A Proposal to Fund, Construct, Assemble, Install, and Donate a Holography History Museum to a Qualified and Interested Institution

By

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Abstract

This is a proposal to establish a permanent repository that preserves the rich history of holography and provides a place where scholars and the general public can witness and learn from this amazing field of technology. There is presently no museum which has an adequate breadth to include the major scientific and historical developments as well as to display the applications created throughout its long history. The authors propose to design, develop, assemble, and cover the first two year's operating costs for this repository. They will also donate it to a suitable, qualified institution that agrees to provide space, maintenance, and management for a minimum period of time. The value of the initial donation is difficult to estimate since some of the contents could be considered priceless; however, we anticipate the value of the donated installation and contents to exceed 1 million dollars and to grow quickly in value because of future donations.

1. Background

History- Dennis Gabor invented and named holograms in 1947 [1,2]. With a lot going against Gabor holography, such as lack of coherent light and overlapping conjugate images, he developed some interesting theory, found little practical use for it, and abandoned it to a 15 year near death state, with a few largely academic enthusiasts continuing to nurture it. He gave it up too soon. Emmett Leith and Juris Upatinieks[3] brought holography back to life with modern (off axis) holography. Yuri Denisyuk in Russia independently created a white light reflection variation of holography and produced amazing holograms that were easy to view with white light. Holography exploded because of the striking 3-D images they created, something no one had ever seen or even imagined before. Essentially every country in the world became involved in researching the many potential applications of this new technology. A few years passed before Gabor got back into the game, and except for winning the Nobel Prize for his initial work, never caught up with the pack and contributed little more to the field.

By 1970 holography was being pitched as a savior in almost every existing industry, and engineering and research centers around the world looked to holography for new capabilities and solutions. Engineers and scientists published holographic methods to measure, store information, optically compute, display, locate flaws and weak sites in paintings and sculpture, and provide virtual reality. Inspectors applied it to identification, testing and authentication. The security industry looked at holography for a foolproof anti-counterfeiting solution. The medical industry was promised a method to practice operations on a life like image. The military industry examined how holograms could be used to support war making. Many universities began teaching holography classes and started holography curriculums. Artists imagined holographic art as a hot new medium with limitless possibilities for painting and sculpting with light. The entertainment industry explored 3D holographic movies, TV, toys, games and video recording, while the fashion community pitched holography as a golden source for novel jewelry and clothes. The advertising industry was pitched holography as the golden child for point of sales advertising. The publishing industry recognized an opportunity to enhance graphics for magazines and books. New holography journals appeared to cover the action, and museums emerged everywhere to show this marvel to the public.

A cursory summary of the state of holography today reveals that some applications have matured into multibillion dollar industries and others are still hoping, with many opportunities still visible for the future.

1. The production of commercial embossed holograms as security products (credit cards, currency, etc.) is the largest commercial holography success to date and has evolved into a multi-billion-dollar holography industry today. Practically every human in society owns some of these holograms. Nevertheless, it would seem with some tweaking and different management this field has room for growth. Digital holography and continuing improvements in computer image processing, have definite possibilities to offer this field.
2. Holographic memories have been developed by a few companies, and computing at the speed of light has been touted for years. Several companies have come and gone, and a few still make promises, but there is no significant commercial success so far. Electronic computers continue to outrun optical computers commercially. New recording materials and a blending with electronics will provide new opportunities.
3. Holography education and schools of holography have come and gone. Holography instruction in universities has dwindled, though a few schools still offer courses and some are available on line.
4. Although holographic art began with excitement with many hopeful beginning artists, and some of whom were already well known, like Salvador Dali, it has never been welcomed by the mainstream art community and is not widely recognized and treated as a viable art form.
5. Novelty holographic items for display and advertising, such as baseball cards, greeting cards, cereal boxes, etc. are a rarity today, having been replaced by lower cost or better options, particularly those that provide flashier, brighter, and more easily observed imagery. A few companies appear successful in a highly-specialized market. Advanced high-speed computer

processes and the advent of huge storage capabilities such as the Cloud and digital holography could regenerate these applications and possibly revive holographic display.

6. Holographic jewelry and fashion containing 3D images and arrays of color made nice conversation pieces but were never accepted by the general public as anything more than a trinket or conversation piece.
7. Holographic portraiture, once thought to be a major area of hologram application has not matured. Few portrait studios survive today. A major problem in this area has always been display. New LED sources should provide a method to revive this hope. This could become a huge industry if managed and marketed properly.
8. Holographic metrology and technology has disseminated smoothly into the optics community and is widely used in specialty applications to solve difficult problems. Digital holography and new lasers offer hope for revival in most of these areas. Holography provided new science and ways of looking at optical and physical phenomena and has become an extremely useful metrology tool.
9. Holographic optical elements (HOEs) have found wide ranging applications in solving optical problems. Military applications research in the use of HOEs and holograms to aid virtual and augmented reality and heads up displays are alive and well. Digital holography will be a key factor in future expansion.
10. Publishers such as National Geographic magazine made a hit with three hologram covers using methods pioneered largely by Eidetic Images and ABNH. [Kenneth Haines.] Many other magazines and catalogues followed suit. Holograms on magazines are a rarity today.
11. The False Hologram community call their product holograms, when, in fact, they are not. This misappropriation of the word hologram apparently attempts to exploit the general excitement associated with the word. The general public now widely understands any 3D image to be a hologram. Efforts to set this misappropriation straight have been futile and even companies who know better are beginning to call their 3D “Faux Holography” displays holograms.

A Portending Crisis and an Opportunity- Three of the four original founders of holography have passed on, and their students and associates are either dead or in their 70’s and 80’s. Many of the surviving community are in possession of original holography artifacts and historically important material, including extensive collections of holograms of both historical and esthetic value. Many of them have indicated a desire to contribute their collections to a museum that would display important examples of these and share their knowledge of history with the public. The time to take advantage of this situation is fast running out. In a few years most of these founders will have passed on, their collections and first-hand knowledge will disseminate, and some will be lost forever.

We have an opportunity for a few years to collect and assemble at relatively low cost some of the most important historical examples, original artifacts, and high-quality holograms ever made, including first hand history of the field. Missing such an opportunity could wind up being one of the most disastrous missed opportunities yet in holography.

Existing Museums of Holography- At least a dozen museums of holography have come and gone in many countries[4]. In the USA the most notable were the Museums of Holography of New York and Chicago. These museums attracted many visitors and thrived for a few years before declining and ultimately failing for various reasons, the most obvious reason being financial. The story is similar with holography museums throughout the world. Today there is no viable, stable museum dedicated to holography that displays the vast range of holograms and history that should be in a museum. Universities almost invariably store only the work that has been attributable to their own staff (U. of Michigan). Temporary holography exhibits are still successful in drawing large crowds. The aging and disappearing first holography generation has no place to donate collections of holograms and artifacts. In the USA, there exists a collection at M.I.T. , which has been carefully archived but resides mostly in storage.

In the proposal we analyze previous efforts to create and maintain holography museums, specifically to determine why previous museums ultimately failed to survive. We then explain how the proposed project is different from previous efforts and eliminates those factors that led to failure.

2. Proposal

a. Summary-The authors propose, free of charge, to design, develop, assemble, donate, and cover the first two year's operating costs, a holography repository to a suitable institution that agrees to provide space and maintenance and management for a minimum period of time. The value of the initial donation, is difficult to estimate since some of the contents could be considered priceless; however, we anticipate the value of the donated installation and contents to exceed one million dollars and to grow quickly in value because of future donations.

b. Objective- Create a facility, a valuable national resource, that will archive and display important holograms and holographic artifacts and technology that cover all aspects of holography, including history, applications, examples, and future potential for the benefit and use by educators, students, historians, researchers, and interested people of the general public.

c. Strategy-We will take advantage of this particular time in history to collect available material and assistance from many researchers and collectors who helped to develop the field of holography and who have a desire to contribute valuable holography related material to such an institution and to preserve the history and historical products of their field. We will identify sources, such as qualified institutions (universities, museums, companies), and individuals who would contribute holographic material and time to the repository.

A 501(c)(3) non-profit corporation has been formed to manage the organization, promotion, fund raising, and financing operations. The name of the corporation is The PHASE Holography Institute (PHI) where PHASE is an acronym for Preserving Holography for Art, Science, and Education. Having PHI as a vehicle will augment the development process by, among other factors, making contributions tax deductible. In many cases this will encourage individuals to donate valuable, rare holograms that are often difficult to find a buyer who will pay the full value.

d. Initial Funding-The authors will contribute their own time and will seek help from friends and associates in the field to do the same. PHI will contribute sufficient funds to collect, assemble, and install the initial exhibit in the selected institution and to operate it for at least two years. This will include donations from the authors of $100,000 in cash plus additional cash contributions from others who are willing to contribute to the project.

e. Key Personnel-Initially, the proposal writers, Drs. Kenneth Haines and James Trolinger will direct and carry out the program. Both are well known and respected in the holography community, and they have been friends for over 40 years. We already have verbal commitments from others to volunteer. Additional personnel, including volunteers and paid individuals will be added as the project proceeds. We anticipate that others will volunteer soon after the project is announced.

Dr. Haines was part of the original team working with Professor Emmett Leith at the University of Michigan and principal developer of the technology that is the basis for holographic security in wide use today, for example, on credit cards. In his career he founded and led several holography companies.

Dr. Trolinger was among the first developers of holographic metrology and led teams that fielded many firsts in holography. He was a member of the teams developing the first applications of holography in space and was principle investigator of project SHIVA, (Spaceflight Holography Investigation in a Virtual Apparatus).

Ms. Kris T. **Brummett,** is an expert in auditing, technical writing, and managing non-profit organizations. She has over twenty years' experience in technical writing and project management, having worked for Dupont for 10 years before joining Jacob Holm, where she is currently employed and Quality Systems Management Specialist. She founded and is director of the Old Hickory Veterans Memorial Park, which honors veterans. She will serve as executive secretary of operations of PHI.

More extensive resumes of Haines and Trolinger are included below.

3. Inclusive Areas of Holography

Commercial, Security, and Advertising- The most successful application of holography to date is in holographic security, which has become fully integrated into society. The holographic developments by Leith and Upatnieks at the University of Michigan in the early 1960's led to an immediate hope for its exploitation in many fields. But applications of the technology for commercial ventures proved to be illusive, partially due to the identification of applicable markets and partially due the absence of suitable mass production methods. For a time, it appeared to be an invention looking for an application.

The list of failed ventures is long. But in about 1969, RCA Corporation introduced what appeared to be a great viable product; a video cassette recording system that used, as the storage material, plastic tape on whose surface were embossed holograms [5]. While this attempt to use holography ultimately failed, the production process was introduced to the world. Because the rights to major U. of Michigan patents were held by the Holotron Corporation (a joint venture between Dupont and Battelle), RCA switched to a magnetic tape storage mechanism for which they held the pertinent patents, which became the video cassette product of the day. During this period, Holotron had developed an almost identical system that used a photopolymer, which today is another important holographic material [6]. Other possible applications such as acoustical holography, holography based games (Atari, photo below), and holographic lamps were commercially unsuccessful.

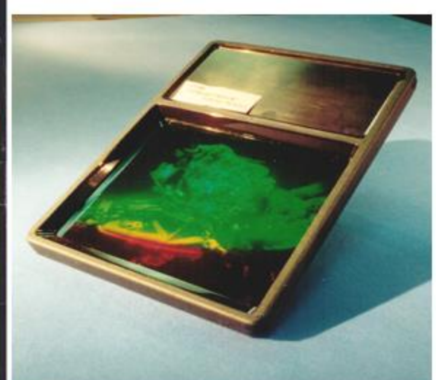
Finally in 1984 a truly successful commercial application of embossed holography applied to credit cards (Master Card and Visa) evolved, initially as a security product and later as an identity icon. Soon after, myriad product applications emerged such as magazines covers (Sports Illustrated, IEEE Computer graphics [7], National Geographics) [8], brochures, greeting cards, and cereal boxes. Each National Geographic edition containing holographic covers required 12 million embossed or cast covers. Another success was the application to currency (the EURO, photo below).

The market continued to spread, and holograms became ubiquitous as advertising and marketing aids. (However, in Asia, they often evolved into simplistic forms which seldom contained true holography.)

RCA

An experimental player for embossed holograms on plastic tape in a cartridge.

1970



Atari Holographic Game

Holograms Applied to Credit Cards., The first Successful Large Volume Application of Holography

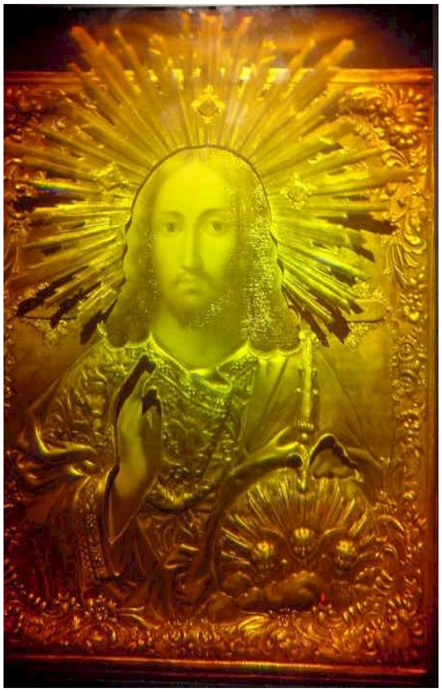
Holograms on Currency

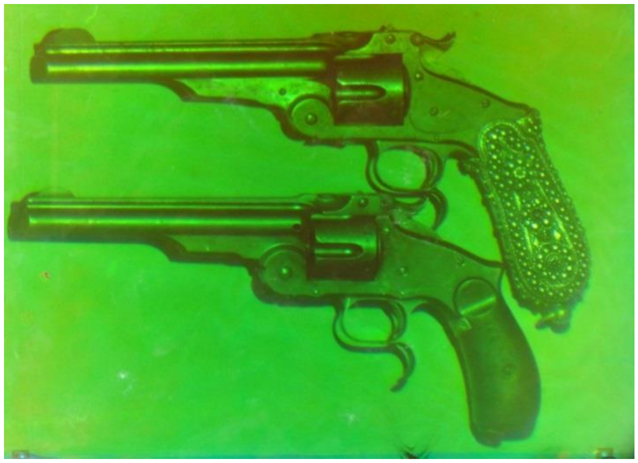
As early as 1990, computers were frequently used in processing images [9,10]. Many holograms today collect a multiplicity of computer processed object views to synthesize 3D image data resulting in excellent images. Products included sports cards for which thousands of different holographic portraits were produced employing these processes.

Holographic fringe structures can be computed directly and subsequently photographed into a recording surface, thus constructing a hologram in an elemental fashion. And because of the continuing evolution of computer processes, it is likely to show up in areas such as Virtual Reality (Magic Leap, etc.).

The dream of holographic TV is still unrealized, but a few organizations still work towards its development.

Archiving and Display-Yuri Denisyuk developed a class of holograms, known as white light reflection holograms, that produced high quality 3D images of relatively large objects that were viewable in white light. They were ideal for displaying such images to the general public because lasers and dark rooms were not required. One of his goals was to record holograms of extremely rare museum pieces so that they effectively could become accessible to many more people. Having the hologram of the object would be essentially equivalent to having the object itself, and in some sense, even better since the problem of protecting and securing the rare object would go away. The Russian community produced many such holograms and installed them in traveling “museums”, drawing wide attention and delight from many thousands of viewers





Hologram of a Russian Icon 18x24

Hologram of two antique revolvers-16x20

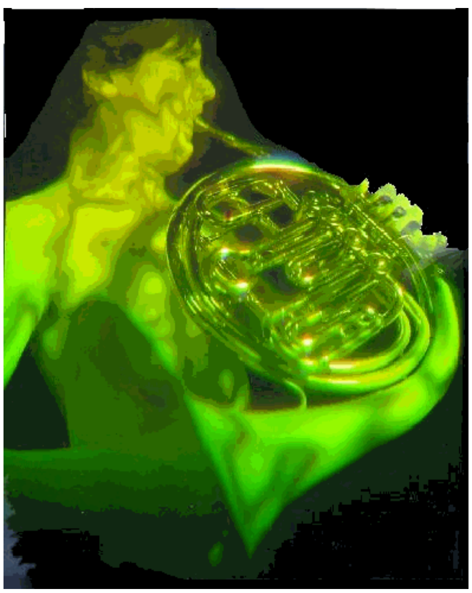
Hologram of President Ronald Reagan. The first hologram of a US president. 16x20

The record and display concept also had equally important implications for archiving, especially for ancient objects that may be deteriorating with time. A hologram of an object would record precise details of that object that would be saved forever, even after the object had rotted away.

In a similar manner, a holographic portrait would permanently record the precise 3-D details of a person for storage and later reference.

This research produced many thousands of excellent holograms that now exist worldwide in collections and specialized displays; however, the original intent of producing a virtual museum has yet to be exploited effectively. Nevertheless, this type of hologram is one of the few types that can hang on a wall anywhere and be easily viewed by passers-by. Except for embossed holograms which do not retain true colors, but instead impart rainbow colors to the image, white light reflection holograms are the most seen holograms by the general public.

Scientific and Technical-Scientific and technical holography focuses on engineering and scientific applications using holography, and covers a wide, diverse range of applications, including holographic data memories, optical elements, and metrology. Unlike most of the other holography communities, holographic metrologists quickly shared and publicized techniques and tricks. No one in the metrology community seemed to be impeded by patent wars, which became common in other communities. Apparently, the first practical use of holography in metrology was 3D particle field holography, and is an example of an evolving application that continues to thrive, grow, and regenerate with each new technological advance. Double pulsed holography allows a 3D analysis of the spray particles ligaments, dynamics, velocity, and mechanisms. One hologram represents many thousands of individual, high resolution, differently focused photographs. This application produced many first of a kind measurements including experiments on ground, in air planes, and even in space [11,12].



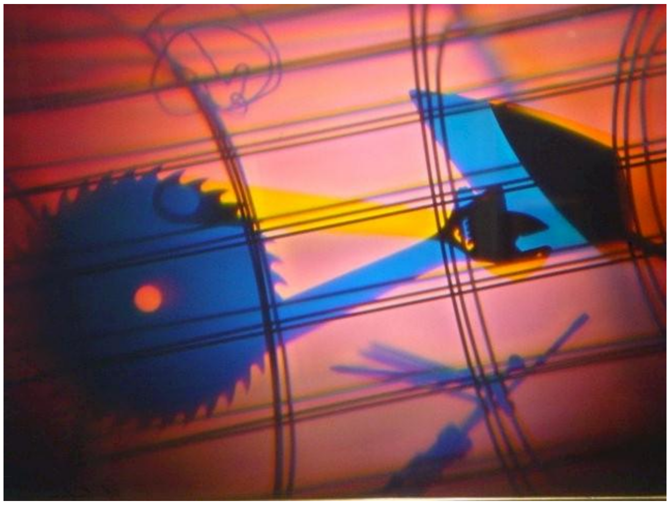
Holographic Interferogram of a full-scale person playing a horn. Fringes measure the movement of the musician's body as well at the vibrational modes of the instrument

Holography and the associated Fourier optics produced new ways of thinking about optical information, its description, filtering, processing, and storage influencing the entire field of optics, not just holography. In addition, holography provided new ways of thinking about the universe, black holes, and virtual reality. Technical holography is a dynamic, growing field today. For example, as analogue holographic metrology became stalled and abandoned because of its limitations and competition, digital holography and the marriage of optics and electronics emerged producing what may be the most powerful technical form of holography yet, breathing new life into all technical applications.

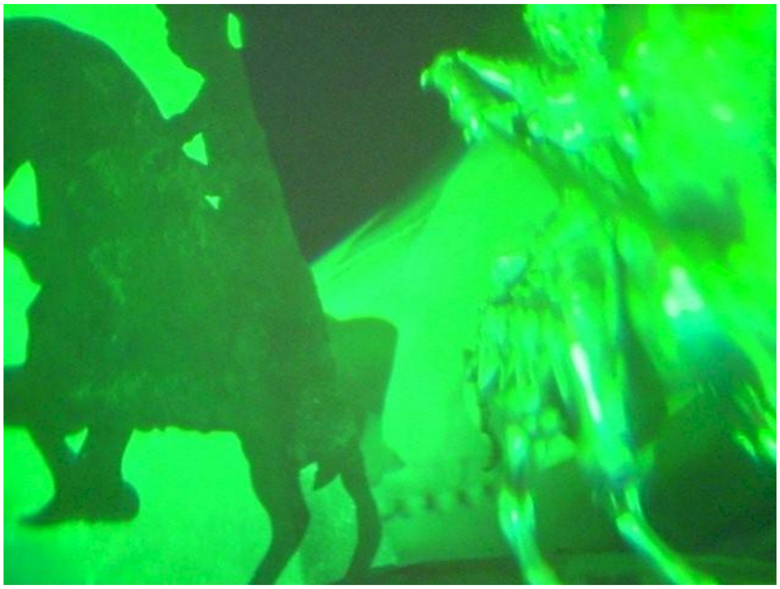
Digital holography deals with the holographic recording and/or reconstruction of wavefronts in discrete quantities using typically a CCD or CMOS camera or a digital device that becomes a digital hologram. Reconstructing wavefronts and images can be performed numerically from digitized holograms. A hologram can be recorded digitally with wavefront reconstruction by analogue means, or recorded by analogue means with wavefront reconstruction digitally, or recording and reconstruction both digitally. The recording can be on other media besides electronic media. All of these are digital holography processes. Most technically oriented digital holocameras record the hologram with a digital camera, store it digitally in a computer, reconstruct and process wavefronts in the computer, and view processed data on a TV monitor. If the reconstructed image is 3D, then a user can scan through it digitally in the computer and view plane by plane on the monitor. Interestingly, holograms produced in digital cameras rarely exist as something you can hold in your hand. They exist as ones and zeros in a computer. Since the hologram is already in a computer, extracting and processing the data is much simpler; this greatly simplifies the major limitations of analogue holographic metrology. Today's high speed digital cameras can record many thousands of holograms per second. Digital particle field holograms computationally reconstruct the 3D image and scan through it looking for the reconstructed particle images and count, size, and characterize particles as they come into focus. Similarly, digital holographic interferometers record wavefronts, reconstruct them and interfere them all in the computer then produce interferograms or even finished data, e.g. contour patterns, on a monitor. Digital holograms are also produced as holographic optical elements (HOEs) on glass or other substrates. Digital holography, the ultimate marriage of optics and electronics, offers great promise in essentially all applications of holography including art. Digital holography has almost completely replaced analogue holography as a measurement tool, but the fundamental holography techniques are the same. Almost every holography measurement can be replaced and improved with digital holography.

Art-As in all art forms, defining what is and is not art is a never-ending argument. Pretty and/or technically well-made holograms, which will "wow" a viewer, will not always qualify as fine art even though many are historically significant. Likewise, many artistically significant holograms are not technically well finished but are significant because of the artist associated with them or because of processes first demonstrated. Artists sometimes explain poor technical quality as artist license. Finally, just as in all arts, some holograms that may not originally have been intended as art when they were made, can now qualify as important art pieces.

Today, there are a small number of recognized holographic artists, many who work side by side with technical holographers. Widely known artists using the holography medium are extremely rare and include Don Close, Bruce Nauman and Salvador Dali. Dali, like many artists, did not actually make holograms but rather oversaw the creation of the imagery that was in them.



Toolworks, 12x18, Hologram on glass, John Kaufman.



Joust-12x18" hologram on glass, Cherry Holographics. The lance protrudes a few inches in front of the hologram.

Rainbow Hologram of a leprechaun, Craig Newswanger. As the viewer moves from left to right, gold sprinkles from above to form the stack of gold coins.

4. Initial Museum Contents

All holograms shown above are already in the collection along with many others. The authors have already assembled materials and artifacts and have a good start towards constructing displays that form the basis for a museum opening. This collection will grow quickly as soon as the project becomes widely advertised

Commercial, Security, and Advertising-The material which we have acquired so far spans the time period from 1963 to about 2008, which dates from the earliest developments of holography. It includes contributions from several of the leading contributors in the field over this period, such as the U. of Michigan, Holotron, Eidetic Images, ABNH, Simian, etc. Some of the material pertains to notable marketing failures, such as the RCA/ Holotron video cassette venture, Atari's Holographic games, Holotron/Battelle's ultrasonic mammogram machine, and Eidetic Image's holographic lamps. But most of the collection relates to remarkably successful products such as Visa and Mastercard authentication holograms for credit cards, Magazine covers, Numerous advertising projects, US mail stamps, sports cards, etc.

Accompanying this collection of hologram products, is an array of production pieces such as nickel stampers and production rolls of holographic hot stamp foil.

Perhaps equally of value is the historic documentation that accompanies these holograms. This includes R&D lab books etc. which describe developments of both optical and production processes, and detailed diagrams of the pertinent equipment. Included in this collection are many documents exchanged between some of the early contributors (Leith, Lohman), some of which have never been published. Also there are files of key items of litigation which dramatically influenced the progress of the field.

Some examples of holograms in the collection, in addition to those shown above are:

1. 4x5 holograms by Emmett Leith (1963)
2. holographic lamps, plus multiple interchangeable holograms (1978)
3. nickel stampers developed for embossing and casting processes (1980)
4. stampers used to mass produce National Geographic covers
5. 4x5 holograms of Prince and Michael Jackson.
6. samples from almost all of the several hundred hologram projects completed by
   a) EIDETICS/ABNH from 1983 to about 2000.
   b) Sample holograms from Simian, Klaser and others.

Archiving and Display- Examples of holograms of archival museum objects already in our possession include museum replicas of sculptures, archeological specimens, ancient objects, icons. We currently have approximately 50 high quality holograms that will qualify as display holograms. In addition, we have hundreds of holograms specifically produced for display and advertising.

Scientific and Technical- Examples of items already in our possession include thousands of holograms produced for a wide range of scientific studies. Among these are holographic interferometry recordings used to measure small changes in optical path length and holograms for the study of 3D phenomena. Example applications include flow visualization, particle field diagnostics, non-destructive testing. The collection includes holograms made in space and holographic optical elements used in space. This class of hologram presents the largest challenge for display in a museum, since scientists usually employ lasers to reconstruct wavefronts from such holograms.

Art-We already have over 50 excellent quality, large format framed holograms that qualify as art holograms. We anticipate that this collection will grow in number and quality quickly. Examples of items already in our possession include a well-known holographic portrait of President Ronald Reagan as well as portraits of many other lesser known people. The collection already contains art holograms produced by well-known artists in the field such as Margaret Benyon and Patrick Boyd.

A Hands-on Station-The latest digital holography technology should make possible producing holograms on demand and at low cost per hologram. We are examining the possibility of creating a station where visitors can place a small object on a platform, push a button and produce a hologram of the object to take away as a souvenir. A future generation of this station is planned to enable the viewer to take a seat, follow instructions and have a holographic portrait as a souvenir.

5. Museum Design

Challenges-Because the four different areas described above cater to four different audiences, the design of such a museum will present a challenge. Critical questions must be considered;

1. Are the different areas and their associated diverse audiences too different to be accommodated by a single institution and in a single museum?
2. Should more than one institution participate?
3. Should exhibits be reduced in number and rotated?
4. Should special shows be accommodated?
5. Should education and research be included?
6. Should a traveling exhibit be incorporated?

Answers to these questions will depend upon the institution, ultimate goals and resources.

Space Requirement and Layout-Part of the proposed work is to design the space and layout for the repository, and here we anticipate what such a design is likely to entail. We anticipate that the areas described herein will reside in three or four separate rooms with a total space 1000-2000 ft^2. Two of the rooms would be designed to provide the maximum wall space to display holograms that hang on the walls. These rooms will contain extensive lighting installations to illuminate holograms with mostly LED sources and also some laser sources. Another room would be designed to house and display artifacts and holography related machinery. A fourth room will require computers, file cabinets, a projection system, and tables chairs. It will be set up as a study for research and would contain files, papers, computers, and digital data.

Typical Display

6. Financing

a. Anticipated Donations

The proposal authors will contribute time and at least $100K in cash in addition to the completed museum. We expect to get contributions from other sources starting as soon as the project is announced.

We will solicit support from interested companies, local and federal government agencies, and individuals. We will offer different degrees of contribution acknowledgement for individuals and organizations that will include donations ranging from $100 to thousands as well as for material donations. Major donors will have their names displayed visibly, while minor donors will receive other forms of acknowledgement such as membership and titles. We will create a "Friends of Holography" list for larger individual donations of cash and content.

b. Requirements and Costs for the accepting institution

The accepting institution will be expected to provide space, utilities, and parking for the collection for an extended period of time. The proposers will hire a full-time curator who will man the repository for the first two years of full operation. After that, the institution will be responsible for providing an individual who will supervise the repository and open it to the public on a regular basis, charging admission or not.

c. Other Sources of Income

We will apply for grants and contributions through the usual sources of arts and sciences foundations. In addition, we will examine the feasibility and benefits of conducting special exhibits, a traveling exhibit, and hologram loans to other qualified museums and organizations for which a charge will be made. An educational program including lectures and printed materials for which charges can be made will also be considered. A gift shop that offers holography related items for sale is a potential source of income. Items such as stock holograms, holography based products, and holograms on consignment could be considered.

It seems entirely reasonable to assume that the repository, if properly managed and promoted, will pay for its continued operation indefinitely.

7. How we differ from other Holography Museums

A technology museum should fuse education and entertainment. Its mission should be to encourage people to engage with the history, impact, and continuing developments of its content. With reference to holography, most museums both past and present have failed to meet these goals for a number of obvious reasons. Some of these reasons have been accurately enumerated by Johnston [4] in-spite of his somewhat limited view of holography. He also presents a strong case for the need of a holography museum. With so many previous failures, showing why our proposal is different and avoids pitfalls of previous attempts, seems important.

The problems with past and current holography museums and repositories.

- **Narrow focus- Most are dedicated primarily to art collections. They provided, almost exclusively, holographic art exhibits.**

Art holography comprises only a tiny portion of the field of holography, and is not one of the success stories of holography. Holography has been largely rejected and, even worse, discounted as a valid art form by the art community in general. Some of the reasons for this appear related to the origins of holography, how it was presented, and the participating individuals. In many cases holographic art was presented with a scientific description and language, employing technical descriptions and gimmickry to draw attention. Some art viewers resented mixing art with science. In some instances, optical technicians, with no art training and little art knowledge, proclaimed themselves “artists”, simply because they could produce good holograms. Early holographic art exhibits comprised pieces that had been produced by a wide range of individuals, including artists, scientists, and technicians, many with essentially no training in art, a very strange, possibly caustic mixture of individuals. Such exhibits, when billed as art, almost universally received disastrous reviews from well-known art critics, and many participating artists felt the need to distance themselves from this particular community.

We will be representing diverse fields such as scientific applications (interferometry, government sponsored research results}, commercial applications (security products, publication industry products, advertising, etc), technology developments, as well as art.

- **They involved mostly individuals who were interested primarily in art holography.**

This created huge gaps, omissions, confusion, and misrepresentation of the history and origins of holographic technology and commerce.

The board of directors for PHI will be selected from a broad range of specialties, including art, industry, technology, and museology. We will cover the entire field and history of holography.

- **Representation of a short time period.**

Most museums do not have adequate access to very early or very recent developments. Our present collection includes documents and example from the earliest inventions and documents beginning in the early 1950’s. We will be incorporating material from many sources and individuals to represent all periods up to the present.

- **Incomplete demonstration of the development of the holography industry.**

Our goal is to provide a relatively complete description of the pertinent patent history, the historical company alliances, physical examples of the multiple failures to create viable large volume products, legal misadventures which plagued the industry, and other important documents and examples which altered the course of development.

- **Lack of engagement with new and future developments related to holography.**

Interest in holography has been ephemeral.

We will be in continuous contact with organizations that are involved in new research and applications. The industry as-a-whole is ever expanding in new areas such as storage devices, 3D TV, and virtual and augmented reality.

- **Incomplete or lack of demonstration of construction and mass production technology.**

We intend to demonstrate these processes with physical components where possible. We are also planning to be able to distribute hologram samples.

- **Existing lighting technology for displaying holograms was difficult and expensive.**

Holograms were not always easy to view. Some holograms could only be viewed with expensive and potentially dangerous lasers.

Lighting technology for holography has improved dramatically with the advent of LED and diode laser sources. LED’s are cheap, operate with low power, produce little heat, and are almost perfect point sources for producing excellent images with holograms. In some cases where holograms are best viewed with lasers, inexpensive diode lasers are now available.

Holography technology has also improved drastically with holograms that are viewable over wide angles and in full color. Many interesting commercial, display, and security holograms are easily viewed with ordinary lighting.

- **None were associated with an established museum.**

The museum will become a branch of a well-established institution experienced in providing museum services to the general public.

- **Some holograms on display were unstable and deteriorated with continuous lighting.**

Knowledge is available for protecting hologram stability and which holograms are more delicate. A system and information will be provided for protecting delicate holograms. Some holograms will deteriorate over time, and a system for accommodating losses will be put in place.

- **Most acted also as a school of holography, providing laboratories and teaching students how to make holograms, placing a relatively large percentage of resources into teaching activities.**

The proposed museum will operate as a museum for the general public. We expect a wide participation with schools and diverse individuals who will be interested in various aspects of the field. Attendants will be able to answer questions about how holograms are made, but teaching how to make holograms is not a goal.

We are able to accomplish these goals because our team will include individuals who have been involved with most aspects of the development and successful application of this industry

8. Schedule

January 2018-October 2018-Proposal presentation period

July 2018-December 2018-Proposal response open period

Januaary 2019-Institution Selection

February 2019-Formal Agreement with institution complete

May 2019Installation Work at institution begins

August 2019-Museum/ Repository opens

8. Resumes

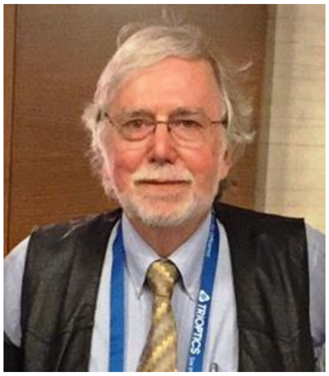
Kenneth A. Haines

Dr. Haines graduated from Queens University in Canada in 1956. In the early 1960's he was a member of the team that pioneered holography under the tutelage of Emmett Leith at the University of Michigan. He left the university in 1967 after obtaining his PhD and served as the Chief Technical Officer for Holotron Corporation, a subsidiary of the Dupont Company which had acquired the holography technology from the university and whose mandate was to commercialize holography. In 1971, he joined the teaching staff at the University of Canterbury in New Zealand. When he returned to the U.S.A., he joined Science Applications, a large national contract research firm. During that time, he contributed to the development of sophisticated interferometric measurement techniques and to the application of holography to medical imaging.

In 1978 Dr Haines founded Eidetic Images, a company that developed methods for mass production of holograms. The American Banknote Company acquired Eidetic Images in 1982 and used this new technology for several high-profile, large volume applications such as the holograms which appear on most credit cards. Dr Haines served as the senior vice-president of American Bank Note Holographics and was in charge of research and development until 1992. Then he and his colleagues started Simian Company in order to develop advanced holographic recording systems. These systems, utilizing computer processed data, were successfully employed to rapidly create many thousands of hologram masters, and the company was sold in 1995 to Republic Powdered Metals, an international holding company.

Dr Haines left RPM in1996, after which time he served in diverse roles such as the technical consultant for OPSEC Company, a producer of 3-D display products, and as the interim Chief Technical Officer for an international telecommunications company, Teltec Global. From 2000 to 2003 he was engaged by an international holography company, Klaser, to implement a research lab in the U.S. and to introduce this company to digital holography methods. He remained as a part-time consultant for ABNH until 2007.

James Davis Trolinger, Ph.D.



Dr. Trolinger is an optical physicist who has devoted his entire career to the pioneering development and fielding of laser-based, state-of-the-art, optical diagnostic methods. During his career he cofounded two successful, high-technology, optical companies, Spectron Development Laboratories Inc., which was acquired by the Titan Corporation in 1986, and MetroLaser Inc., where he has worked since 1988. He and his science teams pioneered many of the first applications of lasers in particle and flow diagnostics and aero covered in over 150 publications of optical diagnostic methods. Among the firsts was fielding holocameras in airplanes for cloud particle studies. He published two AGARDographs on optical flow diagnostics (1974-1988) augmented by visits and research at many laboratories in NATO countries. He has given over 40 invited lectures to audiences in 16 countries, most recently at the Seoul National University and the Korean Advanced Defense Agency (Feb, 2015). Dr. Trolinger served as an investigator on three spaceflight holographic diagnostics experiments (the first US deployment of holography in space) and was the Principal Investigator for the space flight program "SHIVA" (Spaceflight Holography Investigation in a Virtual Apparatus). He currently serves on various advisory boards and committees for professional journals including The University of California, Irvine, Division of Continuing Education.

He was awarded the George W. Goddard award and the Chandra S. Vikram award by SPIE in 2016, and the Aerodynamics Measurement Technique Gold award by the American Institute of Aeronautics and Astronautics for outstanding contributions to aerodynamics and aero optics measurements. Dr. Trolinger received his Bachelor's Degree in Engineering Physics from the University of Tennessee, his Master's Degree in physics from The Louisiana State University and his Ph.D. in Physics from the University of Tennessee.

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