How Flying Keeps You Safely Grounded in Today's Steel Industry

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.

Authors

Bruce Perkins (top row, left)
plant reliability manager,
Stelco, Hamilton, Ont., Canada

Joanne Zaraliakos (top row, right)
safety and industrial hygiene
supervisor, Stelco, Hamilton, Ont.,
Canada

Peter Hole (bottom row)
manager, safety and industrial
hygiene, Stelco, Hamilton, Ont.,
Canada

The leading causes of injury and death in the steel industry are falls and mobile equipment incidents. Despite our best efforts to train and equip our employees, there are still fatalities in our industry. Safety professionals utilize the hierarchy of controls to address hazards when doing risk assessments. Elimination is the most effective way to control hazards. An unmanned aerial vehicle (UAV) (Fig. 1), also known as a drone, can be utilized to eliminate the requirement for employees to work at heights to perform structural inspections. In addition, a UAV can eliminate the use of mobile equipment to perform the inspections and potentially simplify or eliminate any required equipment isolations and lockouts.

Advancement in the steel industry is an absolute necessity. If there had never been any advances in technology, where would we be? If someone said, "That's not how we do it here" or "It can't be done that way," what a different world we would live in today. With this in mind, we embarked on our journey at Stelco (formerly U. S. Steel Canada Inc.) to investigate how we could use this new technology to eliminate potentially dangerous circumstances during risky inspections and to take the human safety element out of the equation.

Getting Started

At first, using a UAV to perform inspections seemed like a simple task. However, the more we researched the idea the more complicated it became. There were numerous factors that had to be taken into consideration, including equipment design, accessories, regulatory and insurance requirements, training, and employee concerns. In addition, management requested that a business case be developed to show that any money spent would be recouped through savings by not using equipment such as manlifts, which are traditionally used to perform the inspections. The following section details some of the factors Stelco identified that any facility should consider when investing in a UAV.

Considerations

Equipment Design and Cost:

- Determining the type of UAV (i.e., four propellers, six propellers, eight propellers, etc.) and guidance system.
- The size of the UAV, which can range from a couple of ounces (grams) to several pounds (kilograms).
- The cost (prices range from a couple of hundred dollars up to CAD100,000). Your facility will need to know the intended use of the UAV and its required return on investment.

Figure 1

Unmanned aerial vehicle (UAV).

- The payload the UAV is capable of carrying (this will determine what type of camera you will be able to attach to the UAV).
- Assessing different manufacturers and the level of technical support available.
- Determining preference for out-of-the-box, "ready to fly" models vs. custom building a UAV.

Accessories:

- Camera requirements (e.g., the ability to take still pictures, video, high resolution, thermographic, etc.).
- Lighting fixtures.
- Computer software (used to calculate raw material inventories).
- Spare batteries (based on flight length expectations).

Other:

- Develop a system to monitor weather reports for the area in which the UAV will fly.
- Consider all possible end uses. This will change as your facility discovers other applications, so do not get fixed on an expensive unit that will be restrictive later on.
- Is the UAV technology limited or upgradable? Your unit will likely be outdated within a year.
- Development of the level of expertise required to fly the UAV.
- Legal and regulatory compliance issues.
- Awareness of location and distance to airports, helipads, etc.
- Need for additional apps or software required to operate the UAV.

None of the above issues were considered insurmountable at Stelco, but in order to validate moving ahead with the project, it was broken down into two categories of "Pros" and "Cons" (Table 1).

Getting Started With the Special Flight Operating Certificate

Canadian regulations dictate that in order to fly a UAV in Canada for something other than recreational purposes, one must first apply for, and receive, a Special Flight Operating Certificate (SFOC) through Transport Canada. The application process consists of several pages of in-depth information on the applicant and the plans for flying the UAV. The type of application to apply for is defined by what one needs to do with the UAV, while the length of time applied for is an individual choice. There are also specific categories for which to apply. For the purposes of Stelco's application, we determined it was most appropriate to apply under the following categories:

Table 1

Pros and Cons of Investing in an Unmanned Aerial Vehicle (UAV)

Pros	Cons
Eliminates personnel working at heights	UAV becomes outdated within one year
Minimize contractor costs	Weather and ambient conditions are always a factor
Minimal equipment rentals	Learning curve for pilot
Minimal setup time	Potential union and employee concerns
No lockout required for most inspections	Regulatory requirements to overcome

- Simplified (small UAVs under 2 kg).
- Restricted (obligations to Transport Canada for every flight).
- Standing (good for 3 to 5 years).

After several conversations and resubmissions to Transport Canada, we were granted an SFOC.

Stelco UAV Flight Requirements

After the SFOC was granted, we proceeded to establish procedures in consultation with the union to ensure safe operation of a UAV:

- The UAV can only be operated by an individual who is in possession of a valid SFOC.
- Each flight is a two-person operation.
- The pilot must have a clear line of sight while the UAV is airborne.
- The ground supervisor is responsible for making sure the pilot has a safe area to walk while operating the UAV (i.e., while the pilot is looking up).
- The ground supervisor views the monitor that displays what the camera is seeing and has the ability to record still photos or video.
- Prior to the launch, a site survey is conducted by both the pilot and ground supervisor.
- A UAV Awareness Contact is sent out prior to each flight to notify employees in the flight area of the intended purpose and flight plan of the drone.

Figure 2

A UAV was used to inspect pilot burner piping connections on the flare stack of a byproduct plant at Stelco.

Setting Up Training

In order to train our pilots and allow them to practice, we sought out an area that was secluded and fenced off from the rest of the plant. To prepare our pilots, we essentially set up an obstacle course. The trainees were required to navigate the UAV through a series of pre-determined patterns, at a pre-described height, in a fixed time period. One of the more difficult maneuvers that the trainee was required to perform involved keeping the camera focused on a spot as the UAV made a 90° turn. To perform this maneuver, the front of the UAV has to be rotated to keep the camera focused on the same target. Successful performance of the tasks was required to become a qualified and proficient UAV operator. Although this was a great learning experience, it was still not a substitute for the real thing. Our first inspection was successfully executed in 2015 on an empty abandoned building located in a secluded area.

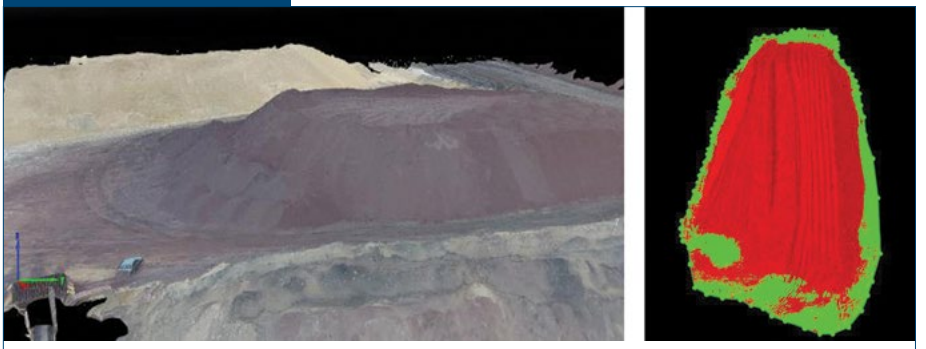
Implementation of the Inspection Process

Initially, the main focus of using the UAV was to reduce the cost of performing structural inspections by allowing us to eliminate the rental of a manlift or a crane equipped with a basket to perform the inspections. After the completion of a couple of inspections, the safety benefits as well as the financial returns became apparent. All of the inspections were taking place from the ground level; there was no interference with the processes being inspected, no workers on manlifts or placed in baskets, no lockouts needed and the UAV could get around to the back of some of the stacks that were previously inaccessible.

Once it became known that the UAV was available for inspections, we received a request to inspect the pilot burner piping connections on the flare stack in one of our byproduct plants (Fig. 2). The previous inspection had cost almost CAD30,000 (including the cost of renting a 250-ton crane with a man-basket). To put an employee on the stack or in a basket is quite an extensive process; roads have to be blocked off, the ground has to be level for the crane, etc. Isolation of the flare stack also required precise planning and coordination with all of the departments that use coke oven gas throughout the plant. With the flare stack off-line, operations are forced to consume all of the gas that is produced. Without the option of flaring any excess gas, there is the risk of backing up the raw gas and flaring it at the coke oven battery bleeder stacks. This is not a desirable option due to the environmental impact and possible safety implications.

The isolation of the stack from the rest of the process typically takes anywhere from 2 to 4 hours if all goes well. Our inspection of this

Figure 3



(a) (b)

Iron ore fine inventories surveyed by UAV.

Figure 4

A UAV was able to survey storage capabilities in Stelco's on-site quarry.

stack utilizing the UAV took approximately 20 minutes to complete. It was performed without interruption to the process and with no lost revenue for downtime, no manpower working at heights, and no expensive third-party inspection or equipment rental costs.

Upon review of the photos taken during the inspection, the manager of the facility stated that the photos were fantastic, but he would have liked more detailed pictures of the connections. Upon receiving the inquiry, another flight was immediately performed with the UAV and the manager had the detailed pictures he requested in his hands within an hour.

Raw Material Inventories

In the latter part of 2015, the use of the UAV was expanded to include the calculation of Stelco's raw material inventories. In the past, we used a third party to come in and perform laser surveys to determine the quantities of raw materials in each of our stockpiles (Fig. 3). After purchasing some software and formulating a plan, we started to perform some surveys using the UAV. We are currently in the midst of proving the concept to management, but so far the results look extremely favorable. If accepted, this will result in further savings on a monthly basis through the elimination of the contract services that currently perform the surveys. Recently, we were also able to assist the environmental department by calculating the remaining volume of storage space available in some of our on-site quarries and landfills (Fig. 4).

Future

In early 2016, Stelco took delivery of a thermal imaging camera that can be mounted onto the UAV. Although this program has yet to evolve, the expectation is that we will be conducting inspections in hard-to-access areas (again, typically requiring manlifts or cranes with baskets) as well as inspecting the high-voltage towers on-site. These inspections have been conducted in the past with the use of optical aids from a distance. For the safety of our employees, putting a person(s) in a manlift or in a basket near or under high-voltage lines is not an option. The use of the UAV allows us to focus in on the connections with far more clarity and from different angles. The entire time the pilot is operating the UAV from the ground and out of harm's way. The capabilities of thermal imaging on the UAV will further enhance the inspections.

Conclusion

The UAV program at Stelco has evolved significantly over its lifetime. Inspections completed range from stacks, buildings and conveyor gantries to an overhead door gearbox, just to name a few. To date, we have logged more than 600 flights. The safety benefits and cost savings of our UAV program are undeniable. Although it may still require equipment to reach areas to facilitate repairs, the number of repairs required relative to the inspections conducted is usually minimal. As technology continues to evolve and engineering becomes more advanced, we will be putting our workers at less risk when we open our minds to change.

Acknowledgment

The authors would like to thank Stelco management for allowing us to pursue the UAV program along with John Slaught, technical resource – byproducts operations, and Gregg James, technical resource and UAV SOFC holder, for their contributions. ✦