities. These are the paradigmatic improvements that AAM will bring to people across the globe, and why the global AAM market is projected to reach between $9 trillion and $19 trillion by 2050.[1]

What will the introduction of AAM mean for the city or regional economy? The most important factor in quantifying economic benefit is through job creation—a bedrock economic statistic. Identifying job growth is essential to understanding how a local or regional economy can benefit from new investments, helping policymakers quantify tangible benefits to impacted populations. The following is a list of cyclical effects catalyzed by job creation:

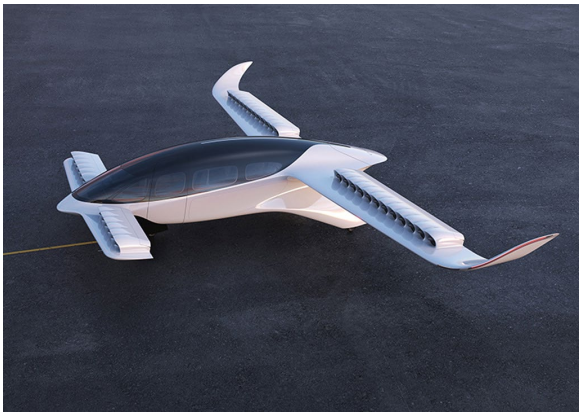

Figure 2: Lilium recently announced a network of 14 exclusive vertiports in Florida, and a proposed network under development in Germany

- Increased employment
- Increased disposable income
- Increased consumer spending
- Increased production of goods and services

Together, these effects are described as an economic virtuous cycle. This is why policymakers in government are so keen to catch opportunities that lead to new jobs. Jobs produce, and with production comes growth. Other knockoff effects include an increased tax base and the attraction of future investment.

The Current Landscape

The U.S. aerospace and defense (A&D) industry plays a significant role in the national economy. In all of 2019, A&D supported 2,190,000 jobs, with total industry revenue amounting to $909 billion. These workers represent 1.4% of America's total workforce. In addition, A&D contributed $17.6 billion in state and local taxes, plus $46 billion in federal taxes.[2] While these figures are already astronomical, AAM will increase this activity, filling in

the gaps in service that traditional commercial flights cannot fulfill. According to a recently released Deloitte white paper on AAM, the new industry could produce as many as 280,000 jobs by 2035 in the U.S. alone, with $8 billion in federal, state, and local taxes.[3]

Figure 3: Horizon Aircraft's all-purpose hybrid eVTOL will be used for disaster relief, Medevac services, cargo transport, regional and air taxi services.

While national studies provide a broad understanding of a particular industry's economic activity, they do not consider a fundamental attribute of AAM: its rollout will be localized, city-by-city. With many use cases available to the technology, the successful introduction of AAM is dependent on the city governments and the unique features of the jurisdiction—GDP, congestion, current public transportation, business climate, geography, decarbonization efforts, and economic and equity goals, among many others. Each city is like a fingerprint—one-of-a-kind—and therefore AAM will impact each economy differently. We at NEXA pioneered this mode of analysis and have produced numerous city and regional-level Economic Impact Assessments to best reflect the economic potential of AAM. Our goal is to map out the economic impact for all cities and regions, painting a global picture of the future of AAM.

Market Study

To assess the potential impact of AAM on a local economy, we must first identify the business opportunity. A city-specific assessment of the business opportunity will yield a city-specific Economic Impact Assessment. NEXA built a proprietary econometric modeling tool that determines passenger demand across a 25-year timespan to 2045. Our model considers ten factors to explain the demand unique to each city. Example factors include airport origination and destination count, per capita GDP, congestion indexes, and population density, to name a few.

With infrastructure development acting as a key ingredient to the successful launch of AAM services worldwide, we factor in existing infrastructure capacity and forecast how much more investment would be needed to support the city or region's demand. The final result provides us with the total business output covering the four NEXA-identified supply chains: unmanned air traffic management (UATM), ground infrastructure (vertiports), operations, and vehicle production.

Our latest market study updated in June 2021 covers 84 cities. Together, they represent just over 25% of global GDP. Our major global AAM business case output over 25 years include:

- Total passengers: 3,296,691,270.
- AAM Infrastructure costs: $34.7 Billion.
- Urban Air Traffic Management Costs: $21.6 Billion.
- Operator Revenues: $429.5 Billion.
- Vehicle costs: $62.2 Billion.

Altogether, AAM is forecasted to generate nearly $550 billion in direct revenues and twice that in economic output. But what does that mean for a local economy? How many jobs will that create, and which industries will benefit the most? What about taxes? These and similar questions can only be answered by running a separate Economic Impact Assessment dealing with a single city or region. This is because each case study is as unique as DNA—different economies mean different impacts from any particular type of investment.

The $550 billion in new business opportunities mentioned above will be generated in large part by four dominant supply chains within the aerospace industry. The following walkthrough of the Economic

	Industries						Households
Industries	Agriculture, Mining, and Utilities	Construction	Manufacturing	Trade	Transportation & Warehousing	Services	
Agriculture, Mining, and Utilities	1.0776	0.0274	0.0728	0.0152	0.0201	0.0155	0.00321
Construction	0.0188	1.0066	0.0085	0.0065	0.0131	0.0113	0.0089
Manufacturing	0.0843	0.1876	1.1915	0.0659	0.1354	0.0630	0.1235
Trade	0.0661	0.1469	0.1031	1.0858	0.1015	0.0745	0.2068
Transportation and Warehousing	0.0484	0.0390	0.0430	0.0447	1.1215	0.0256	0.0460
Services	0.3633	0.6684	0.4447	0.5587	0.6250	1.7214	1.1816
Households	0.2256	0.4460	0.2653	0.03572	0.4333	0.3327	1.2829
Total	**1.6585**	**2.0759**	**1.8636**	**1.7768**	**2.0166**	**1.9113**	**1.5989**

Figure 4: Sample of an output multiplier table from the Bureau of Economic Affairs RIMS II User Guidebook. A $1 increase in final output from the transportation industry yields $2.02 in total output.

Impact Assessment method explains how the total value of the business opportunity for any given economy gets distributed across that particular economy.

Economic Impact Assessment Methodology

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.

Since every city or region has a unique industry makeup, the impact of AAM in each case will be distinct, affecting a variety of interlinked industries in different ways, and creating a unique number and set of jobs. See Figure 4, an example of an output multiplier table, taken from the Bureau of Economic Affairs' RIMS II User Guidebook. The chart features example multipliers of several inter-linked industries. Here, a $1 increase in final output from the Transportation and Warehousing industry yields $2.01 in total output. The additional output value of $1.01 is produced from the six other industries (plus households) that supported Transportation and Warehousing's production of a $1 output.

The I/O modeling tools that NEXA uses to conduct these studies are supplied and supported by various public and private organizations. In North America, these include the United States Bureau of Economic Affairs (BEA) RIMS II, and Canada's equivalents—Statistics Canada, IMPLAN, and REMI.

The three major component results of an I/O model study include estimated job count, GDP growth (or value-added growth), and tax revenue. Depending on model sophistication, other insights can be gleaned, such as industry growth and impact by occupation. Every I/O assessment begins with an exogenous shock—an initial economic stimulus—to a local or regional economy. In this case, we look at the effects of new investment and business activity from AAM. The city-level business cases that NEXA analyzes are the exogenous shocks that get fed into the I/O models.

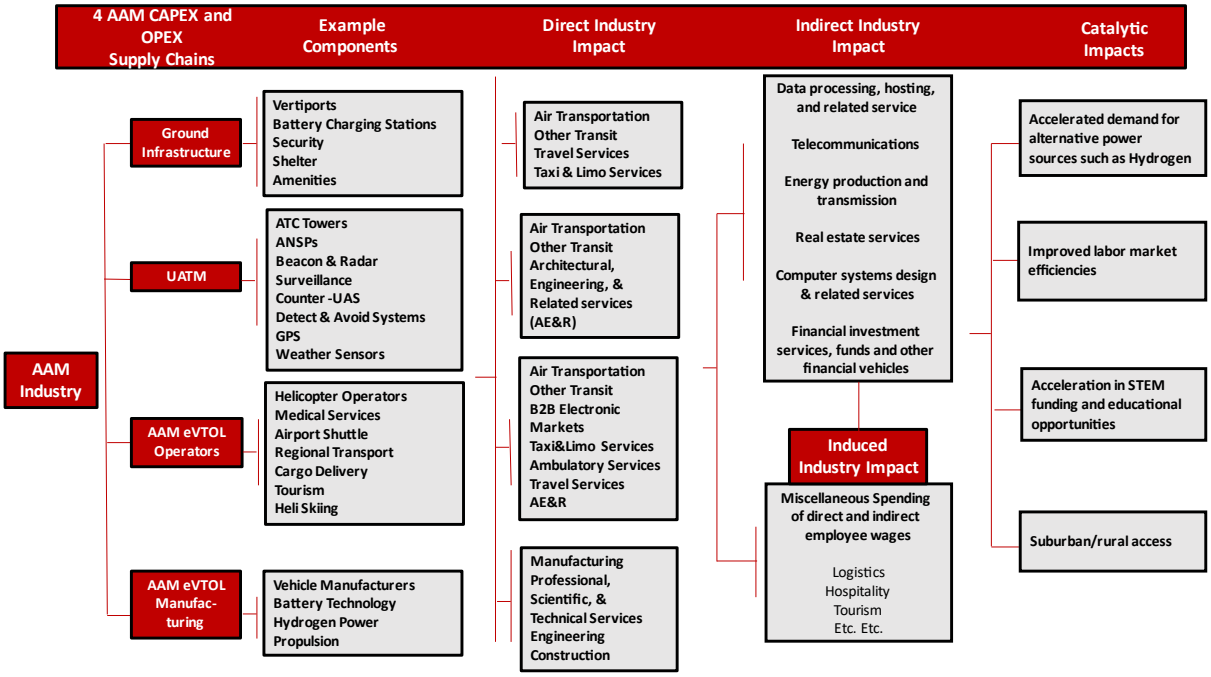

Figure 5 - Econometric Framework for GDP Impact Analysis, Considering the Four Critical Supply Chains at Play.

In all models, the impacts of the exogenous shocks are distributed at the direct, indirect, and induced levels. Direct effects calculate the economic value that an exogenous shock generates by its own means through direct hiring of its own employees, revenue generation from sales, and the portion of its business activity that contributes to national GDP. Indirect effects measure the changes due to inter-industry purchases as they respond to the new demands of the directly affected industries. This includes the chain reaction of output up the production stream since each of the products purchased will require, in turn, the production of various inputs. Finally, induced effects measure the changes in the production of goods and services in response to consumer expenditures induced by households' incomes (i.e., wages) generated by the production of the direct and indirect requirements.

Given this flow of business activity from the exogenous shock, we expect to see job growth, GDP growth, and tax revenues at the direct, indirect, and induced levels. This allows us to assess the impact of the exogenous shock beyond the initial industry or set of industries impacted. Figure 5 is an impact flow chart illustrating the flow of economic activity driven by initial investments in AAM. NEXA created this diagram for our recently completed study of AAM for the state of Ohio, though the chart is applicable for all case studies.

The AAM industry is composed of sub-industries, discussed already as ground infrastructure, UATM, operators, and manufacturers. These four components are assessed at the city or regional level for their business value over 25 years in our groundbreaking market study **Urban Air Mobility:**

Figure 6: Piasecki Aircraft PA890 electric VTOL designed for long range medevac uses.

Infrastructure and Global Markets 2021-2045. To assess the economic impact of the business activity, we first break down what kinds of goods and services would be produced to support the AAM industry. This is illustrated in column two. Each supply chain contains unique goods or services that support that chain's operations. Many or all of the example components listed were factored into the cost model of the business case assessment.

Moving into the third column, we take the example components from column two and further categorize those goods and services into bestfit North American Inudstry Classification Codes (NAICS). These are the industries that Federal statistical agencies use in classiyfying business establishments for the purposes of collecting, analyzing, and publishing statistical data related to each the Canadian, American, and Mexican economies (North America).4 These are the industries that major I/O models (i.e., RIMS II, IMPLAN, etc.) use to qualify their assessed multipliers.

NEXA studied the NAICS industries and selected eight industries that were deemed to have the most relevance to the four supply chains. They are: 1) Air Transportation 2) Taxi & Limousine Services 3) Travel Services 4) Other Transit 5) Architectural, Engineering, and Related Services 6) Engineering Construction 7) Ambulatory Services, and 8) Professional Scientific & Technical Services.

The direct impact of AAM business on these eight industries would have a ripple effect on the broader economy in the form of indirect and induced impacts (column 4 in the chart), thus touching countless additional industries beyond the original eight.5 Examples of these indirect industries include the 1) Telecomm-unications Industry, 2) Real Estate Services, and 3) Computer Systems Design and Related Services, to name a few. Industries impacted at the induced level would be relatively unrelated or miscellaneous industries, such as tourism. This industry ripple effect will touch neary 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

Finally, based on the assessed economic impact and a case study's unique political, economic, and social portfolio, NEXA goes one step further to identify catalytic impacts. An "economic catalyst" is an entity that has (a) two or more groups of customers; (b) who need each other in some way; but (c) can't capture the value from their mutual attraction on their own; and (d) 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. In air transport, for example, catalytic impacts arise from connectivity and interaction benefits, among other things, and social benefits that lift up communities with the jobs and spending that create new businesses.

As mentioned, the catalytic impacts derived from AAM vary depending on the political, economic, and social portfolio of the case study. Different communities or groups of people have different needs or issues affecting their livelihoods. Examples

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
• Etc.

Figure 7: Examples of Catalytic Impacts.

of catalytic impacts stemming from AAM services are shown in Figure 7.

As part of our AAM case study research, NEXA identifies the prevailing social, economic, and political conditions that can be enhanced, solved, or alleviated by the introduction of AAM services. The top 3-4 most relevant catalytic impacts are chosen for in-depth analysis, quantifying and qualifying the impact AAM will have as a catalyst.

Case Studies

NEXA's two most recent Economic Impact Assessments of jurisdictions feature AAM studies on the city and greater region of Vancouver and the entirety of the state of Ohio. Using our econometric business model and applying the appropriate input/output model, NEXA produced a forecast of jobs, GDP, and tax revenues, among other items, for each. We used IMPLAN for Ohio, and then worked together with Statistics Canada for Vancouver. Below is a chart summarizing the major findings. Note that for Vancouver, the impact study forecasts into year 2040, while for Ohio it is extended to 2045.

Total Impact	State of Ohio – by 2045	Greater Vancouver – by 2040
Population (2019)	11.7 Million	2.6 Million
New AAM-Related Permanent Jobs	15,000 FTE over 25 years	2,007 FTE over 20 years
GDP Increase	US$11.4 Billion	C$2.2 Billion
Tax Revenue	$2.5 Billion	C$167 Million

Figure 8: UAM Economic Impact Forecasts at a Glance.

Armed with such an analysis, policymakers in any city or region can point to concrete benefits derived from Advanced Air Mobility. It will provide municipalities and private stakeholders realistic objectives for potential economic development, all the while allowing them to target the specialized needs of their local industries and workers.

Job Classifications

AAM will open up new jobs in a variety of fields for people with all educational levels, from a high school diploma to post-graduate degree in business, science and technology. Examples include:

- Engineering
- Intelligent Transportation Systems
- AAM Operators (Pilots, etc.)
- AAM Operational Support (Maintenance, etc.)
- Aircraft Design & Manufacturing
- Business & Financial Operations
- Quality Control & Safety Engineering
- Medical & Supporting Services
- Travel Support Services
- Hospitality
- All Other

Conclusion

A careful Economic Impact Assessment, forecasting future GDP impacts, job creation and tax revenues, is crucial for any jurisdiction considering the introduction of Advanced Air Mobility services. Legislators and city planners need to understand the need for investment and the potential for jobs and revenues. The general public must be informed of the economic benefits--in addition to those related to mobility—which may also help to decrease public objection. Properly equipped with EIA studies, metropolitan areas will be better equipped to negotiate rights and concessions with vehicle manufacturers and AAM service providers.

Acknowledgements

This paper was prepared using information developed by the authors and by Crown Consulting for the State of Ohio and the Ohio Department of Transportation in a report **"Infrastructure to Support Advanced Autonomous Aircraft Technologies in Ohio"** (April 2021). Also the Canadian Advanced Air Mobility Consortium paper titled **"Economic Impacts of Advanced Air Mobility"** (November 2020) provided the authors with data

and information using similar methodologies and analytics. The authors are extremely grateful to these organizations for their support.

About UAM Geomatics Inc.

UAM Geomatics Inc., a NEXA Capital company, created the groundbreaking study ***"UAM Infrastructure and Global Markets: 2021-2045,"*** which analyzes 84 cities around the world and forecasts the size of eVTOL aircraft fleets, the numbers of vertiports, passengers, revenues, associated costs, and countless other data, along with ArcGIS interactive maps useful in planning the first flight routes.

About NEXA Capital Partners LLC

NEXA Capital Partners, a Washington DC based investment banking and corporate finance advisory firm, has a focus on aerospace sector clients and programs. NEXA works with outstanding companies and management teams currently positioned to benefit from emerging factors driving sector transformation. NEXA seeks opportunities that will eventually lead to high growth public market offerings and /or acquisitions at public multiples.

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Benjamin Merran

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[1] Morgan Stanley "eVTOL/Urban Air Mobility TAM Update: A Slow Take-Off, But Sky's the Limit." May 2021.

[2] https://www.aia-aerospace.org/wp-content/uploads/2020/09/2020-Facts-and-Figures-U.S.-Aerospace-and-Defense.pdf

[3] Advanced Air Mobility | Deloitte Insights

[4] Economic Impact Assessments for cities and regions outside North America will use other classification systems. Consider the the Statistical Classification of Economic Activities in the European Community (NACE) for Europe.

[5] The rippling effect of economic activity from the exogenous shock suffers diminishing returns due to leakages. Each original dollar that gets recycled into the economy gets smaller and smaller. This is why generally one will see the greatest dollar value at the direct level, and least at the induced level. Examples of leakages include savings, un-used taxes, and imports (when an economy imports, those dollars exit the concentric loop).