Prehistoric rock art has intrigued and fascinated researchers from around the world for nearly 300 years. Having once been embraced for its cultural and scientific uniqueness, the study of prehistoric rock art showed promise in being able to open new doors of understanding, above and beyond the written record.

In time, however, as archaeological interests gradually shifted towards large scale stratigraphic excavation and chronometric dating of artifact assemblages, the enthusiasm and promise of rock art studies were soon forgotten. Unfortunately, the gradual marginalization of rock art research in academic and professional circles has had a deleterious affect on the disciplines theoretical and scientific growth. Methods of documenting rock art have changed little in over 250 years and still involve techniques of recording that are not only invasive and inaccurate, but time and labor intensive.

If rock art sites are to be effectively documented for management, conservation and scientific research prior to their destruction, then a fundamental shift in our thinking about how we approach and record rock art sites is in order.
This thesis proposes a change to traditional rock art recording methods in which drawings are the status quo. In a comparative study, this thesis demonstrates that when a more judicious use of drawings is adopted in favor of photography and digital imaging, the recording process becomes more efficient and the data gathered is more accurate and less subjective.

In addition, this thesis will demonstrate how photo-editing and digital imaging techniques provide and facilitate the seamless integration of photographic data into the report writing process, and provide new ways in which to view and analyze photographic data scientifically.
Drawing, Photography and Digital Imaging:
A Comparative Study in Rock Art Recording Methodology

by

Gary A. Curtis

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I dedicate this thesis with Love to the three most important people in my life, my Mother, my Father and my Brother Jim.
"No mystery is closed to an Open Mind"
Tim White
CHAPTER 1: INTRODUCTION

During the formative years of anthropology, the study of rock art was viewed as an important component within the theoretical construct of prehistoric archaeology. It was valued both scientifically and archaeologically for its uniqueness and symbolic imagery. In fact, the first archaeological report to be published in North America (New England scholar Cotton Mather - 1714), involved a rock art site in Massachusetts known as Dighton Rock (Molyneaux 1977, Whitley and Loendorf 1994).

Researchers like Mather during the 18th century believed that rock art represented a form of prehistoric writing that in time would assist researchers in understanding the prehistoric past above and beyond the written record. As a result, early anthropologists pursued the study of rock art by examining the historical relationships which connected language to the written record (philology), in an effort to develop a symbolic vocabulary that would effectively decipher this prehistoric enigma (Mallery 1893, Whitley and Loendorf 1994).

Philology and related theoretical approaches directed the course of rock art research well into the 19th Century, occasionally being expanded scientifically by researchers like H.R. Schoolcraft. In the late 1840's, Schoolcraft felt archaeologists would be in a better position to interpret and understand rock art if the various components of rock art were studied in context, historically and ethnographically (Whitley and Loendorf 1994).
As time passed, archaeology "fell increasingly under the positivist influences of geology (especially the deterministic geological principles of stratigraphy and uniformitarianism)" and the biological revolution of Darwinism, philology as a basis for research gave way, "and archaeology became a discipline defined by the techniques of stratigraphic excavation" and chronology building (Whitley and Loendorf 1994:xi-xii).

As a result, only a handful of anthropologists (i.e. Garrick Mallery-1893; Julian Steward-1929; Strong and Schenck-1925; Strong, Schenck and Steward-1930 and Luther Cressman 1937), continued studying and researching rock art as a cultural and archaeological phenomena. But even the interests of these researchers wandered archaeologically over time and the promise of rock art as a means to understanding the prehistoric past was slowly forgotten.

In the years that followed, archaeological interests would continue to focus around large scale excavation and the gap between mainstream archaeology and rock art research continued to grow (Whitley and Loendorf 1994). Unfortunately, the peripheralization of rock art was extended even further during the early 1950's with the development of radiocarbon dating ($^{14}$C). This important procedure for dating organic archaeological materials provided archaeologists with an unprecedented opportunity to develop and place artifacts within a temporal framework.

Unfortunately, early $^{14}$C dating required that organic samples be sufficiently large to get a reliable date and since rock art contained only trace amounts of recoverably organics, dating it accurately was impossible. Inevitably, a disparity arose between mainstream archaeology and rock art dating chronologies (i.e. absolute vs. relative), which in time provided archaeologists with the leverage they needed to justify dismissing

As a result of long term professional and academic marginalization, rock art research has progressed slowly and is rarely integrated effectively into multi-component site evaluation reports. However, as Clement Meighan noted in 1981, whether rock art's archaeological significance is recognized or not, "The professional 'digging' archaeologist should play a more active role in defining and analyzing rock art. Whatever else it may be, rock art is a part of the archaeological record and where it occurs it has to be fitted into the archaeology of a given region. For archaeologists to ignore the rock art associated with their sites is to leave out an important part of their data" (Meighan 1981:72).

Although today rock art studies are gradually being reintegrated into mainstream archaeology, its effective management and conservation as a cultural resource will continue to be elusive until the scope of this resource is fully realized on both state and federal levels. However, to effectively engage in large scale cultural resource management requires that the systems approach used by agencies and researchers to identify, record and analyze rock art are scientifically sound and efficient.

That this is an issue of concern among rock art researchers is reflected by an international poll of leading professional and avocational rock art specialists who agreed that "much of what has previously passed for rock art recording has [had] very limited use due to [its] lack of rigor and forethought" (Walt and Brayer 1994:6). Most researchers would agree that, a disciplines scientific creditability and growth depends largely on the accuracy and thoroughness of it's recording process. To remain viable as a
research mechanism it is important that the documentation process be consistent, rigorous and dynamic. When recording methodologies are found to be inconsistent, inaccurate and inefficient they should be carefully examined and where appropriate revised. This thesis will examine such a problem in rock art recording methodology.

**Purpose of Study**

The techniques used to document rock art as a prehistoric artifact have changed little in nearly two hundred and fifty years. This process, with few exceptions involves both invasive and noninvasive recording techniques. In some cases, these techniques are not only inaccurate and time consuming, but they infuse an unnecessary level of subjectivity into the data during the recording process. In many quarters, drawing rock art designs is still the principal method of documentation, a process for gathering data that is time consuming, inaccurate and very subjective.

The purpose of this thesis is to: 1) compare the strengths and weaknesses of two recording techniques commonly used in rock art research, drawing and photography, 2) to design a comparative study that compares these techniques under field and office conditions, and 3) demonstrate how the use of photography and digital imaging can effectively improve recording procedures in terms of accuracy and efficiency. In addition, this study will demonstrate the powerful editing and analytical capabilities of digital imaging and how it can be applied to rock art recording methodology.

Accurate and efficient recording of rock art sites has been bottle-necked over time by an over reliance on formal drawings, poorly designed recording forms and the frequent use of untrained and inexperienced personnel. If researchers are to realistically
address management and conservation issues effectively, then it is essential that the recording process provide as much information in the least amount of time without sacrificing data quality or consistency.

Definition of Terms

For the purpose of this thesis, the term rock art will be used to define a class of prehistoric artifacts whose articulation involves the placement of design elements on the surfaces of boulder, cliffs, caves and rock outcrops.

Over the past decade, use of the term 'rock art' to describe prehistoric/historic cultural paintings and carvings has come under attack by professional and avocational researchers because "it imposes a preconceived interpretation of the subject matter it labels -- much of which is not art" (Swartz 1991a:111). Although I respect and understand the reasoning behind such arguments, until a better term is developed and accepted for this particular class of artifact, the terms rock art and design elements will be used throughout the course of this thesis.

In general, rock art designs are manufactured in one of two ways: 1) Pictographs, (Figure 1.1) which are design elements painted or drawn onto a rock's surface; or 2) Petroglyphs, (Figure 1.2) design elements that are created through the act of pecking, scratching, carving and/or abrading a rock's surface (Steward 1929, Heizer and Baumhoff 1962, Meighan 1981, Schaafsma 1985).

Although rare, occasionally rock art manufacturing techniques are combined into one design or a series of designs (i.e. petroglyphs that are also painted), but a term has yet to be designated for this occurrence. When rock art design elements are found separately
or in combination upon the natural landscape (i.e. boulder, cliffs, caves, rockshelters), and in a defined area, the encompassing area is referred to as being a rock art site.

Figure 1.1: Pictographs from Klamath Falls, OR (G.Curtis).
Research Design

The database used for this thesis covers more than 100 years of research and development in archaeology, rock art and computer science technology.

The focus of this study examines drawing, the principal method in which rock art sites are traditionally documented. A method of recording that inherently weakens the scientific structure of the data gathered because the technique itself is inaccurate and subjective. The study will test whether or not advances in digital imaging and the use of photography and other automated recording systems, can effectively improve recording methodology in terms of accuracy and consistency, and thereby providing a more effective and efficient approach for recording rock art in the future.

Recording a rock art site can be accomplished on a number of different levels and through a variety of techniques. Unfortunately, many of the traditional techniques used to record rock art sites over the past hundred years or so (see Loendorf, Olson, Conner and Dean 1998:4-5) are not only subjective and inaccurate, but they have, during the recording process, imparted long term negative impacts onto the artifact itself (Loendorf, Olson, Conner and Dean 1998, Lamberts 1989, Lee 1991, Price 1989, Sanger and Meighan 1990, Rosenfeld 1988, Walt and Brayer 1994).

Although some methods of invasive rock art recording like tracings and rubbings, can be helpful in acquiring information under specific circumstances and when applied by a trained and experienced professional, techniques such as moldings, castings, chalking, charcoal, crayons, aluminum powder, oil paint, marine varnish and kerosene, are highly destructive, damaging not only the artifact, but the chemistry of the substrate it's been placed on. Such technique should never be used except under the most extreme
circumstances (i.e. a rock art site is in immediate danger of being destroyed) and then only by, or in the presence of trained professionals.

Although recording standards have gradually improved over time and the necessity for preservation and conservation of these sites is slowly being integrated into the various land managing agencies nationwide, a standardized approach to recording and managing rock art sites as a non-renewable resource has yet to be adopted by the rock art research community as a whole (Swartz 1980, 1985, 1991b, 1993, Walt and Brayer 1994, Murdoch 1996).

This does not negate however, the requisite for developing efficient and scientifically relevant recording methodologies. More efficient and expeditious recording of rock art sites would inevitably lead to further development of regional and national database facilities for inter and intra-site correlation, which in turn would strengthen the disciplines overall theoretical foundation. Until these goals are fully addressed and realized, rock art research as a discipline will always remain 'outside' the realm of credible scientific and archaeological pursuit.

For the purposes of this thesis, the following questions will examined 1) Can data acquisition under normal rock art recording conditions be improved quantitatively and qualitatively by a more liberal use of photography over drawing, while using digital imaging and other automated recording techniques to assist?

2) can digital imaging be applied analytically to photographs as a means of attaining new and previously unavailable data? and 3) Can digital imaging techniques be used to troubleshoot and correct photographic problems which in the past have rendered photographic efforts to be less accurate and less effective?
In terms of rock art recording methodology, these questions have importance scientifically and methodologically. With the steady march of technological growth and its subsequent integration into our daily lives, incorporating even some of the smallest technological improvement into a disciplines recording methodology can have system wide benefits. In the following section, I will briefly examine these questions and their method of application and resolution.

Methods

1) Can data acquisition, under normal rock art recording conditions, be improved quantitatively and qualitatively by a more liberal use of photography over drawing, using digital imaging and other automated recording techniques to assist?

To investigate this question effectively, it was necessary to design a comparative study between drawing and photography, where under field conditions, these techniques could be evaluated and analyzed in terms of data acquisition, data accuracy and consistency, and recording efficiency.

The following steps will outline the basic structure for the implementation of this study: a) initiate a site survey to identify and document the sites cultural components, establish site boundaries and a datum (s), and render a site map with the survey results; b) locate, label, and record a selected set of rock art panels using manual drawing techniques, hand written notes, sketches etc., and document the time, effectiveness and accuracy involved, c) photograph the same panels drawn in step b), record notes/observations with a tape recorder (and transcribe later), use digital imaging to edit,
and analyze photos, and again document the time, effectiveness and accuracy involved and d) compare the results of steps b and c to determine which methodological approach provides the accurate and most efficient results.

2) Can digital imaging be applied analytically to photographs as a means of attaining new and previously unavailable data?

In question two, I investigate how researchers can reveal additional information from a photo that prior to the advent of digital imaging was unavailable. Examples of such exploration might entail the clarification, and color enhancement of faded pictographs, to revealing the 'hidden' nature of a design element, whose surface has been partially obscured by lichens, mosses, or patina. A process that is relatively straightforward for a computer but impractical or impossible to attain through normal photographic or drawing processes.

3) Can digital imaging techniques be used to troubleshoot and correct photographic problems which in the past have rendered photographic efforts static, or less accurate and effective?

Question three addresses common photographic problems one encounters in the lab or office, but which go unnoticed until fieldwork has ended and film processing is completed. Such problems might include photographs with poor lighting or contrast, photographs exhibiting color shifting and saturation dispersion, or even photographs displaying poor clarity and blurring. In addition to these photographic concern, there are those photographs where quality is not the problem but content is lacking, that is to say, a photograph was taken without a reader board for instance, or there is no scale or north arrow.
To demonstrate how these problems can be resolved using digital imaging, slides were first professionally scanned onto a photo-CD by Kodak, uploaded from a CD ROM into a computer, and then edited digitally using one of two photo-editing/paint programs (Adobe Photoshop and CorelDraw), to achieve the desired results.

Selecting a Project Area

Before the comparative study could be initiated however, a rock art site had to be selected. With the assistance of Bill Cannon (Lake Co. BLM Archaeologist), Fortyfour Lake rock art site was chosen for the study named and is just southeast of Hart Mountain (T37S R26E sec. 31 / T38S R26E sec. 6). Fortyfour Lake was chosen for the project not only because the area needed further exploration and documentation, but because the site would provide a variety of challenges in recording. Arrangements were made with the BLM to access the site in June of 1994 and research permits were attained from the Oregon State Historic Preservation Office in Salem.

Digital Imaging and Archaeology

As of 2001, the archaeological community has yet to fully recognize or appreciate the enormous potential digital imaging technology can bring to the discipline (i.e. educationally, scientifically and operationally). Not only would such integration save time and money, but the process of acquiring, analyzing and interpreting data would be able to expand into areas of research previously unrealized.

For example, during the course of excavating a 1 meter by 1 meter archaeological test unit, digital imaging techniques could be used to: 1) create a layer by layer photo-
accurate soil profile as work progresses; 2) create a three dimensional site profile that reflects the sites various components in context; or 3) digitally reconstruct a site excavation methodology and use the acquired data analytically, or educationally as a hands-on interactive teaching simulation for entry level archaeological students (c.f. Dibble, McPherron and Roth 2000, Dibble and McPherron 1989, 1996).

Photo-imaging techniques can be a powerful tool in the office as well, providing digital solutions for a number of common photographic problems, including: photographs without a reader board, reader boards and scales that are illegible, pictures that display poor color balance, contrast, or focus. Photo-imaging techniques can also be used to reveal 'hidden' details of a photograph that would be invisible to the naked eye under normal viewing circumstances.

When the work is finished (i.e. maps, text, drawings, photo's, etc.), the collected data can be easily and safely stored on rewrite-able compact discs for long-term storage and accessibility. Although frequent handling and office use of data CD's will shorten long term storage life, it is by far the most efficient and most durable storage medium we have available for digital information.

According to recent studies by Kodak:

Long life for any information storage medium is always a combination of manufacturers and users responsibilities. Repeated tests show that 95% of Kodak write-able CDs will have a data lifetime of greater than 200 years if stored [under archival conditions] in the dark at 25°C, 40% relative humidity (RH). Stored in an office or home environment, the lifetime should be 100 years or more (Kodak 2000:1).
However, with the accelerated growth of computer technology in today's world, there is an acknowledged concern that the data stored on today's state of the art mediums might be rendered unreadable or unusable in the future.

While such concerns are valid, the continued growth of computer science technology has actually increased our ability to upgrade and transfer obsolete technological formats to current standards. Taking into consideration the longevity of today's storage media, there is no reason to believe that our ability to upgrade older storage media will deteriorate at any time in the foreseeable future.

Because of digital imaging's impressive array of recording and analytical possibilities for rock art research, I decided to explore this imaging technology as a means of improving traditional rock art recording practices. As a result, after consultation with my committee chair and the BLM, a comparative study was designed to test these techniques at Fortyfour Lake rock art site in southeastern Oregon.

**Summary**

The purpose of this thesis is to determine if under normal circumstances, the use of photography and digital imaging as a primary recording approach, can qualitatively and quantitatively improve an otherwise inefficient and inaccurate recording process in which drawings are the status quo.

Equally important to this study is in determining whether or not digital imaging techniques can provide new opportunities for artifact analysis and identification that have been previously unavailable in the field of prehistoric rock art research.
In Oregon, literally hundreds of rock art sites remain officially unrecorded. In addition, when rock art sites are investigated and documented, the methodology being used lacks proper guidelines and rigor for effective scientific research and management. This poses a serious problem for researchers and cultural resource managers. If cultural resources programs are to effectively protect and manage rock art as a cultural resource, and if the discipline of rock art research is to evolve and garner credibility among its constituents, then a fundamental change in how rock art is viewed and documented is in order.

**Thesis Structure**

This thesis is presented in five chapters. In Chapter 2, Oregon's rock art is placed in environmental context geographically, geologically and climatically, and followed by a discussion on how these environmental forces can impede effective documentation and promote substrate degradation and deterioration. Chapter 2 concludes with a review of those individuals who have contributed Oregon's rock art research heritage.

Chapter 3 discusses the process of rock art recording and examines the pro's and con's of drawing and photography in rock art recording methodology and concludes with a discussion on digital imaging technology. Chapter 4 reviews and discusses the comparative study between drawing and photography and illustrates where digital imaging techniques can be used to improve the recording process. Chapter 4 closes with a demonstration of how digital imaging techniques can be used to trouble shoot common photographic problems in rock art recording. Chapter 5, the final chapter, summarizes the study results and discusses the effectiveness and limitations of the current study.
CHAPTER 2: OREGON ROCK ART: ENVIRONMENTAL CONTEXT AND PREVIOUS RESEARCH

This chapter provides a synthesis of the environmental and climatic setting of southeastern Oregon and discuss how these dynamic forces both impact and assist rock art recording. The chapter will close with a review of those researchers who have made contributions to Oregon's rock art heritage.

Environmental Setting

Fortyfour Lake rock art site lies within the archaeological and geographical boundaries of the northern Great Basin (Figure 2.1). Spreading across central and southern Oregon "the northern Great Basin is a high desert covered with hardy, low

Figure 2.1 The hydrographic Great Basin (after Grayson 1993). ▲ = Fortyfour Lake (graphics by G.Curtis).
growing plants that form an extensive shrub-steppe biotic community" (Aikens and Jenkins 1994:2).

Spanning more than 165,000 square miles, the hydrographic Great Basin "centers on the state of Nevada, but also includes much of eastern California, western Utah, southcentral Oregon and small portions of southeastern Idaho and Wyoming " (Grayson 1993:11). Named in 1843 by John Fremont during an expedition into the Pacific Northwest for the U.S. Bureau of Topographical Engineers, the Great Basin represents a region whose drainage systems are uniquely closed hydrographically.

Early reports on the Great Basin come from documents kept by early Spanish explorers who during the late 1700s were searching for ways to connect their holdings in California with those held along the southern fringes of the Great Basin. By the early 1800s American, British and Canadian fur trappers were exploring the northern portions of the Great Basin, whose records provided valuable information regarding the people they encountered that were traveling along the Oregon Trail (d'Azevedo 1986).

**Southeastern Oregon**

Southeastern Oregon is a broad plateau of late Cenozoic basalt that is bordered to the north by the Columbia Plateau and to the east by the Western Snake River Basin. Spanning nearly 250 miles along it's east-west axis and 200 miles along it's north-south axis, southeastern Oregon is a semi-arid, sparsely populated stretch of land commonly referred to as the "High Desert " (Hatton 1988:1).

Geologically young, Oregon is divided into nine physiographic provinces (Figure 2.2), four of which are represented in southeastern Oregon. These include the Blue
Mountains, the High Lava Plains, the Owyhee Uplands and the Basin and Range. Fortyfour Lake is located in the Basin and Range portion of southeastern Oregon, an area that is geographically and geologically defined by "a series of long and narrow, north-south trending fault block mountain ranges alternating with broad basins" (Orr, Orr and Baldwin 1992:79).

Figure 2.2: The Physiographic Provinces of Oregon
(after Dicken 1965, in Baldwin 1976:5)

△= Fortyfour Lake

The Basin and Range topography of southeastern Oregon is the result of two major geological processes (Figure 2.3), that began shaping the region's landscape roughly 20 million years ago during the middle Miocene, these were volcanism and extensional plate tectonics. Stretching and gradual cracking of the outer crustal plates
eventually caused smaller plates of land to tilt and raise up and form many of the fault block mountains ranges that characterize this area.

The largest fault block formations in southeastern Oregon are the Steens Mountains. The Steens are a range of mountains that rise 2967 meters above sea level and are located southeast of Fortyfour Lake. Hart Mountain, probably the "best defined
fault-block mountain in the United States" rise to an elevation of 2350 meters above sea level and is located just north of the project area (Orr, Orr and Baldwin 1992:79).

During the Pleistocene and Holocene epochs, many areas in the northern Great Basin, including southeastern Oregon were exposed to violent volcanic eruptions. These volcanic events produced high levels of tephra and ash fallout that not only influenced environmental and climatic conditions over much of the area, but had a profound impact on the regional distribution and adaptive behavior of human populations (Matz 1991, Axelrod 1981, Bacon 1983, Franklin et al. 1985).

Volcanic Activity and Rock Art

In the last thirty years, tephra-studies have become increasingly important to archaeologist as a means of being able to identify and understand past environmental and climatic conditions, and to examine how prehistoric populations were able to adapt to these extreme environmental conditions (Matz 1991). Tephra deposits have also been able to assist archaeologists in dating prehistoric assemblages when they are directly associated with a particular volcanic event.

When tephra deposits partially or fully bury a rock art panel for instance, chemical analysis of the tephra and $^{14}$C dating of the organic fragments (if available), can tell researchers when and from where the tephra deposit came from. Tephrachronology can also provide researchers with a means to place a minimum age to rock art that is associated with a particular event horizon. An example from Lake County Oregon can illustrate this point.
During the early 1990's, archaeologists found that the designs of a particular rock art panel at Long Lake continued down below the ground surface. After performing an excavation adjacent to the rock art panel, it was found that the designs continued down into the soil until they were below a layer of Mt. Mazama ash (Aikens 1993, Ricks and Cannon 1993, Ricks 1996).

Since Mt. Mazama's last eruption occurred approximately 6800 years ago (Matz 1991, Grayson 1993, Orr et al. 1992, Aikens 1993) it is apparent that this particular rock art panel (and perhaps others in the area with the same stylistic attributes and degree of patination), is at least 6800 years old and possibly older since the lowest carvings on the panel "were buried in clay that had already accumulated against the rock before the volcanic ash was laid down" (Aikens 1993:79).

Although such opportunities to date rock art are not always available, tephra studies do provide an intriguing example of how environmental and geological context can contribute to our understanding of prehistoric cultures.

*Climate*

Although southern Oregon's climate varies depending on regional topography, the climate of southeastern Oregon is characteristically defined as warm and dry. Spring provides brief showers and occasional thunderstorms, with temperatures ranging from the mid 60's to high 70's across much of the region. Summers are generally warmer and more arid, and can fall into long periods of very hot, drought like conditions. After periods of prolonged heat, it is not uncommon for tropical moist air to move in from the gulf of California, resulting in thunderstorms that frequently cause flash flooding and
range fires (Hatton 1988: 18). Minor et al (1979:8) summarizes this region's spring and summer climatic profile best by characterizing the area as having "light precipitation, low relative humidity, rapid evaporation, abundant sunshine and extreme ranges in temperature."

Winters are typically cold with occasional snow flurries interspersed with short but intense periods of snow fall. While Marine influences have had a moderating effect on climate for areas west of the Cascades, influencing winter temperatures to stay around 40 F to 50 F degrees, midwinter high temperatures for areas east of the Cascades typically range from 35 F to 39 F degrees (Hatton 1988:14). Annual precipitation for southeastern Oregon ranges from 25 to 50 centimeters a year and elevations within the project area range from a high of 2967 meters to a general floor elevation of 1219 to 1524 meters above seal level.

Environmental Effects on Rock Art

Pictographs and petroglyphs are cultural artifacts whose creation involves the use of rocks and minerals. Intrinsically a part of the natural landscape, rock art is constantly exposed to the forces of weather and climate. The impacts resulting from such exposure are not only complex, but require a multidisciplinary approach to understand.

In the following discussion I will review some of the key factors responsible for rock and rock art decay in a natural setting. Readers seeking further information beyond the framework I have presented, are encouraged to explore the following resources: Blackwelder 1927, 1933, Crotty 1989, Dolanski, 1978, Dorn and Oberlander 1981, 1982, Hughes 1978, Keller 1977, Lambert 1989, Lee 1991, Lewin 1982, Pearson

_SETTING THE STAGE_

In natural landscapes, the rate of deterioration along a rock's surface and/or its underlying structure is rarely consistent, or uniform. It is the result of numerous environmental, biological and chemical interactions, each operating independently or in conjunction with other processes. Processes that are actively working at all times towards degradation and decomposition of the parent material.

The complexity of identifying and studying these processes becomes apparent when one considers the numerous processes that are at work in the natural environment, including rapid changes in temperature and/or humidity, freeze/thaw cycles, orientation and degree of exposure, susceptibility to wind and wind-borne particulates (such as sand), exposure to water (and water soluble pollutants), insolation, chemical and mineral composition of the parent rock, and macroscopic and microscopic surface features such as cracks and fissures that provide footholds for cryptogamic organisms. Even different types of rock art (i.e. petroglyphs or pictographs), can effect the ways in which a rock surface weathers and/or deteriorates.

_WATER_

Pervasive throughout Nature, water is by far the most familiar element involved in the deterioration of rock art. Achieving decomposition in ways that are both subtle and
gross, water can impact the integrity of a rock, in a number of different ways. One of the most obvious way in which water affects rock art, rock surfaces and rock structure is through precipitation, or rain fall. Moisture aggregating and falling as rain may, or may not contain soluble chemicals and minerals held in suspension.

When it does, these pollutants can affect a rocks basic chemistry and/or pH in a number of ways. Another method in which water breaks down rocks is through wave action. Here the process is not only physical, but the recrystalization of soluble salts and minerals prevalent in both lacustrine and coastal settings, can cause decay and attrition. Runoff and water flow can also have a dramatic effect upon a rocks integrity and the longevity of the rock art it supports.

This process can be particularly damaging to pictographs where such events can:
a) result in the deposition of clays, salts, and other minerals onto the rock surface, obliterating and/or filling in design elements, b) result in the leaching out of pigments from a rocks surface, and c) by creating a suitable environment in which lichens, mosses and algae can grow (Rosenfeld 1988, Lambert 1988).

Water can also attack the integrity of a rocks structure or surface from within. Held within the interstitial pores of a rocks matrix , water will, depending on the rocks pore size distribution and porosity, "percolate through the rock matrix, dissolving its soluble constituents" like salts and minerals (Price 1989:18). These solutions eventually migrate towards a rocks surface as a result of capillary action, the rates of which are generally controlled by the humidity and temperatures in a given region. Once moisture reaches a rock surface, evaporation from the sun and wind encourage deposits to form.
During the process of evaporation and the movement of water across a rock surface, pooling can occur in which small micro and macroscopic irregularities in a rock's surface act as accumulation centers for the deposition of salts and minerals. This can cause severe problems when during recrystallization, expansion occurs resulting in grain by grain attrition, or worse yet, exfoliation and spalling (Price 1989, Rosenfeld 1988, Lambert 1988). Water within a rock's matrix can also cause stresses which, during rapid changes in temperature, or during freeze/thaw cycles, will result in the spalling and/or exfoliation of a rock body. In general terms, as water moves across an exposed rock surface, at least two possibilities may result, 1) the weathering of that surface or 2) the promotion of a mineralizing accretion or patina.

**Weathering**

Weathering generally involves two types of decay 1) mechanical and 2) chemical, like those discussed earlier. The American Geological Institute (Bates and Jackson-editors, 1984:316), defines mechanical weathering as the process in which "frost action, salt-crystal growth, absorption of water, and other physical processes break down a rock into fragments, [without] involving a chemical change" in the rock's structure. This type of decay can be particularly damaging to rock art since the resulting cracking, spalling and exfoliation can completely destroy a rock art panel.

Chemical weathering (Bates and Jackson-editors, 1984: 84-85), on the other hand, is the process in "which chemical reactions (hydrolysis, hydration, oxidation, carbonation ion exchange and solution), transform rocks and minerals into new chemical combinations that are stable under conditions prevailing at or near the earth's surface".
Although this type of weathering generally develops more slowly, it can have an equally damaging effect on rock art in the long term by deteriorating the integrity of a rock's structure, as well as obscuring or obliterating the surface of a rock completely. Unfortunately, for rock art researchers both processes work equally well in achieving a fundamental goal in Nature, the physical and chemical degradation of a rock's structure.

*Silcrete Skins, Patina (Desert Varnish)*

The accretion of films, skins and patinas, frequently characterize the surface of rock formations in the 'High Deserts' of Oregon. Silcrete and Desert Varnish, being two of the most common forms to occur. Although the accumulation of minerals on a rock's surface can be complex compositionally, silcretes and patinas are fairly straightforward structurally.

*Silcrete Skins*

Silcrete skins form layers on a rock's surface that can be virtually invisible to the unaided eye, or they can be completely opaque. Frequently a creamy white, silcrete skins are accretions that are primarily composed of amorphous and cryptocrystalline silica (SiO₂), with remnants of manganese (MnO), titanium (Ti), and iron oxide (FeO). Dolanski (1978), one of the first to describes the formational process of silcrete skins as they apply to sandstone surfaces in New South Wales in Australia, considers that silica skins result from the hydrolysis of feldspars and not crystalline quartz solution (Rosenfeld 1988).
"Because they are hard, relatively impervious and chemically stable, silcrete skins form very stable rock surfaces. Where [pictographs] have been applied to the rock surface before, or during formation, they become embedded within the silcrete deposits and the paintings are as stable as the rock surface itself" (Rosenfeld 1988:23). When silcrete skins cover a rock surface, (and are not a part of the rock's fabric), and contain more than just a trace of iron oxides and clays held in suspension, they can leave an opaque covering over a rock's surface that can completely obscure the rock art below it (Walston and Dolanski 1976).

*Patina*

In the 'High Deserts' of southern Oregon, almost all of the exposed basalt rock outcrops, boulders and rimrock cliffs exhibit a reddish brown to dark grayish black surface coloration, commonly referred to as rock or desert varnish. Rock varnish (or patina), is a thin film or skin generally less than 200μm thick and is formed not by the process of weathering, as once commonly thought, but instead by cementation and accretion (Dorn and Whitley 1983, Dorn 1994, Rosenfeld 1988).

Although rock varnish is composed primarily of clays cemented onto a rock's surface, and bound together by iron and manganese oxides (Rosenfeld 1988, Potter and Rossman 1979), its chemistry, structure and color can vary greatly.

Found in both moist and dry environments, rock varnish is generally the surface skin Native Americans breached during the process of creating a petroglyph design on a cliff, boulder, or basalt outcrop. When recording a petroglyph site, one often encounters varying degrees of patinization across a rock's surface and on the designs themselves.
One of the major problems in recording a petroglyph site occurs when the design elements one is documenting, have been completely repatinated. One can literally be standing in front of a panel of petroglyph designs, and not see them unless the angle of lighting is just right, because the surface of the rock has been completely repatinated. Photography is frequently ineffective even when using special techniques, and drawings can be exceedingly difficult to render since much of the details are obscured, forcing one to guess at filling in the missing attributes.

Rubbings, while effective at times in recording heavily patinated petroglyphs designs, is nevertheless a time consuming process that results is a document that is difficult to store and curate, and involves a process of recording that frequently damages the artifact by exposing the artifact and rock surface unnecessary chemicals (Loendorf, Olson, Conner and Dean 1998, Walt and Brayer 1994, Price 1989, Rosenfeld 1988, Lambert 1988).

However, with the advances currently underway in computer science technology, photography and photo-imaging software, problems in documenting rock art more safely and accurately are now being more effectively addressed.

**Dating**

Assuming that design elements made at the same time will weather in a more or less consistent manner, given shared conditions such as orientation, inclination and degree of exposure, the degree of patinization can aid archaeologist in determining relative age of the design elements (especially petroglyphs) present on a given panel.
These differences can also be used to separate stylistic elements, resulting in the possible correlation and eventual determination of the cultural groups once occupying a given area.

Absolute dating of rock art however, is still being refined. While the level of confidence is higher in the dating of pictographs (Clottes 1994, Chaffee, Hyman, and Rowe 1994), due to the fact that organics (such as urine, fat and blood), are frequently used as binding agents with the mineral pigment (such as red ochre or hematite), and therefore can be dated by accelerated mass spectrometry (AMS), $^{14}$C dating, efforts in determining the absolute dating of petroglyphs is still being developed.


Other Considerations

There are a number of other agents (biologically, chemically and physically), that can effect the decay of rocks and rock art in a natural setting. Bacteria on a rocks surface can cause corrosion by converting atmospheric nitrogen into ammonia, allowing other types of bacteria to oxidize the ammonia into nitric acid (Schaffer 1972, in Rosenfeld 1988). Nitric acid will eat way at a rock surface causing it to become pitted and gouged.
Another type of bacteria can convert the sulfur found in bird droppings into sulfuric acid, which is another highly corrosive chemical.

Lichens and algae can derive sustenance directly from the atmosphere and a rock's mineral composition. This can be achieved "without the intermediary of organic products" commonly found in soils, that other colonizers of rock surfaces may need (like mosses and fungi). All lichens can cause damage to a rock's surface through physical and chemical assault and as a result, open the door for further deterioration and encroachment to occur (Rosenfeld 1988:40).

Mud structures built by wasps, termites and birds also play a role in the decay of a rock's surface. These structures are not only abrasive to a rock's surface, but the mineral and chemical rich soil, laden with bacteria and other organisms will constantly attack the integrity of a rock's structure. When such structures are of sufficient size and number they can completely obscure the visibility of the artifact below. Remnants from past mud building activities can cause damage as well since they tend to accrete onto a rock's surface making it difficult to remove without damaging the underlying artifact.

Rock art and rock surfaces are also impacted by larger animal, including humans. This holds particularly true for rockshelters and caves where animals can have long term contact and impact on a rock's surface through excreta, physical contact and stirring up sand and dust particulates into the air that can act as an abrasive element on rock surfaces.
Rock Art Research in Oregon

Rock art refers to a class of artifacts whose genesis involves the placement of design elements onto a rock's surface. These design elements may either be painted or drawn (pictographs), or pecked, engraved and scratched onto a rock's surface (petroglyphs). Considered a fundamental aspect of prehistoric Native American religion, rock art has intrigued and fascinated researchers for over 250 years.

In the latter half of the 19th century, when anthropology was just in its infancy, encounters with Native American rock art fueled the imagination of many Great Basin explorers (Bruff 1873, Loew 1876, Simpson 1876, Angel 1881, Taylor 1860, 1861), the mysteries of which provided a catalyst for future research. And yet today, after 250 years of research worldwide, pictographs and petroglyphs as manifestations of prehistoric culture, have relinquished little as to their meaning and role in Native American societies.

Nevertheless, early archaeologists and ethnographers, such as Garrick Mallery, Julian Steward, and Luther Cressman, recognized that rock art was a unique and important class of artifact to study, an artifact perhaps singular in its potential to offer insights into the psychology and ideology of the prehistoric mind. As a result, these pioneers of prehistory led the way in exploring Oregon's rock art legacy and in time, others followed.

_Garrick Mallery_

One of the earliest researchers to address Oregon rock art is Col. Garrick Mallery. In 1879, after leaving Fort Rice on the upper Missouri River, where he was serving out
his military command, Col. Mallery was appointed 'ethnologist' for the recently formed Bureau of Ethnology.

While it is not clear whether Mallery actually visited Oregon, in his classic work *Picture-Writing of the American Indians*, three areas in Oregon (The Dalles, Gaston, and north Klamath Falls) are briefly discussed.

This work was published as part of the Tenth Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, between 1888-89. Mallery felt that "picture writing is a mode of expressing thoughts or noting facts by marks which at first were confined to the portrayal of natural or artificial objects" (Mallery 1893:25). He further states that picture writing "is one distinctive form of thought-writing without reference to sound, gesture-language being the other and probably earlier form" (Mallery 1893:26).

Although several researchers were investigating Oregon's rock art prior to Mallery, most notably (Abbot 1857-in the Klamath Basin, Denison 1878-near Chiloquin Oregon, from Swartz 1978), Mallery's overall scope of work in rock art research was enormous, not only encompassing North and South America, but Africa and Asia. As a research document for comparing rock art and ethnographic accounts on a grand scale Mallery's work stands alone.

*Julian H. Steward*

Receiving his Ph.D. in Anthropology in 1929 from the University of California, Berkeley, and apparently the first professional anthropologist to do his doctoral dissertation on rock art (Petroglyphs of California and Adjacent States). Steward was the
first person to use the terms 'pictographs' for painted images and 'petroglyphs' for carved
or abraded images normally found on a rock's surface (Grant 1983).

From 1924 to 1926, Steward joined ranks with Strong and Schenk resulting in
surveying the archaeological resources along the Columbia River between Portland and
The Dalles, Oregon (Strong, Schenk and Steward 1930). It was during this two-year
period that many of the pictographs and petroglyphs along the Columbia River Gorge
were recorded. Although a report of their findings was published in 1930, it is an
unfortunate fact that the majority of these sites are now under water as a result of
Bonneville Dam being constructed on the Columbia River in 1938. Steward felt that if
researchers were able to study the symbolism and artistic elements of modern day tribal
groups that greater insight into the meaning and purpose of rock art could be ascertained
(Steward 1929:224).

While this implies a sustained continuity of culture through time, "as well as an
artistic connection between prehistoric" rock art and other culturally expressed artistic
forms (Heizer and Baumhoff 1962:5), Steward's ideas are assuredly worth pursuing.
While Steward is better known for developing ethnographic models of the Shoshone and
Desert Cultures, his documentation of rock art along the Columbia River was in the end,
fortuitous for us all.

**Luther Cressman**

In 1929, Luther S. Cressman became the first anthropologist to be hired by the
University of Oregon in Eugene. Known as "The Father of Oregon Archaeology",
Cressman began working at a site located in south-western Oregon known as Gold Hill in 1930 (Aikens and Jenkins 1994). His pioneering multidisciplinary approach to archaeological research was "a landmark in the broad application of interdisciplinary perspectives...an approach taken for granted today, but extremely rare in the 1930s" (Aikens and Jenkins 1994:iii).

In the spring of 1932, Cressman began a five year project that was designed to systematically study the petroglyphs of Oregon. To facilitate his analysis of artifact distribution, Cressman divided Oregon up into seven physiographical regions (Cressman 1937). His research encompassed not only the high desert country of central, eastern and southern Oregon, but extended into the Cascades and Willamette Valley.

In 1935, Cressman established both the Department of Anthropology and the State Museum of Anthropology at the University of Oregon. In 1937, the same year Cressman's research into Oregon's rock art resulted in the publication of his second monograph, Petroglyphs of Oregon, Cressman was shown Fort Rock Cave by Forester Walter Perry, which in the years to follow, allowed Cressman and his protégé Stephen Bedwell to establish for the first time the antiquity (11,000 to 13,200 BP) of the Northern Great Basin. (Aikens and Jenkins 1994, Bedwell 1973).

Cressman's monograph on Oregon's rock art describes 60 sites, 15 of which are in Lake County. Among the sites recorded by Cressman between 1932 and 1936 are: red pictographs at Devils Lake Pass in the Oregon Cascades, white pictographs at Dry River Gorge just east of Bend in central Oregon, petroglyphs at Long Lake, and rock art sites just south of Hart Mountain and east of Warner Valley. Cressman retired from the
University of Oregon in 1963, but continued his work in the Fort Rock Basin well into the 1970s.

B.K. Swartz Jr.

Currently a Professor of Anthropology at Ball State University, Muncie, Indiana, B. K. Swartz, Jr. has been an active rock art researcher for more than forty years in the United States and abroad. A native of California, Dr. Swartz received his Ph.D. in 1964 from the University of Arizona for his work on testing archaeological procedures from excavations along the south shore of Tule Lake (Swartz 2000).

Swartz's research involving Oregon's rock art was undertaken between 1959 and 1961. During this period Swartz conducted "an appraisal of the petroglyph resources of the Klamath Basin" (Swartz 1978:13), for the Klamath County Museum in Klamath Falls, Oregon, where he was Curator. A total of 119 rock art sites were recorded "within the drainage of the Klamath River east of the Coast Range, 55 of which were, or included pictographs" (Swartz 1978:3, 2000).

An advocate for the preservation of rock art data by intensive documentation, Dr. Swartz has made important contributions in rock art recording methodology (Swartz 1980, 1991d). In 1980, Dr. Swartz compiled and edited a statement on behalf of the American Committee to Advance the Study of Petroglyphs and Pictographs proposing that a minimum set of standards be adopted for rock art recording (Swartz 1980, 1991a, 1991b, see Appendix 1).
Recently, Dr. Swartz has established through his website a Global Archive of Prehistoric Rock Art Photographs (http://web.bsu.edu/rockart/) to assist in storing and disseminating photographic data to researchers throughout the world (Swartz 2000).

*Malcolm and Louise Loring*

In the early 1960's, Oregon's rock art inventory was significantly expanded by a husband and wife team, Malcolm and Louise Loring. The Lorings worked diligently for a number years researching and recording rock art sites throughout southern Washington, Oregon, and western Idaho. In Oregon, the Lorings documented 247 rock art sites, all of which were organized by county. Of the sites recorded, 88 were located in Lake County. While some of their work overlapped the efforts of Luther Cressman 30 years prior, many sites were new and previously unrecorded. A few of these sites include Reservoir Lake, Fortyfour Lake, Long Lake, Abert Rim, Picture Rock Pass, Hart Lake, Crump Lake and Reservoir Lake.

Eventually, through the assistance of the UCLA Institute of Archaeology, the Lorings were able to publish their results in a two volume set, *Pictographs and Petroglyphs of the Oregon Country* (Loring and Loring 1982, 1983). Important for the number of new sites Loring and Loring visited and described, their research was particularly important to land managers and rock art researchers region wide in getting an overview of the rock art resources within their respective districts.
Current Research in Lake County

Although no colleges in Oregon offering Anthropology as a field of study currently include rock art studies as a part of their curriculum, the study of rock art has nevertheless continued to grow in both academic and profession ranks.

In Lake County Oregon, Bill Cannon, Lakeview BLM archaeologist (Cannon and Ricks 1986, 1988, Cannon, Creger, Fowler, Hattori and Ricks 1990), has managed and recorded rock art sites in Oregon for more than 25 years. One of Mr. Cannon's many projects included a collaborative effort with Mary Ricks that focused on the Warner Valley and Lake County rock art inventory.

Their collaborative efforts resulted in a regional database and publication titled, *The Lake County Rock Art Inventory: Implications for Prehistoric Settlement and Land Use Patterns* published in 1986. Cannon has encouraged and mentored many avocational and professional archaeologists interested in rock art over the years, and is currently President of the Association of Oregon Archaeologists (2001).

Mary Ricks (Ricks 1992, 1994, 1996), is also currently active in Lake County rock art research. Recently finishing her Ph.D. at Portland State University in 1995, Ricks dissertation *A Survey and Analysis of Prehistoric Rock Art of the Warner Valley Region, Lake County, Oregon*, was published as Anthropology Technical Report 96-1 through the University of Nevada, Reno. Ricks long term collaboration with Bill Cannon researching and documenting Lake County's rock art legacy is reflected in a number of professional research papers, reports and publications (Ricks and Cannon 1985, 1986, 1990, 1993a, 1993b).
"It may be that the most valuable and useful work done in rock art up to the relatively recent past is the faithful recording of data so that future researchers will have a reliable data base"
George Frison 1994:106

**Introduction**

Prehistoric rock art as a cultural phenomena has been viewed with regional curiosity for hundreds of years. But it wasn't until September 12th 1940, after two boys discovered the Upper Paleolithic cave paintings of Lascaux in southern France, that rock art captured the interest and imagination of the world. The publics interest grew so quickly in fact, that in ten short years Lascaux Cave was receiving 125,000 visitors annually (Pfeiffer 1982), eventually forcing its closure due to site degradation, vandalism and garbage.

As time passed however, the magic and mystery of rock art began to fade and only dedicated researchers were left to explore the challenging mysteries of prehistoric art. Today, as a result of the explosive growth in computer science industries over the last decade and our unprecedented capacity to communicate, share and exchange information over the Internet, interest in prehistoric rock art (i.e. culturally, artistically, commercially, scientifically, and recreationally), has once again captured the worlds attention.

Unfortunately, popularity and exposure are not without a price. As public interest and site visitation increase, there is inevitably a corresponding increase in site degradation, looting, vandalism and refuse. As a result, this raises the question of how to
effectively manage rock art sites conservationally and recreationally, in advance of vandalism, natural deterioration or destruction? If the questions were being directed towards a single site, the issues involved would be complicated, and difficult to address. Raising these concerns to a county, state or national level speaks to the complexity and magnitude the problem actually involves.

However, before management and conservation programs can be effectively developed to address these concerns, steps must first be taken to systematically inventory the nature and extent of rock art sites that currently exist on state and federal lands. It is difficult to assess and evaluate a resource, for the development of management and conservation programs, if the location and composition of the site to be addressed has yet to be identified.

In Oregon, rock art sites are generally found east of the Cascade Range on public lands administered by the Forest Service, BLM and U.S. Fish and Wildlife Service. These agencies collectively manage 53% of the states available land and cultural resource base (n.d. statistics map on file at State SHPO-Brauner 2001), and who "As wards of the public domain, are responsible by law [Federal Land Policy and Management Act of 1976, Public Law 94-579] to identify, manage, and protect all cultural resources, under their jurisdiction, including rock art" (Swartz and Zancanella 1991:114).

However, most cultural resource programs which operate under the auspices of the federal government not only face departmental understaffing, they are typically expected to work within the narrow confines of a fiscally restricted budget. As a result, the capacity in which a resource managers is able to comply with and effectively resolve
the various issues surrounding cultural resource management, as outlined by the federal mandate, in many respects has been compromised.

In an effort to move forward in developing programs that address the needs of rock art management and conservation within the state, agencies will frequently enter into joint partnerships with interested and qualified researchers who are willing to participate in inventorying and/or documenting the districts cultural resources for scientific and management purposes.

However, in order to successfully inventory and record a rock art site so that relevant information will be acquired, it is important to understand the recording process for what it is, along with the techniques that make it work. This process and corresponding methodology will be examined more closely in the following discussion.

The Recording Process

It can not be overstated how important careful planning, organization and flexibility are in documenting a rock art site for the first time, or in adding to previously documented research. Field work can often result in frustrating setbacks and unproductive recording, if the appropriate measures aren't taken care of ahead of time to carefully plan and anticipate problems in advance.

Having a project run smoothly and reach a satisfactory conclusion, will depend entirely on the amount of time one spends in its' thoughtful preparation. When a site has been identified for documentation, one of the first steps in getting the process started is to determine land ownership. If the site is located on public land, the appropriated
managing agency should be contacted and a meeting arranged with the Regional or District Archaeologist to discuss the project.

This meeting is important to the structuring of the project in several ways. First, it provides an opportunity to discuss with a trained professional, the location and composition of the project, the methodology to be used and the reasons behind initiating the project in the first place. The archaeologist will be able to provide information regarding the site's current disposition, whether the site has been previously recorded or not, assist in acquiring cultural resource permits (if necessary) and provide clarification, and copies of state and federal cultural resource laws that will have a bearing on your project. In addition, the archaeologist can identify tribal affiliations associated with the project area and help provide additional equipment, maps, site forms and other pertinent information and advice.

Following the completion of this meeting, state and federal law requires that tribal authorities associated with the site area be notified that a rock art recording project is in the process of being developed and arrange a meeting to discuss the project with the acting tribal archaeologist or cultural resource specialist. As a rule, most Native Americans view rock art sites with special, if not sacred reverence. These sites are often considered 'places of power' that may or may not incorporate additional levels of spiritual, or ritual significance.

As a result, it is important during the recording process that Native American beliefs and traditions are taken into account and respected. In addition, this meeting will provide the tribe with an opportunity to express any concerns or requests they may have in the proper and respectful handling of the site during the recording process.
Before moving the project into the field, it is also important to develop a proper understanding of the site area by examining its' cultural and environmental setting. By examining the project areas local and regional history, prehistory, ethnography, geology, geography, climate and biological resources, the site and project area are placed within a contextual framework that provides a structure the project itself can develop from.

Earlier it was stated that the two most important steps in managing a rock art site effectively are first identifying the site's location and second documenting its' content and condition for future management consideration. Gunn (1995a:94) notes that, the basic questions which guide recording a rock art site for management purposes include: "what is it? (content); where is it? (location); how important is it? (significance); and how threatened is it (threat)."

The most efficient way in which to answer these questions effectively, is in initiating a thorough and systematic survey of the site in advance of any other recording activity. A systematic investigation of the site will help establish the extent and layout of the sites physical boundaries, the location, distribution, composition and condition (i.e. stages of weathering and deterioration, vandalism, pothunting) of it's artifact assemblages and determine if auxiliary sites (i.e. historic, prehistoric) or artifacts are present within, or adjacent to the project area.

Surveys also provide the necessary understanding of a site to effectively establish a datum(s) or reference point, for your work to proceed from. Normally, datums are small aluminum tags that are attached to a small piece of rebar that has been painted a bright color (i.e. orange) on one end for easy identification.
The stake is then driven into the ground or if necessary attached to the base of a tree (permanence is the issue here), in a strategic location that will allow it to be used as a reference point when mapping out and describing the site and its contents. If the site is large, subdatum's are usually required and vectored off of the original datum. Datum tags are also used to identify a site and therefore must be inscribed with the following information: site name and/or number (i.e. The Johnson Ranch 35JE51B-if available), the date and the name of the recorder.

It is important that during each step of the recording process, a detailed, well organized set of notes (including sketches and maps), be maintained which documents your approach, methodology and observations. The importance of legible, well organized notes in any research project cannot be overestimated. After the survey has been completed, time should be taken to finish all notes and sketches (i.e. of the site, artifacts, etc.) and the results of the survey, including any comments or observations that may be relevant to the project at hand. These notes will assist in developing a realistic approach to record the site by and help maximize time and resources for completing the project.

Sketches are quickly rendered drawings that generally supplement written, photographic and mapping documents. Sketches, although less accurate graphically than formal drawing, nevertheless help clarifying notes taken during the recording process. Formal drawings on the other hand, are more carefully rendered, detailed depictions of design element(s), panel(s), etc., that incorporate scientific and archaeological drawing conventions for clarity and accuracy.
It is at this stage of the recording process, that the recording of a rock art site becomes a little more ambiguous. As of June 2001, the professional community of rock art researchers has yet to adopt a systematic set of requirements or minimum standards that would effectively guide one through the process of documenting a rock art site.

As a result, archaeological contracting firms, universities and various rock art organizations across the nation, formulate and design their own set of recording criteria they feel is important in effectively and accurately documenting a rock art site. This lack of standardization in recording methodology makes it difficult for researcher to not only document a site properly, but to exchange and correlate information with other scientists or agencies that is relevant to scientific and/or management needs. This can only be accomplished, if on some level the information being recorded is structured around a common platform that would allow a correlative process to occur.

Part of the problem in developing a standardized approach to rock art recording lies in the fact that, recording a rock art site can occur on a variety of different levels, each dependent upon the requirements of the project, it's research design, and the person or organization doing the recording and their level of understanding in rock art research recording methodology (Gunn 1995a, 1995b, Swartz 1985, 1993, Loendorf, Olson, Connor and Dean 1998, Lee 1991, Dickman 1986).

For example, an archaeologists working for a land managing agency such as the BLM, whose interests are guided by districts wide, long term management concerns, might benefit the most from a thorough, but general recording of a rock art site that focuses more on management and conservation issues, than on style, function or mode of execution. On the other hand, a researcher whose investigating a specific set of research
questions (theoretically or technical) may be compelled to take a more focused approach to recording a rock art site and only address a specific area or issue within the site itself.

Another approach to recording a rock art site might present itself in a situation where a crew during a cultural resource survey, encounters a rock art site miles away from any convenient access point, equipment, supplies and time are limited and the likelihood that the site will be visited again in the foreseeable future may be remote due to the inaccessibility of the site.

Fortunately, in respect to the general recording of a rock art site, there are a number of good publications and manuals available that can assist in recording a rock art site successfully. These documents provide information on the recording process in general, techniques and methods to use during the recording process and how to perform them, equipment and tools that may be needed and names of people to contact in case a special problem or concern arises.

It is recommended therefore, that prior to mobilizing a project out into the field, the following documents be examined (in addition to those previously mentioned) if not acquired, so that relevant technical information is on hand for future reference in case an unforeseen problem or question occurs. These documents include:

1). The Minimum Standards for Recording Rock Art, (Swartz 1980, 1985-see Appendix 1).
It is also important to keep in mind that using surface enhancement techniques such as chalking or the painting on rock art design element to enhance their visibility for recording purposes (i.e. drawing, photography) or the application of other foreign materials to the rocks surface (i.e. crayons, ink, oil, shellac, varnish, etc.), are no longer considered an acceptable or ethical way to record a rock art site.

Studies have shown that use of such materials not only damages the artifact and promotes/accelerates rock art deterioration, it almost always negates the possibilities to do future research in areas such as rock art dating (Loendorf, Olson, Conner and Dean 1998, Swartz 1985, Sanger and Meighan 1990, Bednarik 1988, Price 1989, Rosenfeld 1988, Lambert 1988, Chaffee, Hyman and Rowe 1994a).

One of the most time consuming and technical aspects of the documentation process is in the accurate recording of rock art imagery. In the following discussion I will examine the techniques one can use in recording rock art images and then provide a comparative review of two techniques (drawing and photography) that have stood the test of time.

Recording Rock Art Images

"Existing documenting techniques need to be evaluated as additional research allows us to compare the merits of various techniques" Loendorf, Olson, Conner and Dean 1998:5.

The manner in which rock art images are documented during the recording process can be distinguished as either manual or automated techniques. Traditionally, manual recording techniques have included: drawings, tracing, rubbings, moldings and casting (Walt and Brayer 1994, Brayer, Walt and David 1998).
However, many of these techniques have had a damaging effect on rock art in the past, leaving behind in the process of recording, chemical residues (visible or not) that accelerates rock decomposition and impedes future research efforts. As a result of the invasive nature that most of these techniques employ, many researchers today have chosen not to use these techniques except under the most exceptional of circumstances. The one exception evaluation is drawing, which under normal circumstances is considered to be a noninvasive recording technique and effective when properly applied.

Automated image recording captures a complete design element by using an image sensor, machine or scanner. In general these techniques can be used to "reveal the internal structure of an object, to record the objects surface topography, [or] enhance the objects contrast against its background" (Walt and Brayer 1994:12).

Automated techniques can be broken down further into active and passive systems. Active systems are where "the object of interest is specially illuminated by some type of energy and the reflected, transmitted or scattered energy is measured." (Walt and Brayer 1994:12). Examples of active automated recording systems include radar and laser (which can measures an objects orientation and topography), x-ray (which measures an objects internal structure), ultrasound (internal structure) and Florescence Photography (which measure an object through image contrast).

Passive systems on the other hand, "utilize an objects own emitted or reflected energy, gathered from ambient illumination or environmental influences" (Walt and Brayer 1994:12). As a result, nearly all passive techniques rely on contrast enhancement of the image.
These methods can be non-invasive such as ultra-violet photography, infra-red photography and normal photography, or invasive by using chalk, shellac, charcoal, or crayons. In the following discussion, I will compare and contrast the strengths and weakness of two recording techniques (drawing and photography), that are commonly incorporated into most recording projects. The purpose of the comparison is to reveal which method is the most effective in efficiently and accurately recording rock art images. This comparative review should also reveal which method (if any) is generally preferred by most professional researchers and why.

Comparative Review of Drawing and Photography

[Considering] the quantity of rock art in need of recording versus the time and finances available, effort should not be expended on unnecessary efforts to provide a full record in any technique that duplicates an accurate record in another technique, or that takes a significant amount of additional time and effort beyond that which can provide an accurate record by another means (Hedges 1999:192).

In this section I review and discuss the strengths and weaknesses of two recording techniques commonly used in rock art documentation, drawing (manual recording) and photography (automated recording). In preparation for the following review, I examined a broad range of professional and avocational publications. This approach, while limiting personal bias, also provided an adequate field for consensus of the recording techniques under review.

The data presented reflects the opinions and experiences of archaeologists, university professors, art historians, professional artists, professional photographers,
conservators, curators, park rangers and avocationalists. In order to provide an organized presentation, authors whose publications had a bearing on the technique current under review are presented first. Following the list of authors is a bulleted list of strengths and weaknesses of each technique, to be then followed by a discussion of that technique. Authors when quoted directly are cited, but otherwise, the results reflect a consensus of opinion.

Formal Drawings

The publications of 30 authors were reviewed and a consensus polled regarding the strengths and weaknesses of drawing in rock art recording methodology. The authors and their publications are cited below in Table 3.1, and the results of the consensus follows in a bulleted format.

Table 3.1
Authors and referenced publications.

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A consensus on the strengths of drawing revealed that:

- drawings pose very little, if any risk, to the artifact and require only minimal supplies to get started.

- drawings were most useful in difficult photographic situations (low light, shadowy conditions, faded images, lightly executed designs elements).

- drawings are valuable documents when drawn to scale, display correct image to image relationships, accurate image geometry, and display a legend, north arrow and scale, and employ a consistent set of visual conventions.

- drawings were faster and more preferable as a recording technique than tracing though less accurate (five authors supported tracing as a viable recording method, most considered it outdated and invasive).

- drawing was attractive as a recording technique because it was inexpensive (obviously this statement reflects the use of a volunteer work force, since paying a field tech $8-10hr to draw one rock art panel would add up quickly).

- drawing is an inexpensive way to document a rock art site (if volunteers are used!).

A consensus on the strengths of drawing revealed that:

- drawings are probably the most subjective of all recording techniques.

- the quality and usefulness of the information a drawing can impart is totally reliant upon the artistic and observational skills of the recorder.

- drawings (excluding volunteer work) are costly, and time intensive. Long drawing sessions lead to boredom, mental and visual fatigue, and operator error.

- drawings generally require several sessions to finish and need verification by separate parties for recording oversights and errors.

- drawings frequently lack scale, north arrow, legends, visual conventions, measurements, and annotated notes, rendering the drawing useless as a scientific or recording document.

- drawings are unable to accurately render color, image geometry, element to element relationships, textures, weathering, patina and vegetative encroachments.
drawings are difficult to store and curate (archival paper is rarely used in drawing rock art, as a result drawings deteriorate rapidly from high levels of acid in the paper).

- Drawing pose problems in reuse, access after curation and are especially vulnerable to damage from weather, travel and repeated use.

Discussion

Drawings have been a fundamental recording technique in rock art studies since the late 1800's and archaeologists have frequently relied on them as a fail-safe mechanism in the event of poor photographic results. However, because drawings are inherently subjective, time intensive and extremely vulnerable to mental and visual fatigue factors which causes image distortion and other drawing inaccuracies, their usefulness as a scientific document is questionable.

Technically, drawing rock art involves transposing a three-dimensional image from a stone surface onto a two-dimensional paper surface, a process that requires "an enormous amount of distillation and subjective judgement" (Dorman 1996: 11).

Surprisingly, according to several recent studies, professional illustrators are just as likely to produce an inaccurate drawing as beginners are.

In 1997, a study was designed to quantify variations in drawing accuracy among 18 members of an Earthwatch team, whose level of experience ranged from "professional archaeologists with extensive experience [in] rock art," to "artists with little rock art experience, to complete novices" (Brayer, Walt and David 1998:3).

Members were asked to draw the same set of rock art panels located inside a rockshelter in Queensland, Australia that represented a recording situation in which drawings were considered the most productive (i.e. a difficult photographic situation due
to reduced light and faded images). In order to analysis the results comparatively, all panels were marked with control points to be used in document registration after scanning (Brayer, Walt and David 1998:3).

Photographs were then taken from the same station as the drawings were made from and then both products were scanned into a computer. Using the control points as reference guides, both photos and drawings were registered to each other using digital imaging software (i.e. Adobe Photoshop). Registration ensures the control points on both documents match up geometrically as close as possible. After document registration, the results were then compared quantitatively for accuracy in geometry, image to image relationships and contextual information.

The study concluded that "if the results hold up under more samples, it means, at least for these types of panels, that expert drawings are no more accurate than those of beginners and that both are worse than recording [with] a photograph." The report also stated that "free hand drawing is very inaccurate...even if methods are tightly regulated" and that "drawing has the disadvantage of requiring substantially more time and skill by the recorder than does photography" (Brayer, Walt and David 1999:1-6).

Removing all subjectivity from the recording process, is unrealistic if not impossible. Humans by nature, are subjective beings. As soon as an individual opens their eyes in the morning, they begin the process of subjectively interpreting the world around them (D'Arragon 1995). "Since one can only draw what one sees, what one notices, what one thinks is relevant" based on experience, knowledge and expectations, rock art drawings should be viewed as interpretations and explanations of an image, rather than a faithful reproduction that is impartial and objective (Smit 1991:251).
Such tendencies can be illustrated by the following example. In the early 1960's, researcher Campbell Grant, visited a rock art site near Moab, Utah to examine a petroglyph referred to as the Moab Mammoth. Although Grant had reservation about the petroglyph's authenticity, due to its lack of weathering and patina, Grant nevertheless made a drawing of the design (Figure 3.1) for his book *Rock Art of the American Indian* (1967:119). When Grant's drawing is compared side by side with a photograph of the Moab Mammoth (Figure 3.2 - courtesy of Kyle Ross, 2000), it's clear that Grant not

Figure 3.1: Drawing of Moab Mammoth by Campbell Grant (1967:119).

Figure 3.2: Photograph of Moab Mammoth (Courtesy of Kyle Ross 2001).
only selectively edited what he drew by subconsciously leaving out specific attributes of
the design element (Figure 3.3 - A, B and C), the end result supports a predisposed
interpretation of what he 'thought' he was seeing (i.e. a Mammoth).

![Figure 3.3: Attributes from petroglyph Grants drawing left out. (photo K. Ross, graphics G.Curtis).](image)

Figure 3.4 shows the photograph with an inverted color platform using Adobe
Photoshop and Figure 3.5 show a computer rendered drawing of the photograph using
CorelDraw 8 (note that the computer accurately renders the rocks surface cracks [D], and
texture [E] ). Subjectivity and interpretations are unfortunately quite common in rock art
drawings and are admittedly difficult to guard against in the recording process. Once the
process begins, it is often difficult to realize that it is occurring and even more difficult to
stop.

When the Moab Mammoth was first brought to my attention, it was suggested that
it resembled a bear with a fish in it's mouth that was upside down. I must admit that
every time I view the photograph now, a bear holding a fish is what I see.
Figure 3.4: Color inverted photograph of Moab Mammoth (photograph K. Ross, graphics G. Curtis).

Figure 3.5: Computer rendered drawing of Moab Mammoth. (original photograph K. Ross, graphics G. Curtis).
As a result, because drawings are easily influenced by a recorder’s perceptions and are difficult to render accurately even by professionals (i.e. geometry, contextual relationships, color, texture), it would seem reasonable to recommend that the drawing process be regulated more closely and used only in those instances where other techniques are less equipped to handle the recording situation.

Photography

Publications of 44 authors were reviewed and polled regarding the strengths and weaknesses of drawing in rock art recording. Authors are listed in Table 3.2.

Table 3.2
Authors and referenced publications.

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A consensus on the strengths of photography revealed that:

- photography is a completely noninvasive technique for recording rock art.

- photographs are the most accurate, most practical, and most efficient way to record rock art images.

- camera/photographic skills are easier and quicker to learn than drawing skills and the ability to 'see' objectively.

- photographs are able to more readily depict color, geometry, surface texture, element to element relationships, patina, vegetative encroachment, vandalism and environmental context, than drawings.

- photographs more faithfully record what's on a rock art panel, not what the recorder expects to see, wants to see, or interprets.

- photographs are especially effective in areas that are out of reach or difficult to access and draw, such as cliff walls, canyons and dangerous rocky outcrops.

- photographs are very successful at recording complex panels with numerous designs, and long continuous panels that would take days, or weeks to draw.

- new photographic techniques (Henderson 1995), can literally renew, lightly rendered or faded pictographs, allowing them to appear freshly made.

- filters can be used to balance color, limit or enhance contrasts, improve color saturation (i.e. green or blue filters will enhance red pigments in pictographs, polarizing filters will help rid specular reflection and hazy lighting conditions.

- photographs can be easily transferred to a digital format for future research and analysis, placement in reports, storage, database formation, websites etc., and effortless allow the recorder to place notes, symbols, changes, etc. directly onto the photo image itself.

- digital imaging software can help correct many photographic weaknesses including, focus, contrast, color balance and saturation, shadows, geometric registration and rectification, and stitching multiple photos together to create a seamless panorama.
A consensus on the weaknesses of photography revealed that:

- photography involves a small degree of subjectivity and distillation. Geometric distortion can occur when focal planes vary too far off the perpendicular or designs elements are on rounded or abrupt rock surfaces.

- photography to be effective needs proper lighting, otherwise problems may arise with shadows, spectral reflection, color balance, contrast, and poor image capture.

- faintly executed design elements, heavily patinated petroglyphs and light or faded pictographs have been typically difficult to photograph.

- once taken, you can't compensate for a photo's poor color, focus, distortion, darkness or brightness.

- films are temperamental if not handled and stored properly.

- films are expensive to buy and process, processing turn around is slow.

- glyph and panel surface textures cannot be observed in most photographs.

**Discussion**

Since the late 1920s, archaeologists have recognized that the camera had a unique ability to accurately capture a rock art image (Strong, Schenck and Steward 1930). In many cases, however, cameras of the early 20th century were often bulky and difficult pieces of equipment to mobilize and operate in the field. Film formats (especially color) were unreliable and photography in general lacked a consistency in being able produce a crisp, clear photograph (Hyder and Oliver 1983).

Although it is difficult to know for sure how limiting factors in early photographic systems may have influenced early rock art researchers in whether to adopt photography as a standard recording tool or not, it is safe to say that scientific documentation in any discipline requires accurate and reliable methods to record by that are not bound by
awkward equipment and questionable results. Although photography was used intermittently by researchers for the next sixty years to document specific elements of a rock art site (i.e. overview photos, photos of interesting design elements), the disciplines primary recording methodology continued to be centered around drawings, tracings and rubbings.

Today, professional grade camera are not only affordable and light weight, they come in a variety of styles including automatic, manual and digital. Films are available in dozens of format, are high grade technically and reliable and processing can be accomplished in less than a day (or instantaneously with a digital camera). This system wide change in photographic process has encouraged researchers since the mid-1980s to reintegrate photography back into the documenting process as an effective recording tool.

Two factors have contributed significantly to photography's reintegration into the documenting process, improved photographic equipment and film that are capable of consistently putting out, high quality photographic documents, and most recently, our ability to digitally capture, edit and enhance photographic records for interpretation and analysis. Poor photographs no longer need to be viewed as 'fixed' and static documents that contain little or no useful information, when in many cases these photographs can be recovered digitally.

To appreciate how the collaboration of these two industries (photography and computers) has impacted rock art recording and analysis, the following discussion will examine the criticisms leveled at using photography as a recording tool and explore the methods some researcher are using to overcome these technical anomalies.
One of the most consistently difficult problems in rock art recording has been in effectively photographing the subtleties of lightly executed or faded rock art paintings. Whether the pigments are covered by a patina, accreted silica's, scratches, chalk, or just naturally faded from exposure and weathering, these design elements have resisted numerous attempts at being captured adequately for documentation and analysis.

Part of the problem lies in the fact that when light strikes an irregular surface (like that of a cliff wall), it is reflected away from the rock surface in two ways, either by surface or 'specular' reflection often resulting in a glare or by a diffuse backscattering of light (Anderson 1991 in Henderson 1995).

This is an important point to consider when recording faded images because "surface reflectance contains the visual cues related to texture and contour, whereas the backscattered component contains the cues related to colour and internal structures" (Henderson 1995:76).

Because surface glare can effectively block out much of the color information being transmitted from a rock's surface through the backscattering of light, photographs can rarely capture a faded rock art image adequately, even when using special low contrast films or filters designed to increase color saturation (Henderson 1995).

However, if it were possible to eliminate or separate the regular surface reflected light from the diffuse backscattering of light, there would be an increase in the "visibility of the underlying pigment colour" for photographic purposes (Henderson 1995:76). In 1994, Jim Henderson a professional photographer, developed a photographic process
called cross-polarization that is capable of separating reflected in just the manner described. When this technique is applied to photographing faded rock art paintings the results are impressive (Figure 3.6 and 3.7).

Figures 3.6 and 3.7: Before and after photos of faded and chalked pictographs (Courtesy of Applied Photographic Research, 2001).

Because normal sun light is unpolarized and radiates outwards in every possible direction "transverse to the line of travel," light can only becomes polarized when it passes through a special polarizing filter (Figure 3.8).
This filter allows only those waves of light that vibrate on a single linear plane to pass through. When polarized light is projected onto a rock surface, "the primary surface reflections remain polarized in the same plane" (Henderson 1995:76).

Figure 3.8: "Cross Polarization of specular highlights. The main polarized light wave strikes the front surface of the rock and is reflected away. Some of the main wave penetrates the surface into the interior, where it is depolarised. This diffuse, depolarized wave exits the surface of the rock face and is unaffected by the second polarizer on the camera. This component comprises most of the pigment information captured on film" (Courtesy of Applied Photographic Research 2001, Henderson 1995:76, RAR 1995).

When a second polarizing filter is placed in the path of the exiting surface reflections and rotated 90 degrees to their plane of vibration, they will be totally absorbed" (Polaroid 1993 in Henderson 1995:77). "These wave lengths are referred to as being cross-polarized."
This results in the depolarization of the backscattered light as it passes into the surface interior and is scattered. As it "passes back out through the rock surface, this light is not absorbed by the second filter", and the image can be photographed (Henderson 1995:77).

The procedure involves setting up two portable battery operated strobes with modeling lights, each fitted with a rotating polarizing filter, so that the primary light source to take a picture by can be controlled and modified by cross-polarizing it through the lens of a camera (Figure 3.9). For this procedure to work effectively, it must be conducted in a low light setting, such as in the early morning, or late evening (Henderson 1995).


The strobe lights are then placed 30 to 40 degrees on either side of a rock art panel. Once setup is complete, one of the strobe lights can be turned on and positioned to evenly illuminate one side of the rock art panel.
The camera is then fitted with a high quality linear polarizing filter which is slowly rotated while looking at the rock art panel through the camera's viewfinder until all surface reflections disappear (Henderson 1995). When all surface reflections have been removed, the strobe light is turned off and the adjacent strobe light is turned on. This time, as you view the rock art panel through the camera's viewfinder, the polarizing filter on the strobe light is rotated (not the one on the camera) until all surface reflections are again removed (Henderson 1995). Following the completion of these steps, a picture can be taken.

Henderson recommends using Kodak's Ektachrome Professional Plus film for this procedure because it "produces enhanced primary colors and reproduces black and white as neutral colors," other film formats such as Kodak's Kodachrome 64 and Fuji's Velvia slide films are also recommended (Henderson 1995:77).

Another concern regarding photographic weaknesses involves geometric distortion of a design element (which is normally minimal) when photographs are taken of irregular surfaces, when rock art panels are not perpendicular to the focal plane or when photographing long and/or broad panels of rock art that require multiple frames to capture.

Each of these photographic problems when anticipated and prepared for in advance, can be corrected in the office after processing using digital editing software. In the article *A Stitch in Time: Digital Panoramas and Mosaics* (1999), Robert Mark and Evelyn Billo address each of the three examples listed above and demonstrate how to prepare and solve these photographic problems in a step-by-step discussion.
Although each photographic situation is a unique challenge unto itself, photography and photographic processing tools have come along way in being able to address many of the more common photographic problems. Photography as a recording tool can no longer be considered a 'static' and limited procedure, when handled creatively and accompanied by digital imaging tools, photography is transformed into a dynamic process with practically unlimited possibilities.

A relatively common problem that surfaces when photographing a rock art site and in many cases attributable to operator error, is in the cosmetic profile of a photographic print or slide. By cosmetic I am referring to a picture's photographic attributes like color balance and saturation, contrast, focus, and brightness.

In the past, when a photograph's visual appearance was considered unsatisfactory, it was either thrown away or left unused, new photographs were retaken and drawings were rendered in case the photographic process failed again. Photo-retouching during processing was always a possibility but generally an expensive procedure if done professionally on a regular basis.

Today, when a photograph exhibits certain operator or processing induced flaws, in many instance the problems can be corrected by using digital editing tools in programs like Adobe Photoshop or Corel PhotoPaint. Practically any photograph a person takes can be improved to some degree digitally, admittedly though there will always be some photographs that can not be 'fixed' and must be re-taken when time permits.

After a the photo has been scanned and edited, it should be saved to the computers hard drive and a copy save of a rewriteable compact disc or photo-CD. If a hard copy of the edited image is need, it can either be acquired directly off one's printer or the CD can
be taken to a photo retailer and a new slide or print can be processed directly off the CD. Some of the important features that result from scanning a photo into your computer or onto a CD include: digital colors don't fade, duplicate copies are easily attained, photo's can be edited to any shape, size or color, they can be placed on a website or attached as a file to an email or photo's can be easily inserted into word processing documents, spreadsheets or databases and all without affecting the original scanned image.

In the next discussion, I briefly examine how digital technology evolved, what separates analog from digital technology, what is meant by digital image processing and what the differences between bitmapped and vector images.

**Digital Technology**

Although digital technology has received global recognition over the past decade, the capability of being able to digitally process an image, has been around since the early 1900s. Image quality was often poor and transmissions times were measured in hours or days, instead of minutes, but by the 1920s digital photographs were being exchanged on a regular basis between New York City and London using the Bartlane cable picture transmission system (Aaland 1992, Yaroslavsky 1985).

By 1945, after author Arthur C. Clarke suggested that geostationary satellites would aid global communications, a small group of researchers developed the first electronically driven computers which allowed for the first time "the alteration and analysis of pictorial information" [digital imaging] (Aaland and Burger 1992:9, Green 1989, Gray 1999).
In 1949, shortly after Bell Laboratories developed the first solid state transistor (1947) and cable TV first appears in rural USA (1948), Claude Shannon shows that all information can be reduced to 1's and 0's, a breakthrough that would soon revolutionize the computer industry. In 1955 monitors were attached to computers for the first time to view digital data and in 1957 the first photograph was scanned into a computer by Russell Kirsch, a scientist with the National Institute of Standards and Technology, (Green 1989, Aaland and Burger 1992, Kirsch 1995, Gray 1999.).

The principal development of digital imaging has been credited though to the National Aeronautical Science Administration (NASA), who during the early 1960's received, processed and enhanced electronic signals into visual images (analog to digital), from the Mariner spacecraft as it systematically inventoried our solar systems (Green 1989, Yaroslavsky 1985, Aaland and Burger 1992).

By the 1980s, digital image processing was being used on a regular basis by engineers and scientists and in ten short years, with the advent of the personal computer, digital imaging technology hit the public market. Today, powerful digital imaging software tools unavailable to NASA scientists even ten years ago, are now distributed over the Internet as 'freeware' to anyone with a personal computer and a Internet hookup (Aaland and Burger 1992).

In discussing the internal mechanisms that make digital imaging work, it is important to understand how visual and sound wave information is processed by different devices (i.e. cameras, TV, radio) and how a computer handles this information. To begin, this discussion will examine the differences between analog and digital technology.
Analog vs. Digital

Analog technology consist of wave energy (i.e. heat, light, and sound), that is captured by an imaging sensor device and converted into a continuous electrical signal that contains an infinite set of variables. It is an analogous "representation of a natural object which are usually continuous" in nature (Yaroslavsky 1985:9, Aaland and Burger 1992). Examples of optical analogue technology that form pictures in the first half of the 20th century included: cameras, television and video-cameras. When wave signals are noncontinuous and are represented by only a finite, discrete set of values (i.e. numerical digits-like a computer use to interpret and store information), the signal is then referred to as being digital (Aaland and Burger 1992, Yaroslavsky 1985).

Bits and Bytes

In the digital world of computers, all information is represented and stored according to the binary coding of 1's and 0's. Binary digits or bits, are analogous to electrical switches within a computer that transmit pieces of information to the computer in one of two ways (i.e. up/down, on/off, open/closed and yes/no). Bits are the fundamental structure which forms the basis of all memory and disc storage within a computer system (Gookin 1995, Adobe 1995, Aaland and Burger 1992, Bouton and Bouton 1995).

For example, a string of eight bits forms one byte of information. One byte represents a single character of information that can be stored inside a computer. For example, the word 'bit' takes up three bytes of memory or disc space.
A kilobyte is comprised of 1,024 bytes of information, a megabyte is 1,024 kilobytes or 1,048,576 bytes of information and a gigabyte is a 1,024 megabytes or over a billion bytes of information. To put this into perspective, one megabyte of memory storage will accommodate the entire novel War and Peace with room left over. Re-writeable compact discs, which hold 750 megabytes of information can store an entire set of Encyclopedias (Gookin 1995).

So it is not surprising to learn that when a computer looks at a photograph, what it is actually 'seeing' is a mathematical formula that is placed into a matrices of 1's and 0's that when combined together form a picture. Since a computer 'sees' all of the information within it's system as being the same digitally, whether it is sound, text, graphics or film, it is a simple process to integrate these various mediums into a variety of combinations (Aaland and Burger 1992:8, Bouton and Bouton 1995). It is through this process that were able to place text and symbols onto a photo, place photo's within or overlapping other photo's, or combine music and voice files with animated video.

Digital technology's ability to combine and integrate multiple forms of audio and visual information with relative ease, is unquestionably one of it's most important, if not singular advantages over analog technology.

*Digital Image Processing*

Image Acquisition is the process in which a computer acquires a digital representation (bitmap) of a physical object like a photograph, by means of scanner or digitizer. In order for bitmaps to 'look' photographic, the scanning or digitizing process must successfully convert analog information to a digital format while retaining the objects qualities of light, color, depth of field, etc.

Once an object has been scanned and converted into a digital format, it is ready for the next step or Image Display. Here the visual output of the digitally converted object is generated and seen through the aide of a video monitor or through printing [requiring a conversion back to an analog format] (Green 1989, Bouton and Bouton 1995, Adobe 1995, Baxes 1984).

Image Processing. Once an object such as a photograph, has been converted to a digital format and displayed, the digital representation of the photograph can be digitally edited, enhanced or manipulated. From removing, improving or altering color, focus, contrast, to virtual distortion of the physical features represented within the image or 'cutting' portions of a picture out and 'pasting' them back into another scanned image, all can be easily addressed during image processing. Image processing can also involve handling several images simultaneously (i.e. multispectral classification) or as many as two hundred or more (i.e. planetary photomosaics by NASA).

Because digital imaging is a memory intensive operation virtually speaking, it is important that the computer system that is being used to do digital imaging with, have a sufficient amount of RAM or random access memory. When image processing is in progress, the image is held in the computer's temporary memory or RAM in addition to any of the software programs that are actively running (i.e. Windows 2000, Adobe
PhotoShop, CorelDraw) all of which allocate a portion of RAM to run, operate and be viewed on the computer screen. The more RAM a computer system has, the faster and more smoothly image processing will be.

Once an image has been edited and enhanced digitally, it is ready to be saved onto a hard drive or compact disc. Again, because digital images are memory intensive files, where a six megabyte color image requires the same amount of hard drive or compact disc space as 200,000 words (Aaland and Burger 1992), image files are generally saved in a compressed or zip file format to maximize hard drive space.

Computer images and drawings are fundamentally different and can be defined by dividing them into two basic categories, bitmapped and vector. In the next section what comprises a bitmap or vector image will be discussed as well as their difference creation and usage.

*Vector and Bitmapped Images*

When working with digital imaging, or computer assisted graphics in general, it is important to understand the concepts that define and separate the two primary graphical platforms, bitmap (or raster grid) images and vector-based (or object oriented) images.

*Vector or object oriented graphics* (i.e. lines, curve, circle, square, etc.) are not a product of scanning or acquisition, but are instead computer algorithms that are characterized by mathematically formulated objects called vectors. Vector images are created through a series of mathematical equations produced from within a draw program such as Adobe Illustrator or CorelDraw, and used for scientific, architectural and mechanical drawings.
Object oriented graphics are resolution independent, meaning they can be magnified as large as a house or as small as a stamp and remain distortion free in respect to shape, color, focus and experiencing no loss or degradation to the digital information it contains (Adobe 1995:41, n.d:1 manuscript in possession of author).

One of the major advantages one has in using vector based graphics is in it's ability to remain 'distortion free' regardless of the images size, shape or platform. This results from the fact that when the images are saved to a file format, no actual rendering or rasterizing is involved (although rastering of the image does occur if the images are displayed on a monitor or are printed after defining the images size and resolution specifications (Bouton and Bouton 1995). Vector-based graphics are easily skewed, rotated and viewed from any angle, and allow complete control over shape, size, line and color (Adobe 1995, n.d:1 manuscript in possession of author).

**Bitmapped images** can be created in several ways. They can result from either scanning an object such as a photograph into a computer and converting it's information into a digital format, or they can be created in photo-paint software programs such as Adobe Photoshop or Corel PhotoPaint (Adobe 1995, Green 1989).

When a photograph is scanned into a computer the information it contains is broken down into small square shaped picture elements or pixels. As the process continues these pixels are then mapped onto an image grid or raster. Each pixel is assigned a set of two numbers that corresponds to it location in two dimensional space (x, y ) and it's degree of brightness. When color images are bitmapped, three numbers are assigned that correspond to the degree of brightness for each of the primary colors Red, Green and Blue (RGB) (Green 1989).
Bits of information maintain a relationship in respect to each pixel of a graphic. The higher the number of information bits a pixel has the sharper and more colorful and image becomes (i.e. 1 bit per pixel = 2 colors, 8 bits = 256 colors, 24 bits per pixel = 16, 777,216 colors—n.d.:2 manuscript in possession of author). Bitmap resolution or sharpness is determined by the number of pixels along the height and width of the image (height x width) and because the number of pixels used to represent a bitmap image is fixed, bitmap images are considered resolution dependent. When a bitmap image is magnified beyond its fixed level of resolution, the image will become distorted and jagged (Adobe 1995, Green 1985, n.d. manuscript in possession of author).

Because image files are large and require a lot of memory to store, their file formats are usually compressed before saving them to a hard drive or CD [i.e. Tagged Image File Format-TIFF, Graphics Interchange Format-GIF, or Joint Photographic Expert Group-JPEG to name only a few] (Adobe 1995, Green 1985, n.d.:1 manuscript in possession of author).

Working with digital imaging and learning how to apply the various techniques to one's daily life and work, is just one of the many fascinating avenues to explore in the virtual world of computers. Although these discussion have served to introduce digital imaging on a fundamental level, Chapter 4 will explore how this technology can be applied qualitatively and analytically in rock art research studies.
CHAPTER 4: THE PILOT STUDY

Introduction

Fieldwork for this project was conducted during the summer of 1994 at Fortyfour Lake rock art site in Lake County, Oregon. The study compares two traditional rock art recording techniques, drawing and photography, to determine which method should guide the recording process. One of the questions framing this study is 1) should photography be used over drawing, as the principle means in which to record and document a rock art site? and if so, will the recording process improve in terms of consistency, efficiency and accuracy?. Another question under investigation in this study is 2) can the collaboration between digital imaging and photography, a) improve photographic results, b) provide new information, c) be useful as a tool analytically, and d) facilitate and enhance the report writing process?

Equipment

It was important during the course of this study to keep the equipment, tools and general costs at a minimum without sacrificing data acquisition or quality. When the list for this project was being prepared, consideration was given to the equipment recording effectiveness, durability and mobility. With these considerations in mind, the following list was prepared and applied during the course of this rock art study.
Field Equipment

- Site forms, recording manuals, USGS Topo maps, compass, 2 field notebooks
- 35mm SLR Pentax Asahi, 50mm /150mm zoom lenses, Nikon light meter.
- Kodak Kodachrome 64 color slide film / Kodak 200 color print film.
- Bogen Tripod with removable and rotating mounting platforms.
- Two drafting boards (one as a spare), w/ permanent clip mounts and tool tray.
- Drawing materials (paper, pencils reg./color, erasers, rulers, shape templates etc.)
- One erasable reader board, 4 meter sticks marked in 10cm increments.
- Nikon 10x50 Binoculars, Snake Bite Kit, Buck Knife, 2 hand held tape recorders.

Office Equipment

- Pentium II 450mhz Computer w/ 128mgs of Ram, 17" color monitor, one re-writeable and one regular CD ROM, two separate 7.8 gigabyte hard drives.
- Software: Adobe Photoshop 5.02, Adobe Illustrator 8.0, CorelDraw 8.0.
- Microsoft Windows 95, Microsoft Office Suite 97 and VistaScan.
- Astra 2000p Flatbed Scanner, Epson 740 Color printer, Kodak Photo CD's.

Fortyfour Lake Rock Art Site
(T37S R26E sec. 31 / T38S R26E sec. 6)

Fortyfour Lake (Figure 4.1) is located in the southeast corner of Lake County, Oregon, at an elevation of 1799 meters above sea level. It is south of Hart Mountain National Antelope Refuge, east of Warner Valley, north of the California border and west of the Steens Mountains. Located around one of the many high desert playas that
characterize the region (Figure 4.2), Fortyfour Lake is surrounded by late Cenozoic basalt, western Juniper, sage and a variety of grasses and wildflowers. Research for this project took place along the lakes northeastern ridgeline which trends in a northwest by southeast direction.

Figure 4.1: Map of Fortyfour Lake and datum (Jacobs Reservoir USGS Topo Map 1967).
Figure 4.2: Looking north at Fortyfour Lake, by G. Curtis.

Getting Started

After arriving at the site and establishing a base camp, a preliminary site survey was initiated using north-south transects at 15 meter intervals to identify site boundaries and inventory the cultural resources. Diagnostic projectile points were not observed during the initial survey and only one small lithic scatter was encountered along the northeastern shoreline of the lake. Over the course of the project projectile points were eventually encountered (Figure 4.3), and reflect a middle to late period Great Basin occupation of the site area as defined by Aikens (1986, 1993). Although at present these artifacts cannot be directly correlated with the rock art at Fortyfour Lake, the temporal frame represented by the diagnostic artifacts does indicate when people were actively using this area for hunting and gathering activities.
All of the projectile points located after the survey aside from one, were located around the perimeter of the lake, 15ft. to 20ft. from the shoreline and all were made from obsidian (Figure 4.4). The debitage consisted of semi-translucent black to opaque black obsidian, fine grained dark gray basalt, and several colors of cryptocrystalline silica's including yellow and reddish orange.

Twenty-six rock art loci were located (Figure 4.5) during the survey of Fortyfour Lake, many of which were separated by 30 ft. or less. Concentrations of rock art were found along the entire west side of the lake on east facing basalt rimrock, along the northern shoreline on south facing rimrock and on the eastern ridgeline with east facing rimrock.
Figure 4.4: Projectile points and debitage sample from Fortyfour Lake (G.Curtis).

Figure 4.5: Map of rock art locus areas and recording stations at Fortyfour Lake (G.Curtis).
While photos and preliminary notes (using a tape recorder) were taken of the various rock art concentration areas during the survey, only the study area received a more thorough recording effort. Panels designations (i.e. A, B, etc.) used in the study for descriptive identification were based entirely on the configuration of the rocks surface structure and not by design element placement or design continuity. The only exception is when a design element clearly crossed a natural boundary such as a large crack or fracture, then both areas were designated as one panel and addressed accordingly.

Local Archaeology

Besides the rock art found at Fortyfour lake, other rock art sites in the area include those found at Reservoir Lake to the northwest, Long Lake to the northeast and Jacobs Reservoir, May Lake and School Section Lake to the southeast. In addition to these site, there are a number of smaller rock art sites (with only 1 or 2 panels) located along many of the northwest-southeast trending ridgelines in the area or along the rimrock that surrounds many of the dry lake basins that characterize this area.

The Fortyfour Lake region has been researched professionally over the years including work done by Cressman (1937), Hauck and Weder (1978), Loring and Loring (1982, 1983), Minor, Beckham and Toepel (1979), Ricks and Cannon (1994), and Aikens (1993). However, the majority of work in this region has been focused on the Warner Valley (Ricks and Cannon 1986, 1990, Palmer and Yates 1977, Cannon, William J., C.C. Creger, D.D. Fowler, E.M. Hattori, and M.F. Ricks 1990, Ricks 1992, 1994) just west of Fortyfour Lake.
The Pilot Study

This section discusses project design, the data acquired at each of the recording stations and an analysis of what the data means in respect to the study and the research questions. The section concludes with a brief demonstration on how digital imaging techniques can be useful as a recording tool, as a photo-editing tool and as an analytical aide. Although demonstrations have been limited to entry level problem solving, more involved techniques are available with results the surpass those demonstrated within the framework of this thesis. The more one understands the principles of digital imaging the easier it is to creatively resolve many of the more complex problems facing rock art researchers on a daily basis.

Study Criteria

The eastern ridgeline of Fortyfour lake was selected as a suitable location for the pilot study because it was easily accessible to and from the base camp, provided an adequate sampling of rock art and receive sunlight for most of the day. To determine which concentration areas would form the basis of the study, eight loci and their corresponding panels were written on pieces of paper, placed in a box and drawn as lots. Four lots were drawn that reflected three areas of rock art concentration (Figure 4.4) along the eastern ridgeline. These areas would serve as the project recording stations and the basis for the comparative study.

Drawing at each recording station (Method 1) included annotated notes on the drawing itself, sketches, a panel form (see Appendix III) and any other supplemental notes to the recording process as needed. Breaks for food, water, etc., were not figured
into the overall time spent making the drawings (or taking photos) note taking or filling out the panel forms. Time was recorded when the documentation process began and finished.

When the station was recorded photographically (Method 2), photographs were bracketed when necessary and included panel (s) and area overviews (with and without scale and reader boards). Descriptive and observational notes (except for brief sketches) were tape recorded using a voice activated tape recorder and a blank panel form as a template. Notes were then transcribed onto a form and photo's were imaged at a later date. Time was recorded when the documentation process began and finished including imaging of the photographs, editing and transcribing notes after the photo processing and scanning had been accomplished.

It is important to understand when the photographs in this document are being viewed, that software programs such as Microsoft Word are limited in the range of colors they are able to use after a photograph has been inserted into a document. Whereas photo-imaging and paint programs can recognize thousands of individual colors, word processing programs 'see' only a couple of hundred colors that are arranged by family groups.

This has the tendency of over or under saturating an image while enhancing or deleting certain color groups. Photographs in this document are also affected by paper quality and printer the document was printed on. Each printer has a range of colors it is capable of handling and a specific way of handling them. Just how successful it is depends not only on the level of resolution the printer is capable of outputting, but also on how colors are delivered and applied to the page during printing.
Although these factors were considered during the construction of this paper, the photographic results are nevertheless bound by these limitations. When graphic files are viewed and printed from Adobe Photoshop (or similar photo-imaging/editing programs), the difference in quality can be quite dramatic.

*Recording Stations #1 through #4*

Starting on the next page drawings and photographs from each recording station will be presented along with the date, the amount of time it took to record the entire station and prevailing weather conditions at the time the station was recorded. Following the presentation will be a discussion and a comparative analysis of the results for each station. Photographs had to be digitally cropped to fit within the formatting of the page.

Following the study, a brief demonstration of digital imaging will be given, in which some of the more common photographic problems are addressed and an example or two in how digital imaging can be use analytically in rock art research and how imaging techniques can be use to reveal 'hidden' or difficult to see rock art panels.
6/21/94 - Recording Station #1 (Method 1)

Drawing with annotated notes, panel form, addition sketches and observations.

Start Time: 1pm.    Finished: 3.30pm.    Weather: Sunny/Clear

Recording Time 2 hours 30 minutes

Figure 4.6: Drawing of Recording Station #1 (G.Curtis).
6/24/94 - Recording Station #1 (Method 2)

Photographed panel, tape recorded notes, additional sketches and observations.

**Start Time:** 1pm  **Finished:** 1:30pm  **Weather:** Sunny/high clouds moving in

**Time accrued:** 30 minutes

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9/10/94 - Imaging Time and Transcribing Notes

**Start Time:** 9am  **Finished:** 9:40am  **Time:** 40 minutes

**Total recording time:** 1 hour 10 minutes

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Figure 4.7: Photograph of Recording Station #1 (G.Curtis).
Discussion

Recording Station #1 took 2 hours 30 minutes to draw, record notes and sketches and fill out the panel form. Photographing the recording station, taking notes by tape recorder, sketches, imaging and transcription of audio records took 1 hour 10 minutes, a difference of 1 hour 20 minutes. Recording Station #1 was difficult to see, draw and photograph. The problems encountered in recording this station resulted from heavy patination on the boulders surface. The patina ranged in coloration from reddish brown to brownish and was heavy to moderately heavy in its degree of accretion. The petroglyphs were very close in coloration to the boulder surface but with less saturation.

As a result, photography in this instance was insufficient at showing the presence of design elements on this particular boulder. Although some petroglyphs are visible in Panel A of Figure 4.7 (bottom left), identification of additional design elements from the photograph is difficult at best. Close-up photos of panels B and C were taken with a blue filter to enhance color saturation and later under different lighting, but without marked improvement. Overall, photography has proven to be insufficient at recording this particular recording station.

Formal drawing of Recording Station #1 turned out to be the best method to use for recording these elements given the panel and glyphs overall condition. The drawing was able to document the presence of the design elements more effectively and accurately, their distribution and positioning on the boulder, and their basic geometric orientation.

Although drawing was necessary at this station, the photograph was nevertheless effective in showing more readily and accurately the boulders surface texture (when
zoom viewed in Adobe Photoshop), color, encroachment of lichens and mosses, the 
boilders actual shape and structural condition and the contextual setting of the artifact.

Because of the problems involved in accurately relaying a panels contextual 
setting, weathering and general structural attributes via a drawing, the decision was made 
at the beginning of the project minimize this aspect of the drawing process and save time. 
This information was more effective and efficiently gathered through good descriptive 
notes and photography which can provide a detailed level of information in one good 
photo.

Digitally enhancing the photographs from this recording station in Adobe 
Photoshop was unproductive as well (although a more experienced user may attain better 
results). Aside from not being able to see all of the design elements in the photograph, 
the photograph was improved somewhat by digitally editing the image for clarity, and 
color and 'fixing' the ruler and menue board for easier identification.

Recording Station #1 is an example where both recording methods are needed to 
acquire a complete recording of the artifact (and easily assessed that it would be so at the 
beginning of the process). Although photographing Recording Station #1 was more 
efficient in overall time and more accurate in presenting some forms of information, such 
information is of limited value if the rock art in the photo cannot be identified.

Acquiring productive photographic results with rock art loci and panels such as 
those encountered at Recording Station #1 might be possible if more time were spent 
exploring the use of different types of films, filters, exposure rates and lighting along 
with collaborating these efforts with digital image technology. Together this research 
may eventually provide a solution for future recording efforts.
6/23/94 - Recording Station #2 (Method 1)

Drawing with annotated notes, panel form, addition sketches and observations.

Start Time: 2pm.    Finished: 4:45pm.    Weather: Sunny/high clouds

Total recording time: 2 hours 45 minutes.

Figure 4.8: Drawing of Recording Station #2 (G. Curtis).
6/24/94 - Recording Station #2 (Method 2)

Photographed panel, tape recorded notes, additional sketches and observations.

Start Time: 5:44pm    Finished: 6:15pm    Weather: high clouds moving in.
Time accrued: 30 minutes

9/10/94 - Imaging Time and Transcribing Notes

Start Time: 10am    Finished: 11am    Time: 1 hour
Total recording time: 1 hour 30 minutes

Figure 4.9: Photograph of Recording Station #2 (G.Curtis).
Discussion

Recording Station #2 took 2 hours 45 minutes to draw, record notes and sketches, and fill out the panel form. Photographing the recording station, taking notes by tape recorder, sketches, imaging and transcription of audio records took 1 hour 30 minutes, a difference of 1 hour 15 minutes. Recording Station #2 was difficult to see visually and hard to draw manually. Photographically the petroglyph came out quite well considering the relatively uniform coloration between panel and design element.

The panel surface was covered with a reddish brown to brownish orange patina. The design elements coloration was close to that of the panel surface, and only a little lighter in color saturation. The middle portion of the design was hard to see and it remained undecided as to where the abrading of the design began or ended.

When this panel was viewed under indirect lighting the design appeared to be complete. But because I had viewed the panel under other lighting conditions and was unable to see this section clearly, this section of the drawing was left open until the photographic results were in and analyzed.

This type of problem is a common occurrence when drawing rock art panels in the field and unfortunately it cannot be made any easier or more accurate by one's knowledge or experience in rock art documentation. Trying to determine if part of a design is really there or not, is a serious problem when it comes to document rock art in the field through drawings because it forces the recorder into making decisions about what to record based on what they 'think they are seeing,' rather than what is actually there.
One of the advantages of the photographic process at Recording Station #2 was in discovering that a part of the design was overlooked or hidden during the rendering of the drawing the day before, either because of lighting or my eyes inadvertently blended the similar colors of the panel and design element together (see the separate finger like extensions at the top of the main design of Figure 4.9, then look just to the right of the first three, there is another part of the image that has a similar shape and is unattached to the main design).

In Figure 4.10 Adobe Photoshop is used to invert the photographs color scheme, and those results are then channeled through a blue channel filter to improve contrast. An arrow of identification was placed in the photo using CorelDraw, to identify that part of the design elements which was overlooked during the initial drawing of this station. Both normal and inverted photographs appear to indicate that the drawing is in fact complete and that the central portion that was difficult to draw earlier, was in fact there.

In Figure 4.10a, Figure 4.10's color is inverted once again (but without the photo), to illustrate yet another way in which one can improve the view this particular design element. Digitally altering the contents of a photograph, as in Figures 4.10 and 4.10a, can be an important technique not only for recording purpose, but as a means to identify and analyze hidden attributes not readily apparent in normal color photography. Each new change or alteration gives the researcher an opportunity to view the subject matter from a variety of perspectives, each capable of providing new levels of information that would be inaccessible or unavailable after normal drawing or photographic recording of a design element.
Figure 4.10: Color inverted photograph, red arrow shows a previously undetected part of the design (G.Curtis).

Figure 4.10a: Color inversion of Figure 5.9 (G.Curtis).
Although the drawing of Recording Station #2 provides a good general representation of the panels shape and design geometry, it cannot compete with the volume of information that is transmitted by a single photograph of the same image. When imaging techniques are applied, the process is enhanced even further.

The photograph accurately provides more information about the panel surface texture, coloration, encroachment of lichens and mosses, general condition from weathering, design geometry and its relationship to its immediate contextual environment. Figure 4.11 shows how textual information from a panel record can accompany a photograph.

**Figure 4.11: Integrating textual data and photographs together**
6/22/94 - Recording Station #3 (Method 1)

Drawing with annotated notes, panel form, addition sketches and observations.

Start Time: 12:00pm.  Finished: 2:40pm.  Weather: Sunny/Clear.

Total recording time: 2 hours 40 minutes

Figure 4.12: Drawing of Recording Station #3 (G.Curtis).
6/24/94 - Recording Station #3 (Method 2)

Photographed panel, tape recorded notes, additional sketches and observations.

Start Time: 2:30pm        Finished: 2:55pm        Weather: thin overcast, sunny.

Time accrued: 25 minutes

9/11/94 - Imaging Time and Transcribing Notes

Start Time: 11am        Finished: 11:35am        Time: 35 minutes

Total recording time 1 hour

Figure 4.13: Photograph of Recording Station #3 (G.Curtis).
Discussion

Recording Station #3 took 2 hours 40 minutes to draw, record notes and sketches, and fill out the panel form. Photographing the recording station, taking notes by tape recorder, sketches, imaging and transcription of audio records took 1 hour, a difference of 1 hour 40 minutes. Photographing and drawing this station went smoothly.

The drawing of the boulders ended up being distorted geometrically in the final rendering and the relationships between image to image and image to panel surface are slightly misrepresented. The drawing inaccurately depicts how heavily or how lightly the design elements were abraded onto the rock surface and the drawing overall is moderately distorted and only resembles the design elements stylistically. The photograph shows these relationships more accurately, as well as the panels coloration, general shape, weathering condition, geometry and contextual setting.

When Figure 4.13’s normal color scheme is inverted (Figure 4.14) the results provided new information about the panel that was missed during the earlier drawing session. In the upper left hand corner of the panel, the circular design element has some additional abrading (red arrow) attached to which is very faint and overlooked initially when the drawing was made. It was only discovered when the original photographs color format was inverted.
At this station the drawing is unnecessary and in a normal recording situation would be an ineffective use of time to do so. The photograph clearly and accurately records the characteristics of the design elements and more, which, when added to the descriptive notes recorded on the panel form, etc. sufficiently documents this station for a general recording. Digital imaging of this panel improved viewing of the artifact and assisted in pointing out areas of light abrasion that was difficult to see otherwise and may have never been documented if it had only been drawn. Whether or not the 'new' area is of consequence or importance in the overall analysis is not at issue, that it was more clearly seen and identified using digital imaging is the issue.
6/25/94 - Recording Station #4 (Method 1)

Drawing with annotated notes, panel form, addition sketches and observations.


Total recording time: **3 hours**

---

Figure 4.15: Drawing of Recording Station #4 (G.Curtis).
6/25/94 - Recording Station #4 (Method 2)

Photographed panel, tape recorded notes, made additional sketches and observations.

Start Time: 1pm   Finished: 1:50pm   Weather: cloudy.

Time accrued: 50 minutes

9/11/94 - Imaging Time and Transcribing Notes

Start Time: 12:30pm   Finished: 1:10pm   Time: 40 minutes

Total recording time  1 hour 30 minutes

Figure 4.16 Photograph of Recording Station #4 (G.Curtis).
Discussion

Recording Station #4 took 3 hours to draw, record notes and sketches and fill out the panel form. Photographing the recording station, taking notes by tape recorder, sketches, imaging and transcription of audio records took 1 hour 30 minutes, a difference of 1 hour 30 minutes. Photographing and drawing this station went smoothly.

Although the drawing session took a little longer to render due to the increase of design elements present on the panel, the drawing turned out fairly well in depicting the boulder's shape, the relationship between design elements and design element geometry. However, a single photograph again delivers all of this information in a more efficient, accurate and detailed manner.

For example, in the drawing panels A, B, and C are designated separately based on the fractures in the rocks surface. Between Panels A and C, the drawing clearly shows the circular figure with the four lines attached to it (1), as being entirely in Panel C (an oversight in drawing) and that the fracture boundary it shares with Panel A is above it. The photo clearly shows however, that the petroglyph is in fact bisected by the fracture making the panels both A (based on my criteria stated earlier) instead of A and C. If the drawing alone was the only document we had of this panel this and other inaccuracies may never get detected.

In this instance, because the design element is split in half and is in danger, sometime in the near future of breaking apart, the fact that the error was detected has a bearing on the overall condition of the panel conservationally. Another advantage to photographing panels and combining the results with digital imaging is the ability to
isolate a single panel or group of panels, magnify it and present it for further analysis (Figure 4.16a). Digital imaging clearly adds a new dimension to the recording process, to writing reports and to photo-analysis by providing new levels of information from a photograph that are lacking in traditional rock art drawings.

![Figure 4.16a: Digitally isolated portion of Recording Station #4 (G. Curtis).](image)

It can be clearly seen in Figure 5.16a that the fracture between panels A and C does in fact bisect the one design element. This figure also shows how lichen and mosses are establishing residence along the panel seams and fractures.
In Figure 4.16b I used CorelDraw to make a computer rendered drawing of this panel section. This again illustrates one of the advantages photographs can have over traditionally rendered drawings, after the photograph has been digitally processed and edited.

Digitally rendering a drawing off of a photograph, as seen in figure 4.16b, produces good results, and while the process usually requires some editing of background 'noise', the results will never smear or fade, are easily stored, and provides a literal rendering of the artifact unlike hand drawings which are subjective and interpretive.
When Figure 4.16's normal color scheme is inverted (Figure 4.17), detail and contrast are enhanced by the process and as in Recording Stations #2 and #3, the process of inverting the photograph reveals additional information about the panel and the petroglyph designs with the unaided eye (i.e. intensity of design abrasion, clearer view of lightly executed design, etc.).

Figure 4.17: Color inverted photograph of Figure 4.16 (G.Curtis).

By photographing Recording Station #4, taking notes via a tape recorder and using digital imaging to clarify and enhance the photograph for interpretative and scientific analysis, an additional hour and a half of field work was retrieved for application elsewhere.
More accurate and diverse levels of information about the petroglyph panel was acquired and it was done in an efficient, cost effective manner. In the next section, the results of the study and it's implications will be discussed.

Study Results

Although the current study was limited in it's scope and diversity of sampling, it's objective in comparing drawing and photography as rock art recording techniques to determine which method would prove more efficient in recording accuracy, detail and consistency was relevant demonstrated. Although the differences between recording strategies were minimal in configuration and the studies overall sampling size negates an in depth statistical analysis, the outcome of this study (see Table 4.1), suggests that even when making minor changes in the recording approach, the results can effectively improve rock art recording during the documentation process.

Table 4.1: Recording statistics from Recording Stations #1 through #4.

<table>
<thead>
<tr>
<th>Recording Station</th>
<th>Method 1</th>
<th>Method 2</th>
<th>Time Difference</th>
<th>Best Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drawing,</td>
<td>Photography,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sketches notes,</td>
<td>sketches taped</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>panel form</td>
<td>notes, panel form</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rec. Sta. #1</td>
<td>2hrs. 30mins.</td>
<td>1hr. 10mins.</td>
<td>1hr. 20mins.</td>
<td>Both</td>
</tr>
<tr>
<td>Rec. Sta. #2</td>
<td>2hrs. 45mins.</td>
<td>1hr. 30mins.</td>
<td>1hr. 15mins.</td>
<td>Photography</td>
</tr>
<tr>
<td>Rec. Sta. #3</td>
<td>2hrs. 40mins.</td>
<td>1hr.</td>
<td>1hr. 40mins</td>
<td>Photography</td>
</tr>
<tr>
<td>Rec. Sta. #4</td>
<td>3hrs.</td>
<td>1hr. 30mins.</td>
<td>1hr. 30mins</td>
<td>Photography</td>
</tr>
<tr>
<td>Avg. Time</td>
<td>2hrs. 53mins.</td>
<td>1hr. 17mins.</td>
<td>1hr. 26mins.</td>
<td></td>
</tr>
<tr>
<td>Total: 4 Stations</td>
<td>10hrs. 55mins.</td>
<td>5hrs. 10mins.</td>
<td>5hrs. 45mins.</td>
<td>Photography</td>
</tr>
</tbody>
</table>
The recording statistics compiled in Table 4.1 show that when Method 1 (drawing design elements, hand recording all notes, sketches and panel forms) was applied to each of the recording stations, the process took on an average 2 hours and 53 minutes to complete, while recording the same stations using Method 2 (photography, tape recorded notes, sketches, panel forms and digital imaging) took on an average 1 hour and 17 minutes to complete, saving an averaged time of 1 hour and 26 minutes per recording station or 111% increase in efficiency.

Method 1 took 10 hours and 55 minutes to complete all four recording stations, Method 2 took 5 hours and 10 minutes to complete all four recording station. The difference in time spent recording all four stations between the two methods was 5 hours and 45 minutes. Another way to look at this data is by extrapolating these results from this project onto a theoretical site. If this theoretical site contained a 100 rock art panels whose complexity of design and frequency was equal to those used in this study, the time saved recording would translate into 126 hours (or the equivalent of 12.6 10 hour working days or the equivalent of a $1,008 dollars in wages at $8 hour).

Granted, recording a rock art site is rarely as straightforward as this study might at first seem to indicate. Many sites have panels hidden in shadows or vegetation, covered by lichen and moss, vandalized, heavily patinated or covered in silica or caliche, or just difficult to access in one way or another. Each rock art recording situation is unique and challenging. Testing a broader range of recording situations needs to be incorporated into future research projects.
However, if documenting a rock art site can be effectively improved by eliminating redundant methodology especially when a particular technique can clearly handle the recording situation (as this study indicates), then the improvements in the recording process should be even more pronounced when more complex and difficult panels require documentation (Figures 4.18 and 4.19).

Figure 4.18: Complex set of rock art panels at Fortyfour Lake (G. Curtis).
Because the study was conducted entirely on my own, there was an inevitable degree of consistency in the filling out of the panel forms and the observations made that probably would not have existed under a normal recording situation involving other field members with varying degrees of training and experience. This was also apparent in my sketches and drawings.

The quality of my own drawings while adequate on some levels, reflect a lack of training and experience that are essential if the document is going to be accurate and informative as a recording and scientific document. While in the drawing, the general shape and appearance of the design elements are accurate enough to relocate and recognize them onsite, the skills needed to accurately render their geometry and other descriptive and contextual attributes effectively, need to be further developed.
The relevance of this observation reflects one of the most important advantages photography has over drawing in a recording situation. It takes significantly less time and training to produce accurate and detailed results using photography than it does in drawing even straight forward and uncomplicated panel designs. Drawings which try to incorporate all of the intricate details and visual information such as color, texture, cryptogamic growth, weathering and context accurately, not only require extensive skills and training but require an unjustified amount of time to render and complete.

Drawings and descriptive notes, regardless of how detailed they are cannot replace the level of detail captured in a single photograph or in how quickly the information can be communicated when viewed. Bring digital imaging techniques into the picture and apply them to the various recording and analytical photographic challenges one encounters when recording a site and it seems clear that photography can no longer be considered an unreliable and 'static' method of recording but in fact represents a technique for recording that can impart information on multiple levels with scientific relevance and accuracy.

**Digitally Editing Photographic Flaws**

**And Revealing Hidden Images**

One of the most important aspects of digitally editing and enhancing photographs is in the diversity of it's application. Digital editing can restore photo-coloration, color balance and saturation, clarity, focus and contrast, and the ability to add to or remove objects freely from the image being edited (i.e. telephone line, cars etc.) or assist in revealing elements of a photograph (analytically or descriptively) that were under normal
viewing conditions, difficult or impossible to see, speaks to the amazing possibilities
digital imaging can bring to any research discipline including rock art. Before this
project concludes, a demonstration of how digital editing and photo enhancement
techniques can be used to facilitate field and office productivity or trouble shoot common
photographic flaws should be of interest.

In Figure 4.20 a photograph is shown which after processing and scanning, was
too dark and the color and definition are poor. Photographs such as Figure 4.20 would
have been throw away only a few years ago because of it's poor visual properties and
limited scientific usefulness.

Figure 4.20: Photo with poor contrast, color and clarity (G.Curtis).
Processing or scanning 'flaws' (whether professionally acquired or from the office/home) like this occur frequently and in most instances, are easily resolved.

To proceed in editing out or adjusting some of the visual flaws this photograph displays, the scanned photo file must first be opened in a program such as Adobe Photoshop or CorelDraw that have been specifically designed editing or enhancing image files.

Each step in the editing process begins with moving the mouse cursor to the main header on the Menu Bar (i.e. File, Edit, Image, Layer, Select, Filter, View, Window, Help) and proceeding down that particular menu (once it is opened up), to either the next header or the function that is to be used within that menu. The last item in the string which will be underlined and bold is the function that is being used at that point.

To edit the above photograph I went through the following steps.

 Filter ➔ Sharpen ➔ **Unsharp Mask**

"Unsharp masking or USM is a traditional film compositing technique used to sharpen edges in an image. The Unsharp Mask filter corrects blurring introduced during photographing, scanning, resampling, or printing. It is useful for images intended both for print and online" (from Adobe Photoshop v5.02 Help File 1998). Then:

 Filter ➔ Sharpen ➔ **Sharpen**

In doing this you add a little more definition to the image. Then:

 Image ➔ Adjust ➔ **Brightness/Contrast**

This gives you a sliding gradient tool in which you can brighten or darken an image and improve it's contrast/definition to your liking. And finally:

 Image ➔ Adjust ➔ **Color Balance**
This allows you to adjust your colors in three categories: shadows, midtones and highlights. Depending on the situation one can also go to the Hue/Saturation tool found just below Color Balance and lessen/or heighten the intensity of individual colors and hues. Figure 4.21 shows what can be done in approximately five minutes of photo editing time.

Figure 4.21: Figure 4.20 before and after digital editing (G.Curtis).

Another example illustrates how to place a reader board into a photo that has been inadvertently left out, along with a north arrow (Figure 4.22) during the photographic process. A problem easily addressed using Adobe Photoshop and CorelDraw.
Again open the scanned photo file and edit for sharpness, color, brightness and contrast (if necessary and demonstrated earlier). Next create a box, or rectangle on your photograph in Adobe Photoshop, that will act as your new menu board.

![Figure 4.22: Before and after results (G.Curtis).](image)

To do this you will need to use your mouse and the Marquee Tool (the upper left hand corner button of Adobe's vertical tool bar and represented by a series of dashed lines...
forming a box -- if the tool bar isn't showing go to Windows menue in Adobe and click on Show Tools). Once the Marquee tool has been used to create a box by left clicking and holding down the mouse at the desired location and then dragging and shaping an box outline to your liking, the next step is to go up to the Edit Menue and select Cut. This removes all of the pixels currently outlined by the square the marquee tool created and leaving a blank white space in it's place (If the vacancy created by the cut is not white, but black or a series of gray and white squares, you will need to make a copy of the photo and place it in a New window[using the File Menu] with a white background). Once you have a square with a white background you can then place text in this area by using the Text tool (T) found on Adobe's vertical tool bar.

Adding a north arrow to the photo requires using a program called CorelDraw. First save the current photo file in a .pdf file format (which is compatible with CorelDraw). Start CorelDraw and open up the .pdf photo file you just saved. To place a symbol in the photo, with a particular color and at a particular angle, you first open up the symbol tool menu by clicking on a small square button in the tool bar that has a star in it.

This brings up a Symbol Tools menu with a small rectangular window at the top. From here you can find what you want, drag and drop it into the photo, adjust it's size and orientation (clicking on the symbol each time allows for different options) and then fill in with any color you desire (by clicking on the horizontal arrow at the bottom of the color chart you expand your options for colors significantly). To move the arrow to where you want it, just click on the symbol until a small x appear in the center of the arrow (and the arrow is surrounded by square dots), place the mouse cursor over the x and move the
arrow to wherever you want it. Then Save As a .pdf file again so you can open the file back up in Adobe Photoshop if further editing or enhancements are needed.

One of the drawbacks occasionally encountered when using imaging techniques to improve a photograph's overall, color, brightness, and contrast is that the scale and the reader board in a photo can inadvertently become illegible or invisible (Figure 4.23).

Figure 4.23: Before and after replacing lost info from editing (G. Curtis).
This drawback can be easily fixed however in a few short steps in Adobe Photoshop and CorelDraw. First, since the photo is open and assuming you have a white background behind your photo, just use the eraser tool (which looks like an eraser in the left column of the vertical tool bar) to first clean up the current reader board (by left clicking on the tool button and holding it down as the tool cursor is passed over the area of the image to be erased). If you make a mistake just go up to the Edit Menue and select Undo Erase. Another option is to open up the History Window located under the Windows Menue and back click on the actions you have taken so far on the photograph removing the editing and enhancement up to that point.

Next, access the Text Tool and type in any data you wish to be included in the reader board. Having done that, save in a .pdf format again and reopen in CorelDraw. In CorelDraw we want to add bars to the ruler to show 10cm blocks that were original on the ruler but have been rendered nearly invisible through earlier editing. Open up the Symbols Menue again, select in the window at the top of the Symbols Menue, Monotype Sorts and scroll down till you find a line symbol, select a slender example and drag and drop it on to the photo.

Fill in the symbol with the color black, resize and shape it (discussed earlier) to fit on the width of the ruler (in this example a yard stick) and adjust it's orientation (discussed earlier) to fit properly. Then move it into place, release the mouse button and click the mouse cursor on another section of the photo (to finalize positioning) and your done with placing your first hash mark on a ruler.

The process is easily repeated by clicking on the 'new' hash mark (this activates the symbol again) go up to the Edit Menu, left click on Copy and then exit. Then re-open
the Edit Menue, left click on Paste and this places a duplicate symbol *directly on top of the one you just copied*. Move the mouse over to the \( x \) in the middle of the symbol, left click and hold down the mouse and move the symbol to the next spot and release. Repeat this process as often as necessary (using the magnifying tool in Adobe Photoshop make this process easier and ensures accuracy).

There are a number of ways in which photographs can be edited and adjusted to meet ones needs, but scanned drawings can be edited as well. For example in Figure 4.24, I scanned a drawing from *The Archaeology of Oregon* by Aikens (1993:16) and when the image came up in the computer, it looked like the right side of Figure 4.24 because of the original documents paper color, which was a moderately dark beige.

To correct this problem, I reopened the file in Photoshop, making sure the foreground and background colors (represented by the two overlapping squares at the bottom of the vertical tool bar) were both white, clicked on the paint bucket tool (lower left hand side of tool bar) and clicked on various areas of the images background to get the results you see on the left hand side of Figure 4.24. To create Figure 4.24, I used the Marquee Tool to isolate one half of the drawing to work with in the beginning of the editing process.
But perhaps one of the most important advantages digital imaging has to offer is in its ability (through filters, channels, layers, etc.) to reveal elements of a photograph that were captured by the camera, but were too faded or nearly invisible to see by the naked eye under normal color viewing. For example, when digitally editing a petroglyph photograph from Horse Thief State Park along the Columbia River in Washington, a process was discovered that revealed the 'true' nature of the design element that was under normal conditions photographically (and in person) very difficult to see.

The petroglyph in Figure 4.25 was moderately pecked (~.5cm) and covered with a variety of lichens and moss colonies that obscured the designs visibility on the rock surface.
To see what the image actually looked like the first step was inverting the normal color of the image by Menu → Adjust → Invert. Then, the Channel Filter Tool was needed. This was accessed by Window → Show Channels. This brought up a color channel selecting window and in this case blue was selected to improve contrast and clarity. The results can be seen in Figure 4.26.
Figure 4.26: Color inversion of Figure 4.25 after applying a blue channel (G.Curtis).

The level of imaging sophistication needed to reveal hidden or obscure design elements in a photograph, has only been available to the public since the early 1990's. The original photo, which in Figure 4.25 was cropped, edited for color, contrast and sharpness, possible would have been thrown away a few years earlier since it was difficult to see what was in the photo and therefore it's usefulness as a visual record capable of transmitting relevant information was in question. Today, however, photographs exhibiting various grades of quality can provide relevant scientific information if a person has the proper training and tools to acquire it.
Although these examples have been brief and reflect only the basic levels digital imaging is capable of, they have demonstrated trouble shooting application and analytical potential when used in combination with photographs and digital drawings. This undoubtedly adds a whole new dimension to what can now be accomplished with those once static and barely usable photographic documents. When these digital tools are used to their fullest extent, their ability to expedite, improve, clarify and open new vistas in scientific analysis is limited only by the imagination of the person sitting behind the computer.
CHAPTER 5: SUMMARY AND CONCLUSIONS

Rock art represents a unique class of artifact archaeologically, whose potential contributions for adding to our understanding about prehistoric cultural systems has been collectively ignored by the anthropological and academic communities at large. In addition, because of rock art's increased popularity publicly, in conjunction with the continued pressures of environmental stress and deterioration, this often fragile and non-renewable resource is quickly disappearing from the natural landscape before it can be adequately inventoried and studied.

While cultural resource programs operating within land managing agencies, (which in Oregon oversee 53% of the states cultural resource base) are bound by law to "identify, manage, and protect all cultural resources, under their jurisdiction, including rock art" (Swartz and Zancanella 1991:114 - Federal Land Policy and Management Act of 1976, Public Law 94-579), funding and staffing for such inventorying and managing programs (since they provide little in the way of financial return), are minimal.

Most importantly however, is the fact that when the opportunities does exist to document and record rock art sites for research, conservation and management, the recording methods and techniques used to facilitate this process (primarily drawings and tracings, and photography, has not only bottlenecked productivity and efficiency, but the data acquired by the over application of these techniques is inconsistent and inaccurate.

With the state of affairs being as they are, investigating ways of improving the basic approach taken to record rock art and determine if in fact the process can be made
more efficient, more accurate and more productive, seemed like a reasonable research project. But in able to effectively examine the many layers of rock art recording within the framework of this thesis, it was necessary to narrow the scope of the investigation down to examining only a couple elements (drawing and photography), of a larger recording problem.

The basic premise was to determine if under normal circumstances, the use of photography, digital imaging and other automated recording techniques could qualitatively and quantitatively improve an otherwise inefficient and inaccurate recording system in which drawing are the status quo. The goal is not to replace drawing as a recording mechanism, but rather to advocate it's use be more judicious and relegated to those situations where it can be most effective.

Equally important in this study was in determining whether or not digital imaging techniques can provide additional opportunities for artifact analysis and identification, that have been up until recently, unavailable in the field. In addition, it was important to demonstrate how using digital editing to improve and trouble shoot common photographic problems and oversight can be easily corrected and thereby be more fully integrated into the recording process and facilitating that process on several levels

**Effectiveness of Approach**

The comparative approach used in this study had in effect, two parts. The first part of the study involved a comparative literature review in which the strengths and
weakness of drawing and photographs were examined. This was accomplished by performing a thorough examination of the professional and avocational literature base to determine a consensus of past and present rock art practitioners regarding the accuracy, efficiency and overall consistency of drawing and photography as recording tools.

The results of that consensus clearly showed that most researchers felt that while drawings are necessary and sometimes important to the recording process, the drawings process raised a number of concern in terms of its subjectivity, inaccuracy's, general inconsistencies and that the process frequently required large blocks of time for documentation.

Another concern with drawings, that was raised in the consensus and studies that were examined (Walt and Brayer 1994, Walt, Brayer and David 1998) was the fact that there was little in the way of training, experience, skill or equipment that could effectively offset most of the problems associated with drawing. Even in large scale studies that incorporated professional graphic artists, trained archaeologists and rock art specialist, the end results reflected that these professionally trained individuals had any advantages or were able to make any noticeable improvements to the accuracy or consistency of the drawing process. And none of the participants were able to compete with the efficiency, detail and accuracy of a good photograph.

It was nearly unanimous in the consensus that photography was considered the best method to use in general when documenting a rock art site, the fact that photography isn't used more effectively or more predominantly rests in some of the problems discussed earlier.
Problem which in many cases are solvable today with better photographic equipment and techniques, and with the assistance of digital image processing.

One of the criticisms noted against photography as a recording method included it's inability to effectively render adequate pictures of pictographic panels whose images have faded, leached out or had been covered by a semi-translucent mineral skin. These situations however, are also difficult for researchers to draw resulting in a recording document that is even more subjectively interpreted and distorted.

But as it was discussed in Chapter 3, the photographic technique of cross polarization, developed by Jim Henderson (Henderson 1995), can now be applied to a large majority of these panels and effectively restore their visual properties many times over.

Another criticism leveled at photography involved it's limited use analytically and that visual properties such as color, contrast, clarity etc. are often poor. These concerns can now be effectively addressed using digital imaging and digital editing programs such as Adobe Photoshop, Photoshop Elements, Adobe Photo Deluxe, Paintshop Pro, CorelDraw and Adobe Illustrator.

Finally, photography was seen at times as integrating to much distortion into the image capture process when photographs were taken of rock art panels that were not perpendicular to the focal plane or when multiple connecting panels were photographed that extended outside of the image capture field. Again work by individuals such as Robert Mark and Evelyn Billo have shown that with the proper field preparation, and proper equipment, that these problems can be resolved with very satisfying results, using imaging software to register and/or rectify the photo image after processing.
Photography does have some problems, no system is perfect in all respects, but using photography as a recording mechanism and combining it with digital technology is in fact one of the best approaches available to record rock art sites en masse, knowing that problems once hampering the effective use of field photography can now be addressed.

The study results in comparing drawing and photography at Fortyfour Lake rock art site in southeastern Lake County Oregon, were encouraging. Although the study needs to be expanded in it's testing parameters, it nevertheless showed that even with minor field adjustments to the recording approach, overall accuracy and productively of the recording process can be improved in a consistent and efficient manner. In fact, efficiency was improved 111% using photography as a recording tool over drawing and if more difficult panels had been incorporated into the study, as some may criticize it for lacking, the disparity in efficiency and accuracy between the two methods would no doubt increase.

It was mentioned earlier that the point of this study is not to replace drawings as a recording method, but only point out that it be used only in those circumstances when photography or other recording methods are unavailing. But many projects insist on have every design element on the site drawn (along with selected tracings) for some reason and in the end, lots of paperwork has to be processed and stored, the data, aside from the drawn representation of the rock art, is minimal and large blocks of recording time have been ineffectively used.
Digital imaging has also shown its value in this study as well and not only in its ability to correct cosmetic photographic flaws like color, contrast and brightness, but that it can be effectively used as an analytical tool and as an editor to replace lost or overlooked information. The best part about getting involved with digital imaging and applying it to one's work is that the learning curve to do the basic modifications this thesis has demonstrated is low. Far more time would be spent learning how to render a drawing accurately, to scale, while incorporating the proper perspective and accurate design geometry throughout the exercise. Once a few photographic principles are understood and a few imaging techniques mastered, the combined techniques can be applied effectively and efficiently to one's work on multiple levels resulting in increased productivity and analysis.

Study Limitations and Improvement

Probably the most beneficial results to come out of this study is able to identify those areas in which the study missed the mark on a fundamental level and therefore requiring revision. This level of self analysis not only helps strengthen elements of structure and organization for future research projects, it helps insure that the data acquired during the project is accurate and consistent.

One of the most obvious factors hampering the relevance of this study, was in its inherent bias from my having to exercise both sides of the argument. Although volunteers were initially on hand to help in the execution of this project, because of the site's remoteness and difficult commute, only a few days of volunteer assistance was available. This resulted in downsizing the projects sampling and variability to complete
the time frame that had been allotted for the project. This in turn limited the level of
statistical analysis that could be applied after the project had been completed.

Another limiting factor in my analysis, aside from the study's sample size, was
that in 1994 when this project was initiated, the means to technically compare
photographs and drawings in a computer for recording accuracy, inconsistencies, using
registration and rectification techniques, had not been fully developed for public
application.

Today, however, this level of analysis can be accomplished quite easily by
establishing reference points on each panel being recorded, scan the results (i.e. drawings
and photographs) and then, while the images are superimposed over each other in a
program such as Adobe Photoshop, align the reference points for each document (see
Walt, Brayer, and David 1998). Such comparisons effectively demonstrate how
inaccurate drawings can be and how inconsistent drawings are (from person to person, or
drawing to drawing from the same person) when compared with a photograph.

When fieldwork began in 1994, I had not received a IFRAO (International
Federation of Rock Art Organizations) color chart/scale (Figure. 5.1) and was therefore
unable to incorporate it into my photographs for this study.
Scaled color charts when used in a photograph and scanned into a computer, not only provide scaling for objects viewed in the photograph, but facilitates reconstituting photographic colors that may have been affected or lost during image acquisition, processing or scanning (Bednarik and Seshadri 1995 see Appendix 4).

Another area that suffered descriptively, resulted from my inability to accurately and consistently describe various shades of color as they related to a rocks surface patina, weathering, design coloration, etc. It is a fact that hue and chroma recognition varies from person to person, which can be complicated further by a variety of unforseen problems inherent to recording under field conditions. These include different types of lighting, an objects orientation, temperature, surface moisture, etc. These problems would have been more accurately described if a Munsell Color Chart (Figure 5.2) had been used throughout the course of this study.

One of last areas in which the current project could have been improved involved recording diversity. If the study had incorporated a broader range of recording situations in which both methods were challenged illustratively and photographically, the study
would have more effectively demonstrated which recording approach would better serve the needs of those who actively document prehistoric rock art sites.

The difficulty is that most people, myself included, lack the experience, skills and training to adequately draw rock art panels that are as complex as those referenced in Figures 4.18 and 4.19. Although the panels recorded in this study seem straightforward, they nevertheless presented unique challenges in rendering that resulted in inaccuracies and lost time. It seems apparent that if professional graphic artists have a hard time

Figure 5.2: One page from a Munsell Color Chart (Munsell 1994).
competing with photographic accuracy in depicting design geometry and general consistency, then the answer to more effectively and more efficiently document a rock art site must lie in another direction.

I plan to continue researching rock art recording methodology and believe that future projects and recording opportunities will benefit if: 1) the limitations from the current project are taken into consideration and resolved and 2) maximize field and office equipment and add GIS and GPS technology to the documenting tool kit.

Ideas for improving office and field equipment include:

- hand held GPS units for specific locational data regarding panels, locus, etc.
- hand held digital voice recorder to be used in conjunction with voice recognition software such as ViaVoice, or Dragon Systems Naturally Speaking Mobile, which allows one to transposes audio notes into textual notes automatically through a computer or laptop.
- acquire software packages for panoramic photographic stitching, photo-registration and rectification and geographical mapping (including GIS), for home and office use.
- acquire a good digital and SLR Camera with accompanying accessories.
- Incorporate a Munsell Color Chart and IFRAO color chart into the recording process for consistent color descriptions, scaling and referencing.
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APPENDICES
MINIMUM RECORDING STANDARDS
PROPOSED BY THE AMERICAN
COMMITTEE TO ADVANCE THE STUDY
OF PETROGLYPHS AND PICTOGRAPHS

It is impossible to prepare a universal, objective set of standards for recording petroglyphs and pictographs. Data collected often relate to specific problems being investigated. Much of the data is not objective by nature — but is observational or contextual. Also, strictness of standards should vary by site fragility and accessibility. A deteriorating petroglyph 100 miles from permanent settlement, encountered by a solitary archaeologist doing survey work in rugged wilderness, requires different treatment than one scheduled for imminent demolition by highway construction or petroglyph that is thoroughly stabilized. The following standards are minimal and based on non-returnable, transitory, single visits to friable surface localities. Important recording opportunities, such as the relation of the season and time of day with face-light exposure for photographic enhancement, are not always available. Broad, regional archaeological observations should be made in concert with specific petroglyph recordings.

In deciding which techniques to apply in a particular case, one’s goal should be optimal data recording with minimal resource destruction. Methods requiring surface pressure, application or insertion, such as painting (aluminum powder, tempera, etc.), tracing, rubbing, molding or grid-anchoring, cannot be universally condoned and should not be attempted on friable surface markings. These approaches can break down the basic rock structure or may contaminate or alter the surface, distorting potential trace-element studies. Also, direct transfer records demand greater storage space. Chalking should never be done; water spraying, especially of pictographs, should not be done unless there is no doubt that panel is scheduled for destruction.

Various photographic techniques are stressed, since they are documentary in nature and do not require physical contact. Careful photographic work and draughtsmanship are probably sufficient for basic petroglyph and pictograph recording, but easy-to-record additional metric data should be included to provide useful comparative information.

Five types of petroglyph-pictograph records should be made.

1. FACE RECORDING FORM

<table>
<thead>
<tr>
<th>Metric data (objective)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site and face (or panel) designation</td>
</tr>
<tr>
<td>Face datum</td>
</tr>
<tr>
<td>Face dimensions (straight)</td>
</tr>
<tr>
<td>Face dimensions (surface)</td>
</tr>
<tr>
<td>Direction of face (in degrees, compass, check for magnetic distortion, iron in rock, etc.)</td>
</tr>
<tr>
<td>Inclination of face (in degrees, plumb bob and protractor)</td>
</tr>
<tr>
<td>Height of base of face from ground</td>
</tr>
<tr>
<td>Height of top of face from ground</td>
</tr>
<tr>
<td>Cross-section of lines (for each discrete design element and each style, petroglyphs)</td>
</tr>
<tr>
<td>Colors including rock surfaces (Munsell Color Chart, pictographs)</td>
</tr>
<tr>
<td>Hardness of rock (Moh Scale)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observational data (descriptive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vandalism</td>
</tr>
<tr>
<td>Natural defacement (e.g. erosion of surface, waterlines, lichen, patina, smoke blackening, etc.)</td>
</tr>
<tr>
<td>Old ground surfaces</td>
</tr>
<tr>
<td>Superpositions</td>
</tr>
<tr>
<td>Type of rock</td>
</tr>
<tr>
<td>Conformation of rock (cracks, holes incorporation, etc.)</td>
</tr>
<tr>
<td>Wear surface (e.g. carved, cut, engraved, pecked, ground or abraded, rubbed, drilled, secondary smoothing, etc. for petroglyphs; or brushed, daubed, blown, stencilled, etc. if a pictograph)</td>
</tr>
</tbody>
</table>
PHOTOGRAPHS

Take a large number of photographs, especially if in inaccessible regions, both fine-grained black and white, and, especially for pictographs, externally coupled color (Kodachrome) film with a Macbeth ColorChecker. Avoid using internally coupled film, even if truer color is rendered. Vary exposure and angles, take close-ups, use slide-lighting, experiment with filters, and panoramas from site and of site. Photograph everything, attempt to use constant distances and systematic coverage and record procedure. Keep records of photographs with site and face designations. Scales are optional if face dimensions are recorded and may clutter photographs. Black and white negatives should be fully processed chemically—not machine processed. Developed color film should be sent to a professional laboratory for processing. Store prints in acid-free envelopes.

DRAWINGS

Make drawings to a consistent scale. Work with pencils, so you may revise. Use a different color for each technique of rendering, style, or pigment if pictograph, and to note by "drawing over" superpositions. Learn important design element conventions, note offsetting in designs. Do not assume the markings are art, and avoid interpretive preconceptions. Record all markings, including "graffiti." If at all possible, have two or more persons make drawings independently. Though comparable information is on Face Recording Form include scale, directional indicator and site and face designations on each drawing.

MAP

The map should show relationship of faces within sites, and of sites to each other, unmarked boulders, trails, other significant landforms, data points (preferably from GS benchmarks) to map, site and face, directional indicator, and complete field numbering of sites and faces.

GENERAL DESCRIPTION

Mention the geomorphology of the area, landforms, e.g. routes, passes, washes, etc., site situation, e.g. river valley cliff, cave, mountain top, distribution of plant cover, location of other archaeological sites in the area, cultural associations (portable and non-portable), especially diagnostic and decorated remains such as points and pottery, tools or materials that may have been used to produce the markings. Note unique features of the surroundings. This section can be refined and standardized by eventual comparison of such accounts in varied areas.

Future conservation recommendations may be made based on site uniqueness, condition and location, i.e. ignore (initiate no policy—keep from public), protect (barriers, fences, grilling, security system), restore, stabilize (impregnation, coating), or salvage (further, more intensive recording if being destroyed).

Compiled by: B.K. Swartz, Jr.

The American Committee to Advance the Study of Petroglyphs and Pictographs was organized in 1979-1980. It is composed of approximately 41 scholars. The Committee recognizes that professional archaeologists have long neglected rock art research, and it seeks in part to rectify that situation.

The foregoing paper on minimum recording standards was one of the initial projects of the Committee.

ARARA Code of Ethics

The American Rock Art Research Association subscribes to the following Code of Ethics and enjoins its members, as a condition of membership, to abide by the standards of conduct stated herein.

1. All local, state, and national antiquities laws will be strictly adhered to by the membership of ARARA. Rock art research shall be subject to appropriate regulations and property access requirements.

2. All rock art recording shall be non-destructive with regard to the rock art itself and the associated archaeological remains which may be present. No artifacts shall be collected unless the work is done as part of a legally constituted program of archaeological survey or excavation.

3. No excavation shall be conducted unless the work is done as part of a legally constituted excavation project. Removal of soil shall not be undertaken for the sole purpose of exposing subsurface rock art.

4. Potentially destructive recording and research procedures shall be undertaken only after careful consideration of any potential damage to the rock art site.

5. Using the name of the American Rock Art Research Association, the initials of ARARA, and/or the logos adopted by the Association and the identification of an individual as a member of ARARA are allowed only in conjunction with rock art projects undertaken in full accordance with accepted professional archeological standards. The name ARARA may not be used for commercial purposes. While members may use their affiliation with ARARA for identification purposes, research projects may not be represented as having the sponsorship of ARARA without express approval of the Executive Committee.

The ARARA Code of Ethics, points 1 through 5, was adopted at the annual business meeting on May 24, 1987. The Code of Ethics was amended with the addition of the opening paragraph at the annual business meeting, May 28, 1988.
**APPENDIX 3**

**PETROGLYPH/PICTOGRAPH SITE FORM**
**BUREAU OF LAND MANAGEMENT**

1. **Site Number**
   - **District**
   - **County**

2. **Type of Site**

3. **Location**

4. **Map Reference**
   - **k, l, m**
   - **T. R.**
   - Compass bearings to common reference point

   (attach copy of map to form)

5. **Landowner and Address**

6. **Dimension of Petroglyph/Pictograph Area(s)**

7. **Kind of Rock Surface**

8. **Direction in which rock faces**

9. **Elevation**
   - **Color if painted**

10. **Design Elements Present**
APPENDIX 3 (Continued)

23. Tracings or Rubbings

________________________________________________________________________

24. Recorded by

Date ___________________ Time ___________________

Weather Conditions

25. General Remarks

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
26. Draw Design Elements Below

27. Scale________________________
### ADDITIONAL PANELS ATTACHMENT

<table>
<thead>
<tr>
<th>1. Site Number</th>
<th>Panel Number</th>
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<th>2. Location</th>
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<tr>
<th>3. Dimension of Petroglyph/Pictograph Area</th>
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<th>4. Distance from other Panels</th>
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<th>5. Direction in which rock faces</th>
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<th>6. Kind of Rock</th>
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<tr>
<th>7. Elevation</th>
<th>8. Color if Painted</th>
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<th>9. Design Elements Present</th>
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<th>10. Superimposition</th>
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<tr>
<th>11. Apparent Age Indications</th>
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<th>12. Condition</th>
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<tr>
<th>13. General Remarks</th>
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</table>
APPENDIX 3 (Continued)

14. Photos

15. Aerial Photos

16. Tracings or Rubbings

17. Recorded by ____________________ Date __________
   Time ____________________ Weather Conditions __________

18. Draw Design Elements Below:

19. Scale ____________________
Introducing the IFRAO Standard Scale

Preamble

The IFRAO (International Federation of Rock Art Organisations) Standard Scale was first proposed in IFRAO Report No. 6 (Bednarik 1991). Consultation of researchers and various specialists in the following years has led to progressive evolution of the design (cf. Rock Art Research 8: 156) until it was finalised in 1993. The Australian Institute of Aboriginal and Torres Strait Islander Studies then made available a grant to meet the cost of producing the Scale through its Rock Art Protection Program. The Institute realised the enormous advantages of such a measure — in documentation, computerisation, and the study of rock art and patination.

Purpose of the Scale

We know that there are many millions of photographs and colour transparencies of rock art in existence world-wide: in my estimation at least twenty millions. Many archives have in the order of hundreds of thousands of images, while thousands of individual researchers each possess collections of many thousands of colour slides or photographs. We also know that such a photographic record is irreplaceable and yet it is doomed to eventual destruction. No known photographic dye is fade-proof, and we still lack any form of permanent photographic or digitised storage of imagery (Dickman 1984). In short, this enormous effort of creating a visual record of world rock art is ultimately in vain.

Even with rapid rock art deterioration it will be survived by most rock art, fortunately. But there is a simple way of rendering this massive record permanently useful: digitised colour re-constitution or reconstruction.

In scientific photography it is essential to know the size of an image, and for this purpose, Taylor et al. (1979) designed a simple ten-centimetre scale for rock art recording. A scale has other roles too. It serves as a general indication of a photograph’s sharpness, by showing how well it was focused and processed. Manual focusing is often difficult with rock art, because of the typical lack of straight or well-defined lines, and the operation of a camera with viewfinder focusing is much easier by selecting one of the lines on a scale.

More important than the black and white scale markings are the colour blots. The colour properties of an object are always distorted in a photograph, by such factors as optics, film type, paper type, temperature and, most particularly, lighting conditions. Therefore a colour photograph cannot be expected to be a true record of chroma, value and hue. However, by checking the colour distortion on a scale photographed with the rock art we can obtain an indication of its severity. Some rock art researchers (a very tiny minority) have been using a variety of colour scales, including the Munsell Soil Colour Chart, the Kodak Colour Separation Guide, the Letraset Pantone colour chart and a variety of others. These colour standard charts are all expensive, they are all different, and standardisation would obviously be desirable here.

The main reason for needing a standard photographic scale, however, is its function as a COLOUR CALIBRATION DEVICE for a variety of computer-supported uses. Electronic colour enhancement methods have been used in rock art studies for many years (Rip 1983). In 1994, electronic colour re-constitution of rock art images was achieved at the National Museum of Man in Bhopal, India, calibrated with the IFRAO Standard Scale as the profile device (Bednarik and Seshadri 1995). This has led to the development of colour-re-constitution software at the Museum.

The original colour values of colour-distorted and even faded rock art photographs can now be automatically re-constituted almost in an instant. The only precondition is that the photograph must bear a colour standard against which the computer can calibrate. The greatest advantage is that the computer does not recover the colour properties of the original photograph, before it faded, but goes beyond that — all the way back to the true colour of the rock art image at the moment it was photographed! It re-constitutes the actual colour properties of the subject at the time, even if this was several decades earlier.

Colour re-constitution thus compensates for photographic distortion as well as for the subsequent fading of dyes.

This technology opens enormous possibilities in research, recording, documentation storage, computerised image manipulation, publishing and conservation studies. For instance, such techniques can facilitate mathematically precise monitoring of deterioration of rock art pigment or patinae over any period of time (Pager 1992; Ward and Maggs 1994). They permit the recovery of objective colour infor-
APPENDIX 4 (Continued)

formation, free of the 'technical subjectivity' of conventional colour information. They facilitate the digitisation of real colour information, which can then be used in many ways: it can be permanently stored, it can be used as the basis of enhancement procedures (Rip 1989), or it can be cross-checked in intra- and intersite studies for various purposes by engaging computer search functions. Such information can also be used in conservation, retouch, graffiti and lacunae repair, comparative pigment studies, sourcing studies, dating work, recovery of very faint images, printing of colour plates and so forth. It provides a reliable and standardised base for numerous applications, and while many of the technologies required may not yet have been developed, it is most reasonable to expect that they will be available within a few years. All that is required at this stage is that every photograph taken of rock art for scientific purposes must bear the same colour calibration standard scale.

The long-term effect of the use of the IFRAO Standard Scale will be a standardisation of the photographic record of world rock art. Our archival record will become a permanent record by virtue of its retrievability. The greatest fear of all rock art students, that the art will deteriorate beyond archival recovery, can be met by the knowledge that the susceptibility of our photographic record to colour calibration will lead to an 'ultimate conservation method'. We will have the means of preserving rock art in pristine condition forever, at least in our archives.

Use of the IFRAO Standard Scale

The IFRAO Standard Scale bears the printing date and will be periodically reprinted to guard against it fading. It should be stored in a dark, dry and cool place when not in use. It includes a grey scale for comparing tone values. The patches correspond with reflection densities of 0.0, 0.70 and 1.60 respectively.

The Scale must never be placed over rock art, or very close to a motif. Preferably it should not be attached to the rock face. In vertical or over-head locations, the Scale should be hand held. Only where definitely undecorated and structurally sound rock surface is available may the use of small double-sided adhesive pads be considered, or the insertion of small metal pins through the Scale to affix it to soft rock surfaces (e.g. in limestone caves), but this is to be avoided wherever possible.

The Scale should be positioned parallel to the predominant plane of the rock art motif and the same distance from the camera lens. Ensure that the lighting source is not directly reflected by the Scale. One Scale should be used for distances of up to 1.5 m. Between 1.5 and 4.5 m, two Scales are required. The Scale cannot be used with precision at distances exceeding 4.5 m, using lenses of standard focal length. Best results will be achieved at distances of under 1 m. Where artificial lighting is required, place the Scale on upper left corner and light the image from same direction. However, natural lighting is preferred to artificial. The small scale on the left-hand end of the IFRAO Scale is intended for close-up photographs. For best digital results, slides or negatives are preferred to prints.

The IFRAO Standard Scale is distributed free to all rock art researchers of the world (the members of the thirty IFRAO-affiliated organisations). In addition, it is rapidly being adopted by specialists in various other fields. Specimens of the Scale are available from the IFRAO Convener's office (P.O. Box 216, Caulfield South, Vic. 3162, Australia). The sale of the IFRAO Scale for profit is not permitted. The Scale is not subject to copyright within IFRAO and may be reproduced by any organisation affiliated with IFRAO — but again, not for profit.

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REFERENCES


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