WHITE PAPER

Commercial Real Estate Group
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Tucson, Arizona: Arizona's Optics Advantage

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By Michael Coretz and Jan Knight

Tucson, Arizona can boast of many things. The business benefits are plentiful and one key advantage for those working in Optics and Photonics is that Tucson is home to the **premier educational and research institution in optics, photonics and astronomy.** The University of Arizona is known worldwide for its researchers, innovative work and talented student base.

Other great reasons include the dry heat, sunny days and the opportunity to play golf year-round. Yes, those things are attractive to both tourists and residents alike and often initially attract a founder or entrepreneur to this Southwest city of about a million people.

This white paper will give anyone considering starting, relocating or expanding their optics business a variety of reasons to put Tucson, Arizona on the short list of potential cities to consider. In fact, you'll be in very good company if you do.

This white paper published by Commercial Real Estate Group of Tucson, LLC. Contact Michael Coretz, your Tucson commercial real estate partner, for more information.

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Introduction

So, What Exactly do Companies in the Optics Industry Do or Make?

If you work in the industry, then you'll have a good answer to that question, but if not, it turns out that you are likely reading this white paper on an optics-enabled device right now. Optics technology is present in many products and services that we all know and use daily, and in some cases hourly. Some products are considered photonic products and others are thought of as photonics-enabled products.

Applications of photonics and optics are seen in almost any other industry segment you can think of. In obvious ones like astronomy, space and planetary sciences, aerospace and aviation, it's easy to imagine just how lasers and mirrors are incorporated into devices. However, photonics technologies are involved in construction, IT, engineering, biotechnology, GIS, transportation and more.

The U.S. Optics Industry: Facts & Figures

SPIE, an international society for optics and photonics, monitors market data for both segments, photonics and photonics-enabled products.

- Global sales of photonic-enabled services (internet, streaming video, audio cloud storage services, e-commerce) are over $10 trillion and photonic-enabled products (lighting, vision systems, autonomous vehicles, data centers, smart phones, medical imaging) have global sales of over $1.4 trillion. (SPIE.org 2018)
- Photonics is a major enabling technology for the emergence of most new "smart" systems with applications appearing in every-day life to the most advanced science.
- Over 3,000 companies worldwide are involved in photonics and optics with about a third of them located in North America. (SPIE.org 2018)
- Growth in emerging markets, legislation regarding energy-efficient equipment and the need for high-speed data transfer and storage systems are the primary drivers for the photonic markets. (Mordor Intelligence 2017)

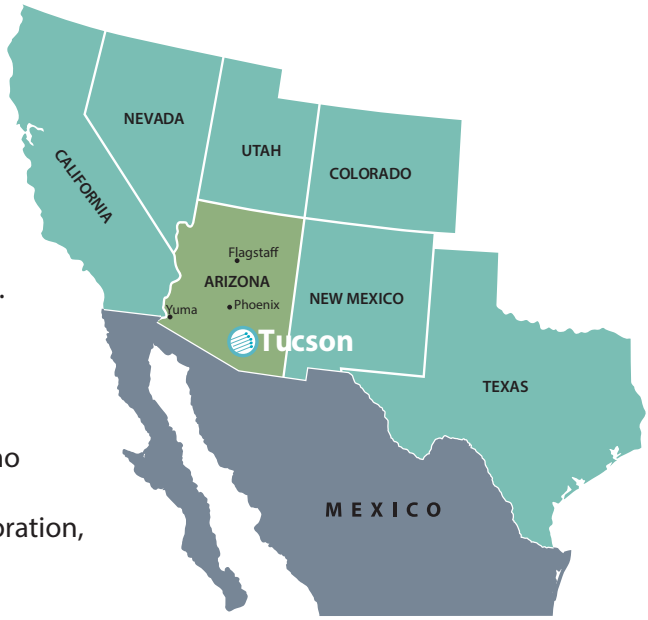
Factors Involved in Promoting a Successful Optics Community

For many technology segments, companies increase their likelihood of success when a strong research presence exists with a community excited about innovation. Plenty of opportunities to partner and collaborate with others within and outside of that segment additionally create a robust business ecosystem. Tucson, Arizona checks all the boxes.

> *"Tucson is ground zero for emerging optical talent and technologies. Having an office in Tucson allows us to keep the pulse of the optics industry. Our Tucson office has tripled in size over the last decade. This wouldn't have been possible without the local talent pipeline and thriving optics ecosystem."*
>
> …Mari Edmund, Chief Marketing Officer, Edmund Optics

When companies are looking for a home for their new optics business startup, relocation or expansion, Tucson, Arizona ought to be the first city that springs to mind.

Why Tucson, Arizona?



There are many reasons why Tucson should be on your short list. Three to start with are location, location, location!

- The world's **premier educational and research institution in optics, photonics and astronomy** is located right here in Tucson at The University of Arizona.
- Tucson boasts a dedicated professional industry association, Optics Valley.
- As a significant Southwestern U.S. hub, Tucson is geographically well-positioned for optics companies who require transportation of material and end product. Its proximity to Mexico, just an hour away, is key for collaboration, partnering, importing and exporting.

The College of Optical Sciences (OSC) at The University of Arizona

Did we mention already that The University of Arizona (UA) College of Optical Sciences (OSC) is known worldwide as **the premier educational and research institution in optics and photonics**?

The OSC, in addition to research, is focused on the application of optics. There are approximately 75 tenured, or tenure-track, faculty and senior researchers, as well as over 40 joint appointments with other colleges such as astronomy, engineering and medicine.

> ***"Our industry partnerships play a critical role in both our educational and research programs here at the College of Optical Sciences. We recognize that–in addition to providing career pathways for our students–our corporate engagements bring outstanding, high-impact, real-world research challenges to our faculty. We welcome anyone with an interest in learning more about how to leverage and grow the Tucson optics ecosystem to visit us here on campus."***
>
> **... Thomas L. Koch, Ph.D., Dean of the College of Optical Sciences**

The college educates more students in optics than any institution in the United States, so it's easy to see why a skilled and highly expert workforce is something that attracts new or expanding companies.

In November 2018, OSC received a $20 million pledge to add 10 endowed faculty positions. The pledge from its founding dean, Professor Emeritus James C. Wyant, and his family will help the college advance optics and photonics research and applications.

OSC supports industry needs in as many ways as it can. Whether you're a one-person startup company or a successful revenue-generating company with hundreds of employees, the OSC formally and informally supports private, commercial enterprise.

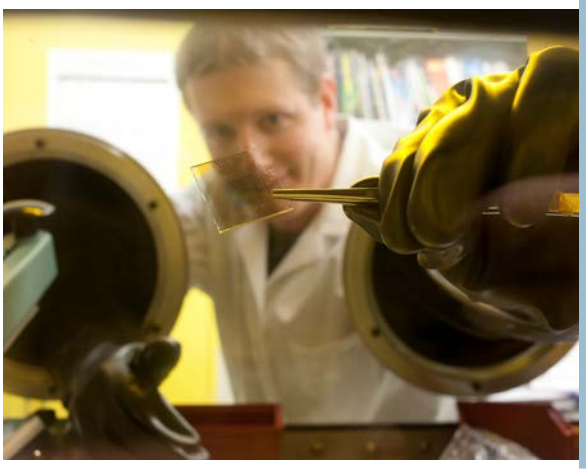
Its Industry Affiliate program aims to partner and collaborate with local businesses to help provide and support a mutually beneficial ecosystem. This successful and growing ecosystem includes access to research, lab facilities, workshops and one of the more important aspects in growing a business, the networking opportunities where business owners and inventors can interact with college staff, faculty and graduate students.

> ***"Optical technologies are not only essential in the communication networks of smart cities, but they are also playing an increasingly important role in numerous IoT devices and applications. Tucson provides an ecosystem of companies, experts, UA faculty and students that creates unique opportunities for new product development."***
>
> **...Dan Kilper, Optical Networking Research Lab**

Another great benefit of being in Tucson with its world-renowned optics program is the weekly OSC Colloquium series at the College of Optical Sciences. Entrepreneurs, owners and innovators in startups and established businesses participate in ongoing exchanges of ideas with UA scientists, faculty and students at these must-attend activities. They offer the latest in ideas, techniques and research.

Additional University of Arizona Resources

- Steward Observatory is the research arm of the department of astronomy at the UA. Its researchers and facilities are heavily involved in the operation of several telescopes in Arizona as well as other high-profile facilities around the world.
- Tech Launch Arizona, as the commercialization department of the university, provides expert assistance and commercialization support to UA faculty inventors. It works closely with the College of Optical Sciences and other associated departments.
- The original UA Tech Park, just a few miles from campus, has over 2 million square feet of office, lab and production space where UA-affiliated companies and other commercial companies can create synergy. AzCI (Arizona Center for Innovation), a tech business incubator, located at the park provides facilities and lab space for early-stage ventures.
- A second 65-acre Tech Park, The Bridges, is also under construction and will focus on biotechnology and laboratory space.
- The BIO5 Institute, a renowned UA-affiliated unit, helps to "harness the collaborative power" of its five core disciplines—agriculture, engineering, medicine, pharmacy and science.
- The National Science Foundation ranks the UA in the Top 25 for research funding with $622 million in R&D expenditures in 2017, putting the university among the top 5% of all universities nationwide.



Advances in optics have revolutionized the basic sciences, drug discovery and medical diagnostics fields. Southern Arizona is home to a diverse group of companies–from multi-nationals to small startups–who leverage optical technology and the expertise of the University of Arizona to cure disease and improve health. The BIO5 Institute catalyzes breakthroughs in optics into better understanding of the world as we work with Southern Arizona companies to meet their needs for optics and biosciences expertise, as well as a highly-trained workforce.

… Jennifer Kehlet Barton, Ph.D., Director, BIO5 Institute

Business Development and Support–Optics Valley Supports and Develops Companies

In 1992, the world's first industry-focused optics cluster was formed in Tucson. As the optics community has grown, the industry is now represented by Optics Valley, a committee of the Arizona Technology Council. Optics Valley seeks to build worldwide collaborations and partnerships through its mission to "Catalyze, Convene and Connect" optics, photonics, astronomy and supporting business interests throughout Arizona. In 2018, membership has grown to over 70 organizations statewide, over 50 of which are in Tucson.

In January 2018, Optics Valley inaugurated its flagship event, Arizona Photonics Days. This annual three-day business conference is designed to introduce global attendees to the breadth and depth of the Arizona optics industry. The program combines company presentations and technical updates with ample time to network and build business relationships.

Availability of Funding

- Recently, three new venture capital funds were launched in Tucson. UA Ventures focuses exclusively on technology coming from the UA. Bluestone Venture Partners aims to build their portfolio around life sciences in the Southwest. Diamond Ventures invests in both real estate and high-growth companies.
- SBIR (Small Business Innovation Research) grants have been awarded to many Tucson-based companies through multiple federal agencies.
- ACA (Arizona Commerce Authority) provides numerous funding opportunities in the form of grants and loans to companies at all stages of growth.
- The Tucson Desert Angels is a highly active angel investor funding group that has invested over $47 million in more than 105 companies since 2000.

- Silicon Valley Bank has a track record of helping Arizona companies and has committed to lending at least $100 million to technology and life-science companies based in Arizona through 2019.

Specialized Commercial Real Estate Needs

Many industry segments have special requirements for the properties they lease or build. Companies in the optics industry are no different. Depending on the specific needs of the company, there might be requirements for any or all the following:

- clean rooms
- laboratories
- coating facilities
- high bays
- electronics manufacturing rooms
- isolated slabs engineering
- complex plumbing and ventilation systems
- collaborative work spaces
- sophisticated, dedicated data centers.

Michael Coretz of Commercial Real Estate Group of Tucson worked tirelessly to find us appropriate office and lab space and as we outgrew that, he worked with us a second time. In addition to his professional real estate expertise, he has been a valuable resource to help connect our company to the Optics Community, and has advised and guided us whenever an opportunity has arisen that he felt might benefit our health and growth. Michael truly cares about his clients and provides a relationship that extends well beyond client and Realtor.

…Tina Valente, Arizona Optical Systems

Additionally, companies in this segment often need to adapt to changing needs related to energy and water efficiency to ensure lower operating costs. Appropriate locations for optics and photonics companies often put them in close proximity to other intellectual resources and facilities.

Often a group of professionals from different disciplines act as the development team. Ranging from scientists, architects, engineers and financiers to building contractors and commercial real estate brokers, the team must understand the special needs of the optics Industry and help anticipate each tenant's future space needs.

A few commercial real estate sources that directly address these needs include CREG Tucson's **Relocation Guide**
www.commercial-real-estate-tucson.com/resources/2018-relocation-guide

and **Infographic on Buying vs. Leasing**
www.commercial-real-estate-tucson.com/market-resources/infographics

CREG Tucson also is an active participant in Optics Valley and with optics companies. It maintains an extensive list of local optics companies that provide a network for all industry businesses and startups.

Let's Not Forget Lifestyle

We know that employers have an easier time recruiting people to work in places that offer not just a great business working environment, but a lifestyle that they and their families can enjoy.

For those who haven't heard, Tucson boasts 350-plus days of sun a year. For most of the year, humidity is low, although the brief summer monsoons bring a welcome break with heavy rainfall and strikingly beautiful storms that amateur and professional photographers love. Tucson is surrounded by mountains, offers the best sunsets and provides hiking and walking opportunities galore.

Tucson Emerges as Global Leader in Bicycling? Yes, Really!

One of Tucson's major benefits for those who like the outdoors is The Loop. Consisting of 131 car-free miles, the paved trails provide an urban system that connects bus and bike routes, hotels, restaurants, parks and trailheads. Most areas are flat and family-friendly. Much of The Loop runs adjacent to Tucson's river beds and almost all of it provides views of the mountains. In addition to cyclists and pedestrians, The Loop is open to horseback riders, who also use adjacent dry river beds. In addition, the city boasts 1,098 miles of bike facilities overall.

"10 Most Bike-Friendly Cities in America." – *Forbes Magazine*
No. 1 "Top Best Bike Towns" – *Outside Magazine*

Golfing & Hiking

For amateurs, there are dozens of municipal courses and PGA pro-designed resort courses, plus golf communities, allowing golfers of all levels to play year-round. Tucson has been home to PGA, LPGA and Championship Tournaments over the years and we even have pros who make Tucson their home.

If you prefer to walk less manicured environs and replace golf clubs for walking poles, there are hiking trails available around the desert floor and within mountain forests. Tucson's world-famous resorts and spas often offer golf and hiking in close proximity and attract visitors and business conferences from all over the world.

Arts & Culture

The *Wall Street Journal* has described the Tucson region as a "mini-mecca" for the arts. Tucson is known for a special arts vibe. It's home and host to fully professional symphony orchestra, opera, ballet and theater companies. It has dozens of small playhouses and hundreds of large and intimate music venues. Its revitalized downtown is also experiencing a renaissance as an entertainment hub.

Food

Another vibe Tucson is known for is food. In 2017, Tucson became the first American city to become part of the UNESCO Creative Cities Network for Gastronomy. The award honors and recognizes the "region's rich agricultural heritage, thriving food traditions and culinary distinctiveness." It's also been named "Best Under the Radar Food City." While the Mexican and Southwestern cuisines are especially prominent, the variety of restaurants, bars and eateries is mind-boggling to even long-time residents.

Tucson's Optics Companies

The presence of dozens of optics and photonics companies in Tucson prove that the community does indeed offer just what they need to be successful. A short list here shows the diversity of the strong optics and photonics supply chain in Tucson and Southern Arizona.

A complete list of company members of Optics Valley is available through a resource listed at the end of this white paper.

> *"We have found that the building of membership in Optics Valley has been of great advantage to our Arizona optics companies. Through our activities and events, companies are now able to collaborate and partner both locally and globally, to the benefit of all parties."*
>
> ...John Dennis, Chair, Optics Valley

4D Technologies designs and manufactures a variety of products to support accurate measurement of optics and optical systems. It serves a diverse set of industry segments. www.4dtechnology.com

Airy Optics serves several industry segments, including aerospace, consumer electronics and packaging, precision optics and scientific instrumentation. It helps solve challenges in polarization. www.airyoptics.com

Äpres Instruments provides the optical manufacturing industry with materials and manufactured components with a focus on interferometers. www.apre-inst.com

Arizona Optical Systems develops custom metrology solutions for some of the optics industry's most demanding applications including telescopes. www.arizonaopticalsystems.com

Breault Research Organization (BRO) is an optical engineering company providing optical software products and training courses to engineers around the world. www.breault.com

Control Vision provides optical sensors, control systems solutions and design services. It also provides R&D equipment to the University of Arizona Optical Sciences Program. www.controlvisioninc.com

Darling Geomatics offers high-tech surveying services, including 3D scanning, laser tracking and aerial collection drones to mining, healthcare, power, construction, airports, civil engineering and other industries. www.darlingltd.com

DILAS is a high-power diode laser company that manufactures systems and components for a variety of industries, including the U.S. defense department. www.dilas.com

Edmund Optics is the world's largest supplier of off-the-shelf optical components. In late 2016 it relocated to its Tucson Design Center, an 8,000-square-foot facility to help support the company's ongoing growth. EO provides optics, imaging and photonics technology to a diverse set of industries, including life sciences, biomedical, semiconductor, R&D and defense. www.edmundoptics.com

Hextek Corp offers custom services in optical mirrors and metrology services. The company works with the U.S. Department of Defense, U.S. Department of Energy, NASA and higher education, as well as the aerospace industry and other commercial entities. www.hextek.com

Lazertel is a manufacturer and developer of high-power semiconductor laser components for defense, automotive, medical industrial and R&D, among other market segments. **www.lasertel.com**

Mahr is a worldwide business in the areas of metrology and high-precision metering. It serves the plastic, medical technology, air and space and synthetic fiber industries. **www.mahr.com**

Nanopec focuses on developing intellectual property in nanotechnology and offers advanced materials and B2B solutions to industrial laboratories and high-tech startups. **www.nanopec.com**

NP Photonics Inc. develops and manufactures specialty fiber lasers, amplifiers and transport fibers for the near- and mid-infrared (IR) wavelength bands. It serves a variety of industries, including defense, metrology and R&D. **www.npphotonics.com**

Optical Data Associates offers an independent test laboratory and consulting services with a focus on optical measurement devices. **www.opdata.com**

Optical Support Inc. is an engineering services company specializing in the design and manufacturing of precise optical instruments and custom metrology tooling. **www.opticalsupportinc.com**

Photometrics designs and manufactures high-performance cameras from development through manufacturing with aftermarket service and support. **www.photometrics.com**

Photon Engineering is an engineering services consulting and software development company specializing in optical engineering, design, analysis and implementation. **www.photonengr.com**

Photonics Automation Specialists designs and manufactures custom instruments, test stations and burn-in towers. **www.photonicsautomation.com**

REhnu supplies concentrating mirrors customized for a variety of solar generation applications and provides consulting services. The co-founders are both well-known University of Arizona astronomy faculty. **www.rehnu.com**

> ***"There are so many different optical specialties and experts here in Tucson that I rarely have to look outside Tucson to solve a particular optics-related problem when providing a solution for my customers."***
>
> **… Jerry Knight-Rubino,**
> **Founder, Photonics Automation Specialists**

Ruda Cardinal is a leader in optical engineering with a specialization in rapid prototyping. It offers optical design, opto mechanical and systems design and manufacturing of components. **www.ruda.com**

Spectral Instruments provides custom CCC-based camera systems for scientific optical imaging solutions. It keeps abreast of developments in optical technologies with its involvement with local astronomical technologies, local high-tech companies and the University of Arizona. **www.specinst.com**

Conclusion

This white paper has identified many factors that must be present in a city or region for optics companies to thrive.

Tucson, Arizona really does check all the boxes. In addition to being home to the premier academic institution for optical sciences, there are many community leaders, stakeholders and local professionals who are eager to help new or established companies make Tucson their new home. As this paper details, many companies are already doing just that. Join us.

TuSimple chose to locate and scale in Tucson for many reasons and high on the list is the world-class talent in optics due to the foundation laid by the University of Arizona, and other local industries that recruit top talent. Tucson is a warm and welcoming city with business friendly environment.

…Robert Brown, TuSimple

Contact Michael Coretz, your Tucson commercial real estate partner, for more information.

Resources, Associations & Publications

Arizona Technology Council **www.aztechcouncil.org**

BIOSA (Bio Association of Southern Arizona) **www.biosaz.org**

BizTucson The Region's Business Magazine **www.biztucson.com**

Desert Angels Investment Funding Group **www.desertangels.org**

Optics Valley **www.aztechcouncil.org/optics-valley-arizona/**

Optics Valley Member List **https://tech.aztechcouncil.org/list/category/optics-98?o=alpha**

Sun Corridor Inc. **www.suncorridorinc.com**

SPIE **www.spie.org**

Sources of Tucson Venture Capital Grow. **www.bit.ly/2Pzfetw**

The University of Arizona

Arizona Center for Innovation (AzCI) **techparks.arizona.edu/azci**

BIO5 Institute **www.bio5.org**

Tech Launch Arizona **techlaunch.arizona.edu**

The College of Optical Sciences **www.optics.arizona.edu**

The University of Arizona **www.arizona.edu**

Tech Parks Arizona **techparks.arizona.edu**

Lifestyle

45 Reasons to Move to Tucson **www.tucsontopia.com/45-reasons-to-move-to-tucson**

Visit Tucson **www.visittucson.org**

Tucson 101 from Sun Corridor
www.suncorridorinc.com/Living-Working/Tucson-Introduction.aspx

Commercial Real Estate

Relocation Guide
www.commercial-real-estate-tucson.com/resources/2018-relocation-guide

Infographic on Buying vs. Leasing
www.commercial-real-estate-tucson.com/market-resources/infographics

New Tucson Opportunity Zones May Spur Growth
www.commercial-real-estate-tucson.com/new-tucson-opportunity-zones-may-spur-growth/

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