Magdalena Ridge Observatory: the Start-up of a New Observatory

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ABSTRACT

This paper discusses the challenges faced in designing and building a new astronomical observatory. Which factors drive an organization (e.g. university) to invest considerable funding and human resources, and experience considerable risk to establish a new research facility?

We identify four main drivers for establishing a new observatory: support for education, research, economic development, and technology development. For public observatories, research is generally the main driver. For non-public observatories, the situation is more complex and is for each situation different.

A detailed description is presented on the drivers and opportunities that resulted in establishing the Magdalena Ridge Observatory. Three main opportunities are identified: a developed site, surplus equipment, and economic development of the Socorro area.

Keywords: observatories, education, research, economic development, technology development, Magdalena Ridge Observatory

1 INTRODUCTION

New telescopes and observatories are continuously under development, and in most cases they are added to an already existing observatory or are managed by an entity that has organizational experience in managing an observatory. It is rather rare for an organization to build an observatory without that organizational legacy in place. The latter is the case for the design, construction and operations of the Magdalena Ridge Observatory (MRO) by New Mexico Tech (NMT) in Socorro [1, 2 3]. This paper attempts to identify the main drivers to establish a new observatory, and for MRO in particular.

A distinction is made between observatories that are managed and funded through a national agency (public observatories), and those that are not. The second category will be referred to as “restricted access observatories”. Since both these terms are rather broad concepts, this paper limits itself to observatories, which host telescopes that have optical or infrared capabilities, and are ground-based, and serve a professional, as opposed to amateur, astronomer base.

The distinction between “restricted access observatories” and public observatories is not fully transparent. The most obvious distinction whether the observatory aims to provide open access, or whether there is some kind of restriction to access based on the proposer’s e.g. affiliation or the kind of science proposed. A mix between open access and restricted access observatories is also possible if a national facility is part of the consortium that operates the observatory.

What drives an organization (e.g. university, corporation, philanthropist) to invest considerable funding, human resources, and to experience considerable risk in establishing a new research facility? Public facilities are open to anybody who is able to write and submit a competitive observing proposal. Why does “open access” to public facilities not fill the need for a fraction of the astronomy user-base? The answer to this question lies in the drivers to establish a new observatory and the associated stakeholder’s interest.

In Section 2, we will discuss the main categories of drivers active in establishing an observatory. In Section 3, we focused on the Magdalena Ridge Observatory. Section 4 gives an overview of our main conclusions.

2 DRIVERS TO START AN OBSERVATORY

The use of a telescope is best known for its application to astronomical science. The functionality is to collect and focus the light of an e.g. a star or a galaxy, in order to study the universe. There are however other applications of that same instrument, being a telescope, which lead to different requirements on its capabilities (technical capabilities, operational modes, etc.). For a main-stream astronomer, these other drivers may not be that obvious as they are outside their field of expertise. However, if these drivers are properly identified and exploited, they can be a major asset to establishing a new research facility.

In this section we identify four main categories of drivers to establish an observatory (Fig 1). For a few of these, we identify subcategories. This list is not complete as e.g. amateur astronomers are not included. This paper limits itself to professional applications.

2.1 Education

This research driver has two subcategories. One is related to education of students. The second is related to education of the general public.

Curriculum: to serve a student base and perform astronomical observations as part of a curriculum. The main goal is to familiarize students with the use and capabilities of sophisticated scientific instruments. This is the main driver for the majority of small telescopes hosted by a university or college. The requirements to provide an educational experience, within the available budget, define the instrument capabilities.

Outreach: astronomy is traditionally very active in educating the general public about our knowledge of the universe. This is referred to as outreach. This ranges from tours of facilities, star parties to

2.2 Research

The research driver has two subcategories. One is related to conducting new science. The second is to obtain data for monitoring.

Astronomy: to obtain observational data and allow groundbreaking science by professional astronomers. Requirements on the observatory are set by the science goals. In general, this means better telescopes than the once currently available. Efficient and reliable operations are mandatory.

Space situational awareness: use of the facility to perform research for military or security applications. In the US Department of Defense (DOD), this is referred to as Space Situational Awareness and refers to the techniques employed for the surveillance of space either from space or ground. The most common application is the imaging of man-man satellites, rockets, near Earth objects (e.g. asteroids), and other potential hazardous objects. The goal is not to increase our scientific knowledge and research the frontiers of science unless it directly impacts public safety. The goal is to obtain observations of selected objects. The requirements are slightly different than for scientific applications in such that the kind of objects to observe are well identified and therefore the telescope capabilities are more tailored to a specific application. The technology demands for this application can be very high and could require new technology development.

2.3 Economic developments

Economic developments are activities to increase the (local) economical situation. Enhance competitive advantage of other local economic activities through synergy at a wide range of levels. This is unlikely to be the main driver for a public observatory. In many cases, once the plan has been conceived for an observatory, economic interest becomes part of the solution. Involvement of industrial parties, geographical location of the observatory, etc. directly leads to economic developments.

2.4 Technology development

Goal is to develop technology that can be applied in future projects, commercialized or patented. Examples are observatories or telescopes, which have been specifically designed and built to demonstrate a technology, or serve as a prototype for more ambitious future projects.

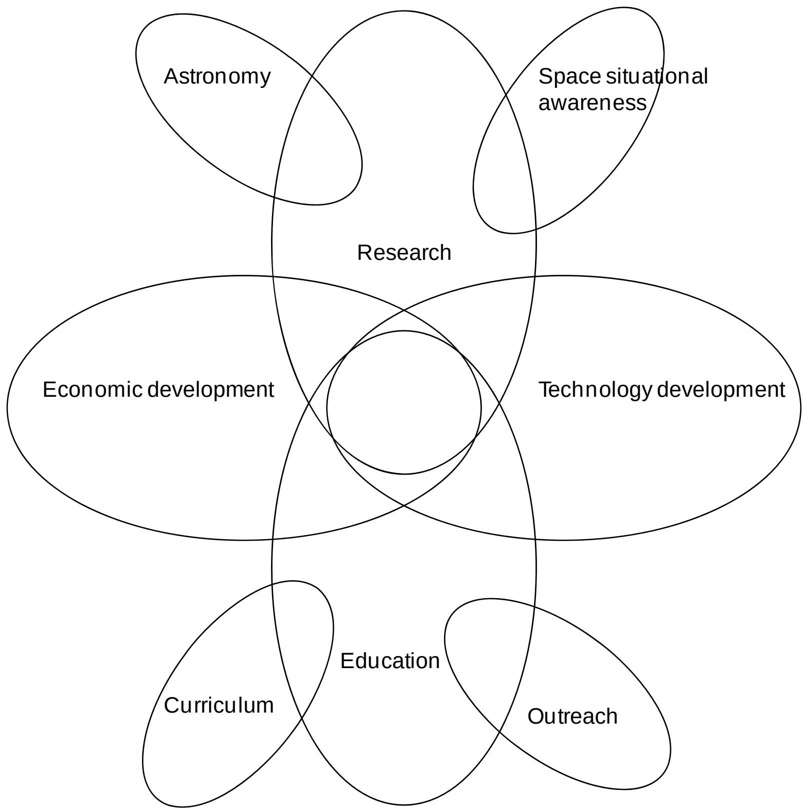

Fig. 1. A graphical presentation of the four main categories of drivers to establish an observatory.

2.5 Public versus "restricted access" observatories

The drivers for "restricted access" observatories can be any of those listed above, and in most cases, it is a mix between a few of them. The driver for a public observatory is most likely primarily the "science case". It all starts with a strong science case, supported by a large group of professional astronomers. Technology development and economic development will naturally be added to the science case to make the "full proposal" stronger and to form a large basis of stakeholders. The inclusion of the "non-research" drivers allows pursuing activities which would not be possible for a public observatory. These are either high-risk activities for which a strong and broad user-base cannot be generated, or a proposal which is not very popular under main-stream astronomers. In both cases, if successful in its execution, the new research facility can have a positive impact on science and exceeds expectations.

3 MAGDALENA RIDGE OBSERVATORY

In the previous section we presented a general review of "drivers for observatory development". This overview is based largely on experience gained in the design and construction of the Magdalena Ridge Observatory (MRO) as managed by the New Mexico Institute of Mining & Technology, aka New Mexico Tech (NMT). This section elaborates on some of the details of the MRO experience as it relates to the thesis of this paper [1, 2, 3].

MRO became a reality because a few key stakeholders saw the opportunity to work together in their common interests to achieve a goal that could not otherwise be realized. Three key opportunities that made the MRO project possible are:

1. The availability of a developed site and basic infrastructure;
2. The donation of surplus equipment from the US Air Force Research Laboratory (AFRL), Directed Energy Directorate based at nearby Kirtland Air Force Base in Albuquerque, NM;
3. Funding made available through the Naval Research Laboratory (NRL) with the support of the New Mexico Congressional Delegation.

Each of these three "opportunities" will be described in turn, leading to a final discussion of their combined impact.

3.1 Developed site: Langmuir Research Site

MRO is located atop Magdalena Ridge, a high-elevation (10.400 - 10,800 feet) mountain ridge situated within the Cibola National Forest district of the Magdalena Mountains, about 15 miles west of Socorro, New Mexico, just east of the site of the Very Large Array (VLA). The initial development of this site for research began in 1963 with Dr. E.J. Workman conducting various scientific measurements in support of an atmospheric research program. The road to the ridge top was completed in 1963 and the first building was also completed in 1963 (the Langmuir Research Facility) with funding provided by the National Science Foundation and the Office of Naval Research (Fig. 2). Over time, the research activities expanded to include astronomy with the construction in 1973 of the Joint Observatory for Cometary Research (JOCR) (Fig. 3). This facility consisted of a twin domed building equipped with both a 35 cm (14 inch) F/2 flat field Schmidt camera and a 40 cm (16 inch) F/35 Cassegrain telescope. JOCR was a collaboration between NASA/Goddard and NMT built for the purpose of studying the perihelion passage of Halley's Comet on February 9, 1986. Later in 1974 the "Supernova Telescope" designed and built by Dr. S.A. Colgate with support from NASA was completed (Fig. 4). This was a 75 cm (30 inch) telescope.

Both of these facilities, JOCR and the Supernova Telescope, were developed by independent principal investigators without the participation of organizations dedicated to their support. These facilities have been taking data since 1963 providing a detailed data set on historical atmospheric conditions for the site [4]. The results showed that the area has many clear nights, good seeing, and low humidity. The proximity to Socorro allowed for easy access. On December 19, 1980, the 96th US congress established the Langmuir Research Site through Public Law 96-550, 94 Stat 3221. An environmental impact study (EIS) was completed in December 2003, which allowed for continued development of the site for atmospheric and astronomical research.

Conclusion: the availability of a developed site with long-term information about weather conditions and in close proximity to a research institute proved to be one of the key aspects for MRO to be initiated (Fig. 2, 3 and 4).

Fig. 2. The Langmuir Research Laboratory built in 1963.

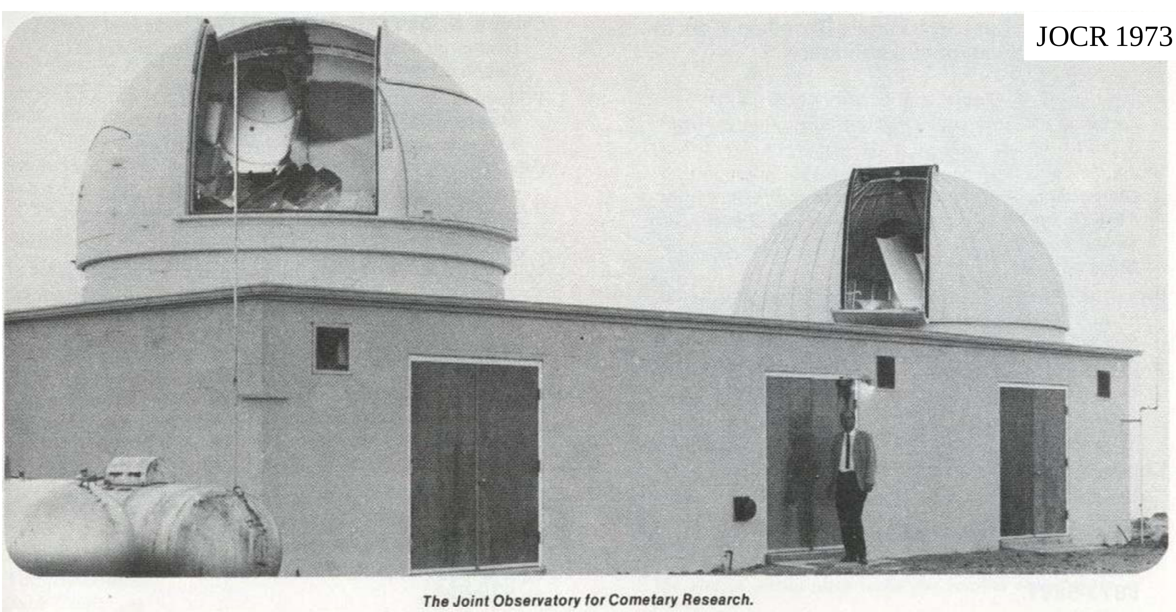

Fig. 3. The JOCR facility built in 1973.

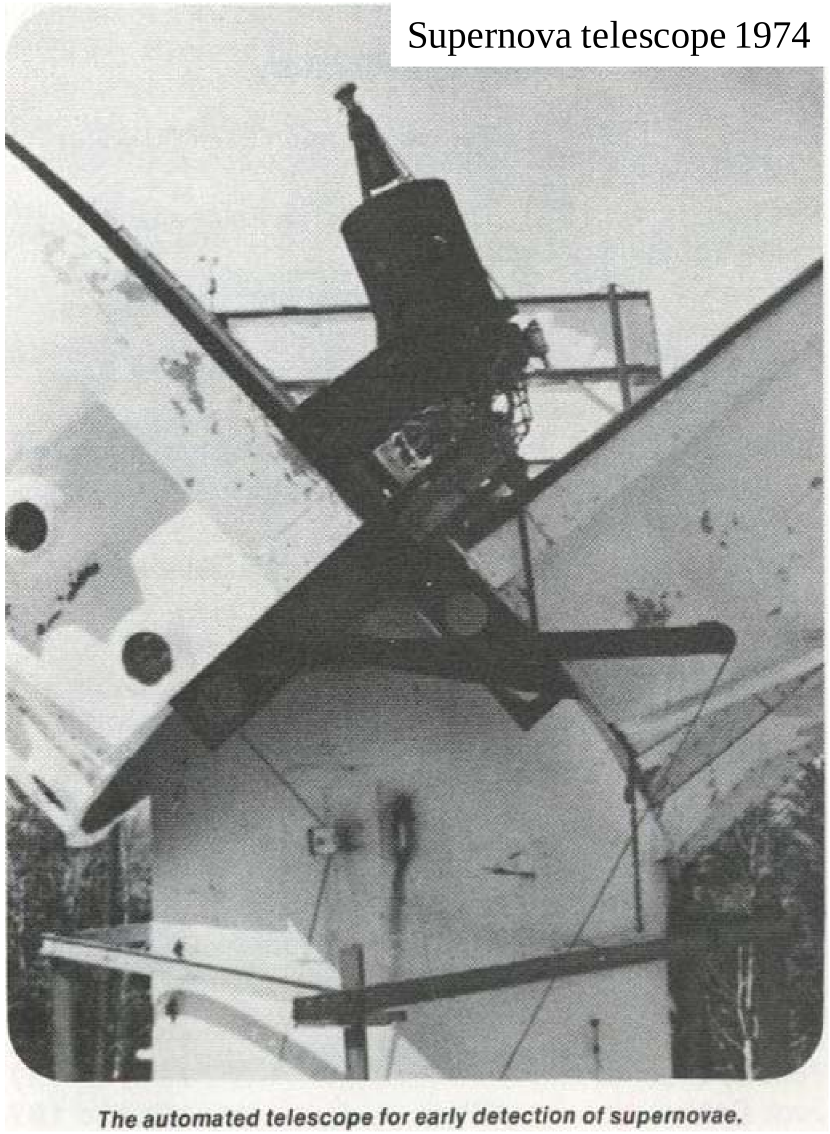

Fig. 4. The Supernova Telescope built in 1974.

3.2 Surplus equipment: 2.4m zero-gravity mirror

In the 1970s several classified research projects in the US developed zero-gravity mirrors for space based applications. Among these was a 2.4meter (7.9-foot) mirror developed by ITEK Corp. of Lexington, MA (Fig. 5). This mirror was never launched into space and was later found to be in storage at the PERKIN ELMER facility in Danbury, CT. At that point in time the AFRL was the legal owner of the mirror and was paying a monthly fee to PERKIN ELMER for its storage there. Since there was no planned use for the mirror, AFRL was interested in the possibility of other possible uses or users for it. At the same time the Terminal High Altitude Area Defense (THAAD) strategic missile was being tested at White Sands Missile Range (WSMR) in south central New Mexico. WSMR, a missile test range, was established in 1933 and covers 225 square miles (583 square km). Missile launches could be tracked and imaged over the south end of WSMR missiles using a 3.5m telescope at Apache Point Observatory (Sunspot, NM) but there was no corresponding capability over the northern part of WSMR. The idea evolved to build a telescope using the surplus mirror and to locate the telescope at the nearby Langmuir Research site in the Magdalena Mts. west of Socorro, NM. This location had earlier been set aside for research by the US Congress and was under the operational control of NMT. The agreement to be struck was to operate the telescope in support of WSMR needs when required (mostly during the day) and in support of NMT education and research needs at other times (mostly during the night). A telephone discussion took place on October 4, 1995, followed by a meeting in Socorro on October 5, 1995 between NMT (Prof. D. Westpfahl) and D. Newton (Army Space and Missile Defense Command, SMDC) as to whether such a telescope could be located on the Langmuir Research site based upon such a multiple user premise. NMT was receptive to the idea and the MRO concept was born. The official start date of MRO is October 5, 1995. Over the years, NMT has received many donations of surplus equipment from AFRL and NRL. This surplus equipment proved to be a very significant contribution to the development of the MRO.

Conclusion: the donation of the 2.4m mirror together with surplus equipment donations initiated the MRO project. Without these contributions the MRO project would not have been initiated.

Fig.5. the MRO 2.4m zero gravity mirror [3] (unknown source).

3.3 Economic development: congressional funding

Initial funding to MRO started in 1998 by the US army. In August 2001 the Magdalena Ridge Observatory Consortium (MROC) submitted a proposal to establish the MRO in response to Broad Agency Announcement 158 issued by the Remote Sensing Division of NRL. This led finally to a cooperative agreement between NMT and NRL (signed on September 19, 2001) to begin this endeavor as a partnership. Additional funding was made available through the issuance of a special budgetary “earmark” enabled by the NM Congressional delegation, identifying this project by name in the Federal Budget. “Earmark” projects are those which US Congressmen believe are very important for their districts but are not selected through a peer review process. To provide economic development for New Mexico, Congressman Joe Skeen, who represented the Second District of New Mexico at the time, designated the MRO project as such an earmark funded project. After the retirement of Mr. Skeen, Senator Domenici continued the support. This earmark project was first approved by Congress and inserted in the NRL budget in 2001. Since then, MRO has been supported by yearly appropriations by Congress.

Conclusion: the funding opportunity offered by the Navy Broad Agency Announcement 158 together with the support of NM Representative Skeen and Senator Domenici made the MRO project possible.

3.4 Criteria for success

The success of the Magdalena Ridge Observatory will be measured using multiple criteria, which are all derived one way or the other from the original drivers to establish the observatory. The criteria for success area:

1. Increased notoriety of New Mexico Tech (largely by word of mouth);
2. Discussion of and reference to New Mexico Tech by the press;
3. Increase in research and research funding;
4. Increase of papers and articles from New Mexico Tech/Magdalena Ridge Observatory;
5. Increase of enrollment of students at New Mexico Tech.

The first two serve the goal to bring New Mexico Tech to the next level of recognition. This will lead to enhanced economic activities in the Socorro area. Number three and four are related to the research driver, and number five to education.

3.5 Discussion

The driver to establish the MRO builds upon a long history of research area conducted at the Langmuir Research site. Small telescopes dedicated to education and research have been located on and in use at this mountain top site for many decades. The incentive to establish the much larger MRO facility on the Langmuir Research Area came with the offer to use a surplus 2.4m mirror from AFRL. The next major incentive came from an earmark by the New Mexico Congressional delegation (Rep. Skeen and Sen. Domenici) in the NRL budget to provide the required funding. These three opportunities: developed site, surplus equipment, and the earmark led to the establishment of the MRO.

In this case, the observatory was not initiated to pursue a very specific science case but rather in response to a mix of the drivers discussed in Section 2. The final result is that the observatory will support WSMR missile tracking requirements, provide the scientific community with an advanced research facility, and lead to economic development in the Socorro, NM area. The high-risk area for the MRO observatory will be fulfilling the technical and operational requirements necessary to support reliable operations for the next 20 years. At the time of writing this paper, June 2008, the 2.4m telescope (Fig. 6) will commence operations on July, 1, 2008, and the interferometer (Fig. 7) is in the final design phases with a completed constructed building.

The impact on the economic development of the MRO in the Socorro area is at this point difficult to quantify. We conducted an interesting exercise to estimate which fraction of the funds invested in MRO is actually spent within the Socorro area. We used the number of staff living in this area and the material purchases from local firms to estimate that 20% of the funding of MRO is locally spent. This includes assuming that staff (total MRO staff is about 30, half of them living in the Socorro area), spent on the average 50% of their salary in the local economy.

Fig.6: the MRO single dish telescope (note the view of the VLA on the horizon).

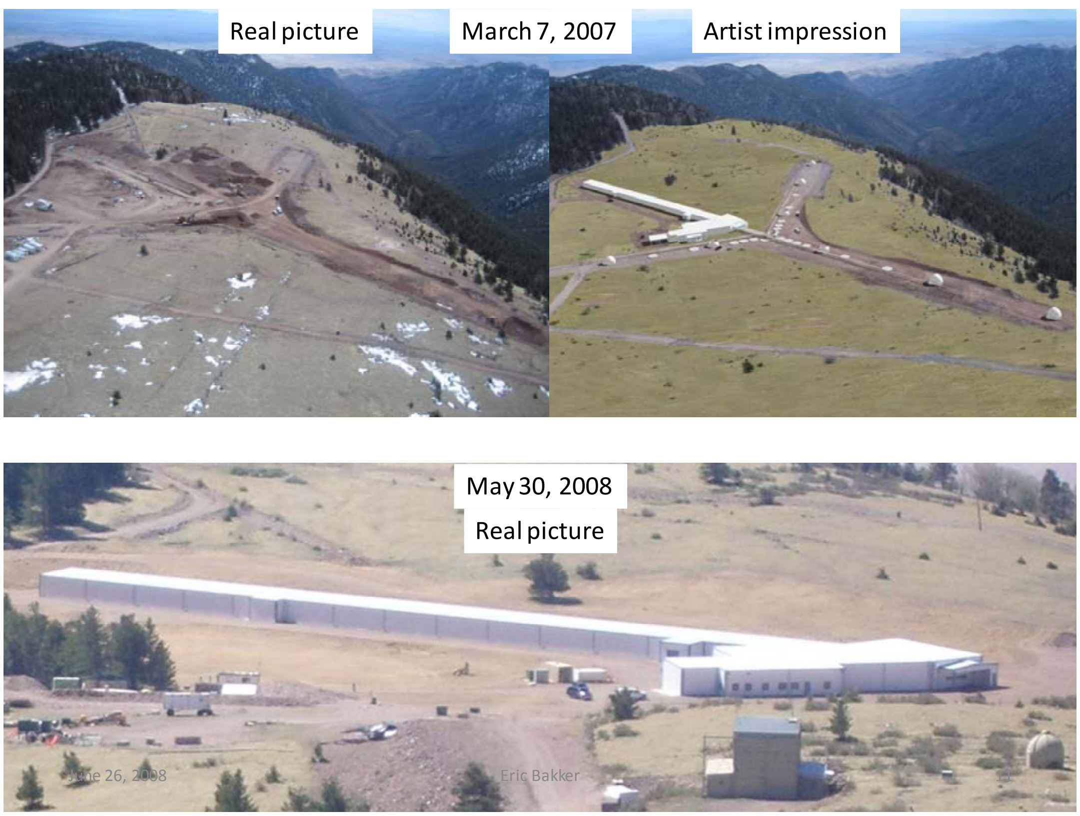

Fig.7: the MRO optical interferometer at two different times (March 2007, and May 2008).

4 CONCLUSIONS

We have explored drivers and opportunities which play a role in establishing the Magdalena Ridge Observatory and presented a generalized version of this.

The conclusion that is drawn from the analysis is that the construction of scientific research infrastructure is not only driven by noble science goals. There are other drivers, which have a considerable impact. For science and technology to mature and have a prosperous future, it can be beneficial to take advantage of these drivers.

A brief overview of the three key opportunities that allowed the Magdalena Ridge Observatory to be started-up shows that these opportunities have emerged over time and are the result of more than 60 years of history of New Mexico Tech with astronomical research. Cleary the MRO project is large and very ambitious for an organization like New Mexico Tech, but it demonstrated that with the right entrepreneurial attitude, and building on the opportunities provided by others, large-scale projects can be undertaking to improve the research infrastructure of the nation.

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