Review of the WIYN Observatory

1 Overview

The WIYN Consortium has requested an evaluation of the effectiveness of its investment in the WIYN Observatory in advancing its goals for support of astronomical research and education.

The review committee finds that in the five years since first light the WIYN Observatory has become a productive forefront astronomical facility. The value of a 3.5 meter facility will not be diminished as the Gemini and other larger telescopes come on line.

The Committee was pleased to find that the WIYN Observatory and the WIYN Consortium are producing forefront scientific results, and that the collaboration is working well.

Particular highlights include:

- the telescope delivers the best images over a wide field of view of any continental US facility.
- operations have already achieved an outstanding level of reliability and efficiency.
- the project has had a major impact on the research opportunities available to member universities, involving a broad base of faculty and providing important career development paths for younger faculty and postdocs.
- the number of Ph.D. dissertations is especially impressive, and the number of publications is in line with any facility at this early stage of operations. For the astronomy departments of the universities of Wisconsin, Indiana and of Yale University the WIYN Observatory has become the largest source of experimental data for doctoral theses.
- the project has served NOAO's interests in 1) providing a proving ground for technological innovations necessary for Gemini development; 2) enabling access to wide-field spectroscopy for the US astronomical community; 3) bringing substantial new aperture online very cost-effectively; and 4) demonstrating the intrinsic quality of site conditions at Kitt Peak.
- the spirit of institutional cooperation is high, excellent support staff have been hired, and resources have been managed prudently, all of which enables a good foundation for further development.

These aspects position WIYN to make significant contributions in the future. To ensure that opportunity, a number of challenges must be confronted, among which are:

- identifying resources (funds and people) for new instrumentation and major upgrades on an on-going basis.
- establishing a path to undertake major new projects (e.g. the construction of new instruments) in a timely way and with efficient use of resources.
- enhancement of instrument-development capabilities at the universities.

- involvement of more university academic staff.
- constraints related to NOAO's separate objectives (e.g. competition for NOAO resources; mountaintop operations and interfaces; obligations to the US community).
- meeting educational goals at the undergraduate level in a way that mutually supports the research effort.
- formulating an aggressive path for future scientific and educational opportunities.
- recovering from staff turn-over.

2 Process

The review committee was

Dr. Craig Foltz	Director, MMT Observatory, University of Arizona and the Smithsonian Institution
Dr. Richard Kron	Director, Yerkes Observatory University of Chicago
Dr. Jeremy Mould	Director, Research School of Astronomy & Astrophysics Australian National University

a. The charge for the 5 year review was written by the WIYN Board.

b. A Self appraisal was carried out by the WIYN Science Advisory Committee.

c. The Review Committee met with

Dr. Jay Gallagher	University of Wisconsin
Dr. Linda Sparke	University of Wisconsin
Dr. Jeffrey Kenney	Yale University
Dr. Abi Saha	NOAO
Dr. David Sawyer	WIYN Operations Manager
Dr. Richard Green	Director, Kitt Peak National Observatory

and others at NOAO on April 17 and 18 2000.

d. The Review Committee visited the Observatory & witnessed the start of observing on 4/17.

e. The review documents included the WIYN Observatory Reference Documents.

f. NOAO users' committee input was also made available to the Chairman.

3 Assessment of system performance & operational issues

The partners' goals included

- ready access to a large telescope
- opportunities to mount visitor instruments
- feasibility of large observational projects
- improved graduate training opportunities
- a step forward in performance versus cost and operational mode of significance to the national observatory

3.1 Scientific strengths

The most outstanding achievement of WIYN is its Delivered Image Quality but it has also performed well in the following areas

- **Temporal phenomena**: WIYN is more accessible than the Mayall telescope.
- **Stellar populations**: WIYN's capabilities complement HST.
- **Galaxies** An integral field unit has been deployed, and reconfigurability is an advantage.
- **University instrumentation** e.g. polarimetry.
- **Involvement** of theorists and radioastronomers.
- **Graduate training**.

3.2 Operational quality and efficiency

WIYN's lost time statistics are as good as anyone's. The site engineer has helped achieve the high quality, and the budget permits further progress A satisfactory compromise between dedicated and KPNO pooled support staff has been developed. It will be important to maintain this in spite of the Operations Manager leaving.

3.3 Safety

The reference documents included the 1996 Report of the safety committee. We were assured that there were no open issues. An NOAO safety officer is now on board.

3.4 What limits the operation ?

- post focal plane hardware inefficiencies
- controller efficiency
- spectrograph efficiency

3.5 Opportunities

The **new Director** when recruited will be a major influence on achieving the scientific agenda

The development of **remote observing** has been impeded by low bandwidth, insufficient information e.g. no cloud camera, and insufficient staff to develop this mode. The committee recommends study of the ARC operations

Queue observing NOAO decided to abandon the queue based on user committee input. NOAO should review this decision from a strategic standpoint. Partner contributions would assist in operation of the queue. This is one of the areas in which a WIYN Observatory scientific staff would make a major contribution.

3.6 Threats

It is important to avoid trying to do everything for everybody, especially given the limited operating budget. A related danger is cost growth through growth of a multiplicity of observing modes.

4 Management

Strengths

- The management model has developed pragmatically.
- There is an appropriate level of redundancy.

Weaknesses

- No scientific staff (compare the SOAR consortium model)
- More postdocs and students are needed to support the enterprise.

To develop, the WIYN Observatory will need to expand its scientific staff, which is subcritical in size. Membership of the WIYN Observatory staff would be a superb research opportunity for postdoctoral fellows based in the university departments. The challenge is to raise the funds to support these positions, which would benefit Observatory operations and the research output.

The realities of NSF grant limitations are that private funds are essential to leverage NSF support for postdoctoral fellows.

However this is achieved, we reiterate that a strengthened scientific staff would reenable queue operation and aid instrument commissioning. And research fellows or postdocs would increase WIYN's high impact science in a few fields.

Opportunities

The Director can help with

- leadership of the instrumentation program
- fund raising – with the assistance of the Board
- public outreach and education
- backup for the operations manager

In seeking to satisfy the first three criteria, the Search committee should not neglect operational qualifications.

We recommend pursuing the search for a Director. We emphasise that the Director's role in fundraising should be a collaboration with the Board In particular, a partnership between the universities' development offices and the Board members is likely to be most productive, as is the case for Carnegie and Lowell Observatories.

Threats

- A dysfunctional instrument development program.
- At present decision making appears to be cumbersome.

An action-oriented Director will be essential to remove log jams. The process should make full use of available university, job shop and NOAO resources. It will probably be best to maximize the university character of NSF proposals.

We recommend that universities offer teaching buyout to help with instrument development. Guaranteed observing time and flexible university funds can also help in this objective.

In the long term, the informal ledger imbalance of instrumentation contributions needs attention by the Indiana & Yale partners.

5 Instrumentation

5.1 General comments

The review committee commends the WIYN Consortium of the applicabiliy of the current suite of instrumentation to the mission of the telescope. i.e., WIYN is going with its strength: wide

field, good images, fast reaction to changing conditions. The committee recognizes the efforts that have gone into this, particularly given the facility's modest budget and applauds the successes in this area. We strongly encourage the improvement of the instrumentation within WIYN's current niche as well as implementation of new facilities, though we note that the partners must continue to survey the field with an eye to determining new niches into which to expand.

A reasonable schedule for deployment of new facility-class instruments at a rate of approximately one every 2-3 years. Care must be taken that development of new instruments does not impinge on upgrades to existing instruments and vice versa.

The committee recognizes that the WIYN Consortium needs to develop strategies to move quickly on development of new and existing instrumentation. We perceived a difficulty in establishing an "action path," even in cases where consensus had been achieved and funds were available. Along with determining the means to act quickly, the consortium should evaluate its process of establishing consortium-wide instrumentation priorities and acting on them with all due haste.

We also noted the need for support for instrument builders at the Universities. The Universities must foster an environment that is conducive to the development of new instrumentation by faculty members. This is particularly important for instruments of facility class or upgrades to such instruments. At the very least, the University administrations should arrange "release time" from teaching. This time should be accounted on the 'soft balance sheet.'

5.2 Priorities

The following list of priorities are arranged an order that is the consensus of the review committee.

1. The Bench Spectrograph. The instrument is clearly versatile and provides, among other things, the best bright time instrument for the telescope. It is the only wide-field, multi-fiber instrument available to US astronomy in the Northern Hemisphere. Although it will be outpaced by the Hectospec on the converted MMT in 12-18 months, it will remain an important facility for the WIYN partners and the US community as a whole since only a limited amount of time will be available to US astronomers on the MMT and the competition from other instruments will be high.

Therefore, it is the opinion of the review committee that all possible resources and manpower should be directed to the improvement of the throughput of the Bench Spectrograph. This is our strongest recommendation. With the current loss of approximately 50% of the light, the WIYN is effectively reduced to a 2.5 m telescope. This is not acceptable. It is the single biggest improvement that can be made to the suite of instrumentation.

We understand that there have been a number of suggestions as to solutions of this problem, ranging from replacement of the collimator and modifications to the fiber slit area through a complete replacement of the spectrograph optics with all-transmissive optical elements. We recommend that the throughput problem be studied by a small committee, specifically including Dr. Sam Barden, and that a brief cost-benefit analysis be carried out as quickly as possible. The committee's recommendation is that, if reasonably simple modifications can result in significant gains, they should be carried out quickly. Any plan to make a major modification to the Bench spectrograph should probably be tabled (see next paragraph).

We recognize that the niche of Hydra and the Bench Spectrograph may change as competing

instruments come on line. The Consortium must consider future upgrades very carefully. For example, should the throughput be increased by a factor of two or more, the surface density of accessible objects will increase and an argument for more fibers could be put forth. This would require a substantial and costly replacement of the fiber positioner. The arguments for such an upgrade should be considered very carefully since its cost might preclude the facility's moving into new areas.

2. CCD Controllers. The existing (H)ARCON controllers should be retired. WIYN imager and Mini-Mosaic should be outfitted with modern, high-speed controllers as soon as possible. This recommendation is second in priority only to the Bench throughput improvements. The current read time of approximately three minutes significantly reduces the observing duty cycle, particularly for imaging applications and is particularly deleterious given the exceptional setting speed and pointing performance of the telescope. If the read time could be reduced to, say, 30 seconds, on a night when 50 frames are taken, more than two hours of observing time could potentially be recovered. Of all of the KPNO telescopes, the WIYN stands to gain the most in observing efficiency by such an upgrade. WIYN and NOAO should treat it as a test case for a new controller, presumably of the SDSU design. Integration of these controllers into the data-taking system is not a trivial task, nor is the capital! ! cost negligible, but it is time to bite the bullet.

3. IFUs. The Densepak IFU offers a unique facility to the community. Development and deployment of other IFUs, including but not limited to the Sixpac should be encouraged. Obviously, their use would benefit from throughput improvements to the Bench Spectrograph. The committee recognizes the impact of such focal-plane assemblies in the study of galaxy kinematics, a field with several strong proponents among the consortium members.

4. Tip-Tilt Module. This instrument should offer gains in DIQ and its deployment is encouraged though its priority for the WIYN consortium should be set lower than the Bench throughput upgrade and the replacement of the CCD controllers. The design should accommodate the IR dewar from the Bench Spectrograph IR camera (see below). The committee recognizes NOAO's strong commitment to this project. We hope that this commitment does not lead to a reduced efforts in the areas mentioned above and vice versa.

5. IR Camera for the Bench Spectrograph. This upgrade opens a new area of observing parameter space and should be pursued. The dewar and detector should be designed so that it can be mounted on the tip-tilt imager. Taken together, these will improve the bright time options on the WIYN. It should be noted however that with only one detector, it would be impossible to switch between near-IR fiber spectroscopy and tip-tilt IR imaging quickly

6. IR Imaging. With the exception of IR tip-tilt imaging, the committee does not recommend that the lean resources of the WIYN consortium be spent on development of traditional JHK imaging. This opinion is expressed in the spirit of "going with one's strength." While an IR imager would offer new capabilities to the WIYN, they are not unique in the community or even on Kitt Peak. The IR tip-tilt option partly offsets the lack of a wider field IR imager and offers exciting prospects for high resolution imaging for ToO applications though at reduced resolution compared to higher-mode AO systems. We note that the option to upgrade the system to higher-mode AO operation is included in the design.

The IR properties (image quality, emissivity and background) of the WIYN telescope should be explored using the loan of the USNO near-IR camera mounted at the modified Cassegrain focus. It is noted that this camera is probably not easily adapted to the tip-tilt module.

7. Optical Spectrograph. The committee supports studies and fundraising efforts in order to provide such a capability at the Cassegrain port with emphasis on a spectrograph of optical quality and design that can exploit the excellent image quality delivered by the telescope. Such an instrument would be a significant improvement to the current suite and is of particular importance given the educational mission of the Universities. The temptation to make this a "do-it-all" instrument should be resisted. Instead, it should be a high-throughput, high-spatial resolution, modest-field slit spectrograph for use in low spectral orders over the wavelength range over which silicon detectors (CCDs) are sensitive. Emphasis put on the UV and blue performance probably dictates that it be a dual-beam instrument though one could consider developing one beam at a time. The committee has no opinion as to whether this should be a test bed for the implementation of VPH gratings. That decision should follow a design study and budget estimate. The addition of such an instrument would be especially beneficial if funds can be derived from outside sources. We recognize that it is difficult to raise funds for such an instrument from the traditional sources so this will be a challenge.

8. Wide-Field Imager. There will be a number of competing instruments coming on line on 4-m class telescopes in the near future. Given the expense and lead-time to produce such an instrument, this may be an opportunity best left alone. Given the price of large-format imagers, the cost-effectiveness of this project should be carefully compared to the gains from the other projects listed above or by improving the existing imaging cameras. For example, the restrictions of the current filter wheel assembly have a detrimental impact on some observing programs and limit flexibility.

9. Data Archive. The committee feels that, given the need for improvements to the current facility instruments, the data archive should not be developed further unless there is an infusion of more resources. "Save the Bits" offers protection from accidental deletion of data. Further archiving of raw or reduced data diverts attention from more pressing projects.

6 The future – the WIYN strategic plan

In addition to strengthening the partnership by funding and enabling instrument development , encouraging initiative and instituting a WIYN Scientific Staff, the Consortium should strengthen itself by encouraging its individual scientists to collaborate through support for meetings , exchanges of sabbatical leave etc. and general development of the culture of the WIYN collaboration. Investment in communications equipment to permit videoconferencing would also help to strengthen the partnership.

The review committee felt that it would be better to develop the 3.5 meter than stretch the resources to support additional telescopes, unless additional resources both money and people equal or exceed the additional task. The committee is saying no more here than that it is better to excel in a single arena than to do a mediocre job in a larger area.

The WIYN Observatory has the potential to compete in scientific productivity measured in published papers with other forefront 4-metre facilities, such as CFHT and the Mayall telescope. It is still ramping up in efficiency.

To achieve this potential, the Consortium will need to find and occupy a scientific niche where WIYN is preeminent in its instrumentation. This will require some further investment.

In many ways its path to its goals has closely parallelled the ARC Consortium of Princeton, Chicago, Washington & NMSU. The original university consortium of this type was Arizona / Harvard-Smithsonian. WIYN should aim to match the performance of that MMT consortium, when it reaches a mature state. Numerical performance indicators in this state would be ~50 papers per year and a national proposal oversubscription rate of more than 2:1.

The university partners report that the WIYN Observatory is a significant aid to recruitment of the top graduate students in observational astronomy, giving them the same kind of competitive advantage that Caltech, Arizona, and Hawaii enjoy.

In conclusion, the WIYN Board should be commended for its effectiveness in obtaining university support for a major research facility and developing a model for national centers' interaction with universities. The next step – to add a scientific staff to the Observatory – is an important one, which we strongly recommend the Board consider positively.

7 Recommendations checklist

Hardware
All possible resources and manpower should be directed to the improvement of the throughput of the Bench Spectrograph. This is our strongest recommendation.

The WIYN imager and Mini-Mosaic should be outfitted with modern, high-speed controllers as soon as possible. This recommendation is second in priority only to the Bench throughput improvements.

Management
The committee recommends that the WIYN Observatory expand its scientific staff. Research Fellows or postdocs would increase WIYN's high impact science in a few fields.

We recommend pursuing the search for a Director. The Search committee should not neglect operational qualifications in this quest.

Operations
The committee recommends study of the ARC Consortium operations in remote observing.

NOAO should review from a strategic standpoint the decision to cease operation of queue observing.

Instrument development
We recommend that universities offer teaching buyout to help with instrument development.

In the long term, the "soft" ledger imbalance needs attention by the Indiana & Yale partners.