RESEARCH PROGRAMS USE ONLY
RESEARCH IDEA NO: **18-020**
DATE OF RECEIPT: **4/20/17**
TOTAL MDT COST W/ICAP: **Stage 1: $64,000; Stage 2: $95,000; Total: $158,000**

RESEARCH PROGRAMS

STAGE 2: RESEARCH TOPIC STATEMENT[1]

Submit completed form to mdtresearch@mt.gov. All fields are required, except the last field: XVIII, Sponsor(s). Incomplete forms will not be accepted.

I. TITLE: Unmanned Arial Vehicle (UAV) Applications for Montana Transportation Corridors

II. TOPIC STATEMENT: This research will compile a comprehensive list of highway design, construction, and maintenance applications that have been successfully implemented in the US and overseas. It will then complete a critical analysis of each potential application within the Montana context, including the review of FAA and other regulations on this topic. The final deliverable will be a White Paper on the topic with recommendations for implementing high value applications with in MDT.

III. RELATED RESEARCH SUMMARY FROM STAGE 1: In 2013, the State of Montana enacted legislation to restrict the use of information gained from UAVs as evidence in a court of law. At this point, the UAV was viewed as an unwarranted invasion of privacy, which required a search warrant to be legal. However, the industrial rather than military/law enforcement use of UAVs has increased substantially to the point where MDT's Aviation Bureau now maintains its own UAV. In 2016, FAA promulgated Rule Part 107 that provides a legal basis for the use of UAVs. UAVs have been found to be a very cost effective means to gather technical information in remote or dangerous locations. A UAV bridge inspection pilot project by the Minnesota DOT concluded that this application not only increases safety for DOT bridge inspectors, but also reduces the time spent gathering bridge condition data. The TransCanada pipeline company is making extensive use of UAV-based imagery to document its progress and protect itself against frivolous law suits for environmental damage during and after construction. The Panama Canal Authority uses UAVs to document actual construction contractor progress as well as to calculate cut and fill volumes. The City of Oklahoma City is using UAVs to conduct topographic surveys in urban areas to avoid the need to install traffic control to protect surveyors and has found that UAV-based digital imagery can equal and sometimes better the accuracy of the Total Station. An OKC pilot project completed the necessary data collection in less than one hour for an area that would have taken a typical survey party two days. Many power companies use drones to inspect transmission towers, eliminating the hazard to workers who used to have to climb the towers to complete each inspection. When combined with off-the-shelf commercial image analysis software, aerial imagery taken from UAVs can literally subtract before and after photographs to mathematically expose any changes. UAVs have been used to produce as-built surveys of completed construction projects and those surveys can be used to inform the agency's asset management database, as well as to contribute to 3D post-construction models for operations and maintenance planning. The list of current uses goes on and it suffices to say that this technology has an almost unlimited number of potential uses in transportation project delivery. Additionally, when combined with the fact that current computing power has reached a level where massive amounts of data can now be processed and converted into actionable technical information automatically with minimal need for human intervention, the power of these tools can be leveraged to the benefit of MDT's workforce constraints in a huge state with a very high percentage of low volume roads in remote, nearly inaccessible areas of Montana.

IV. RESEARCH PROPOSED: The proposed research will take place in two stages. Stage 1 will consist of a comprehensive synthesis domestic and international literature on the topic. It will be supplemented by a survey of US state and Canadian province transportation agencies to uncover those agencies that are currently using UAV technologies and identify potential case studies for each potential application in Montana. An internal survey of MDT personnel is also proposed to identify those areas where UAV technology can be used to cover functions where personnel constraints exist, where safety issues make data collection hazardous, and where accessibility constraints make it difficult or impossible to keep asset management databases current. The synthesis will include an assessment of available methodologies for assembling, cleaning and processing the data collected by the UAVs. Information on software, hardware, and personnel resources required for the data storage, analytics, and maintenance will be included in the data processing portion of the synthesis. Stage 1 will produce a synthesis report that benchmarks the state-of-the-practice in UAV applications in North America. If approved by MDT, Stage 2 will commence with an on-site

[1] Note: All research topics submitted become public property and submitters are not guaranteed to receive a contract for any work that may result from this topic statement.

demonstration of a typical UAV capabilities, conducted in two locations designated by MDT for individuals selected by MDT to furnish MDT decision-makers with a first-hand understanding of the technology's capabilities. After the demonstration, a short survey and structured interviews with demonstration observers will be conducted to further inform the research regarding MDT-specific needs. A critical analysis of the information gathered in the literature, surveys, case study and demonstration outcomes will be conducted within the MDT context, and from that, recommendations for high impact/low effort applications of UAV technology in the MDT program will be made. The critical analysis will include a top-down benefit-cost analysis for each of the recommended alternatives. The research deliverable will consist of a collection of 3 to 5 White Papers (4-6 pages) for the UAV alternatives that were found to have the greatest potential for immediate implementation in MDT. Each paper will make the business case for implementing a specific technology including up-to-date cost information, personnel resource requirements, hardware/software needs, necessary training, and FAA constraints. The research plan will be structured in a manner where the above described effort can be considered Phase I with the ability to move directly into a Phase II pilot implementation project if MDT so desires.

V. RESEARCH PERIOD (Time to complete research project.): Depending on the final scope, 12 months after award of the contract. Assuming an October 1, 2017 NTP, Stage 1 will be complete by March 15, 2017. If MDT approves the project to move to Stage 2, the final deliverables will be turned in on September 30, 2018.

VI. IT COMPONENT: Identify if the project includes an IT component (purchasing of IT hardware, development of databases, acquisition of existing applications, etc.). If so, describe IT component in as much detail as possible.
There will be no IT components as part of the synthesis.

VII. FEASIBILITY, PROBABILITY OF SUCCESS, AND RISK: The fact that this is a synthesis of current practice and that the current use of UAVs for a multitude of transportation engineering and construction applications aptly demonstrates the probability of success for this project. The only risk is that statutory changes make take place that further constrain the use of UAVs before MDT can implement the most promising applications of this technology.

VIII. URGENCY, IMPORTANCE, AND EXPECTED BENEFITS/PAY-OFF: Address urgency, timeliness, and importance of the research. Identify if the research is required for any federal or state initiative or compliance. This section must include a description of how this research will help to meet MDT's mission (i.e., serve the public by providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality and/or sensitivity to the environment).
The overarching benefit of implementing UAV technology is the significant savings possible in the number of human resources required by MDT to complete land surveying, asset management data collection, and construction engineering tasks. MDT is under pressure to reduce the size of its workforce and will probably not see the possibility of increasing the professional workforce for the foreseeable future. The condition of MDT transportation assets are such that the department will have to get more production out of its current personnel and monetary resources. UAVs are a workforce multiplier. For specific tasks, a UAVs can supplement MDT survey crews in the field, increasing the area of coverage while decreasing the time spent on site. The UAV can deploy to locations that are inherently unsafe to reach by a human being to conduct tasks like bridge inspections and can generally perform asset condition data collection tasks without the need to disrupt traffic or establish traffic control. The UAVs ability to access areas that are difficult to enter in the winter or because of natural obstacles like landslides or washed out culverts will provide MDT with the ability to reduce its emergency response time as well as the hazards to MDT maintenance personnel who do the responding. When coupled with state-of-the-art data acquisition and processing software, the result will be a significant increase in MDT's ability to perform data-driven tasks across a given project's life cycle from concept through maintenance and renewal.

IX. IMPLEMENTABILITY, IMPLEMENTATION PLAN, AND RESPONSIBILITY: Address the implementability of the expected results from the proposed project. Identify products that will enhance implementation. Identify any known implementation barriers and how these barriers might be eliminated or reduced. Identify MDT office or entity outside of MDT responsible for implementation. Describe initial implementation plan, include timeframe for implementation.
The above proposal is for a synthesis. Therefore, the implementation will consist of MDT determining which aspects of the UAV technology are good candidates to adopt. Once those areas are selected, it is recommended that pilot studies be configured for each specific area and a rigorous field testing plan be developed to validate the costs and benefits of general implementation. For example, if UAV's ability to conduct topographic surveys is selected, several recent areas that have been surveyed using conventional means would be identified and the UAV would then survey the same area. Upon completion the time, resources, costs, and accuracy of the UAV could be directly compared with the conventional survey to determine if the benefits exceeded the costs. For each area that is chosen for full implementation after the pilot study, the research team would then develop the draft specifications, contract clauses, and operational guidelines necessary to properly employ the technology across the state. Additionally, guided on-line or in-person training would be created to sustain the knowledge needed to effectively employ UAVs in future years.

X. MDT PRIORITY FOCUS AREAS: MDT may, as often as annually, identify priority research focus areas. These focus areas will be listed on http://www.mdt.mt.gov/research/unique/solicit.shtml. None

XI. TOTAL COST ESTIMATE (If the project proposal comes in at a higher cost, it may require further approval and may be delayed.): Stage 1 = $57,000; Stage 2 = $85,000; Total $142,000

XII. MDT FUNDING SOURCE (If MDT Research, enter SPR): SPR

XIII. FUNDING MATCH SOURCE AND AMOUNT: It may be possible to obtain in-kind support for the proposed Stage2 UAV demonstrations from SkySlate, LLC. who will be a member of the research team. ~$30,000.

XIV. FUNDING PARTNER(S): Potentially, SkySlate LLC

XV. POTENTIAL TECHNICAL PANEL MEMBERS (At this time, individuals do not necessarily need to be identified; rather, MDT offices and outside entities can be named. However, if known, individuals may be named): The following offices should be represented: aviation, planning, design, construction, maintenance, and asset management.

XVI. SUBMITTED BY:

NAME: Douglas D. Gransberg, PhD. PE NOTE: Dr. Dominique Pittenger will be the OU PI.
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XVII. CHAMPION: Must be internal to MDT, feel strongly that the research will benefit the Department, and is willing to chair the technical panel. Note: If a champion is not identified by you or Research staff, this topic statement will not move forward.

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XVIII. SPONSOR(S) (optional): Must be internal to MDT (Division Administrator or higher) and willing to ensure implementation occurs, as appropriate. If a sponsor is not identified, this topic statement will not move forward.

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