

The Qhapaq ñan a Study in Sustainability

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INTRODUCTION

The Inka Road or **Qhapaq ñan** (literally the Royal road) in scale alone is one of man's most monumental engineering achievements. It served to unite the four regions of the Empire that encompassed present-day Colombia in the north, Ecuador, Perú, Bolivia, central Argentina, and Chile (Hyslop, 1984). Built without the use of iron, the wheel, or stock animals, the Qhapaq ñan represents important milestones in the development of civil engineering technology. It is clear that the road's creators employed impressive engineering strategies in response to the challenges presented by the aggressive-physical geography of western South America.

QHAPAQ ÑAN

The soldier-chronicler Pedro de Cieza de León spent from 1535 to 1551 in Perú and observed.

One of the things which I admired most, in contemplating and noting down the affairs of this kingdom, was to think how and in what manner they can have made such grand and admirable roads.

Unlike many modern engineering works, the evidence indicates that the Inka's adapted their structures to the natural environment. Moray is an outstanding example how they used nature and the physical environment as a supporting component of their work. Instead of filling and leveling the natural sink holes at Moray the Inka stabilized the side walls and created an agricultural area suitable to a variety of plants. Each level of the terraced sinkholes is suitable for plants having different moisture and temperature requirements. A modern engineer would have just brought in more material, filled the hole, and leveled the area.

Crossing the coastal deserts the Inka road building efforts were minimal, clearing of stones if they were so numerous or large as to disrupt foot travel. Through agricultural terrain high sidewalls were constructed to protect crops from travelers and

animals. Depending on the location these 1 to 2 meter high walls were constructed of stone or tapia (mud/adobe). The roads were sometimes engineered to avoid obstacles but not always because this required added length. To protect the road in areas subjected to rain and snowmelts stone paving was used together with stone-channel drainage structures. There is a section of paved road that extends for 20 km and has a width of 16 meters. There were bridges with stone superstructures, wood superstructures, and fiber superstructures. In each case the Inka match the Qhapaq ñan to the environment. Recognizing and documenting these construction techniques of 600 years ago might allow us to create a more sensitive approach to our building processes, or approaches that work with instead of in conflict with the environment – sustainability in its truest sense.

A WORKSHOP

Virginia Tech University has received funding from the National Science Foundation in the United States to conduct a workshop to assess the current state of knowledge concerning how the Inkas constructed their 25,000 mile road system through such harsh physical environments and to then layout a program of collaborative research with engineering professors from the countries that the Inka Roads traverse.

The Smithsonian's National Museum of the American Indian (NMAI) is organizing a major exhibit about the Qhapaq ñan. That exhibit is scheduled to open in the summer of 2013 with symposia and scholarly publications. Their research effort in support of the exhibit will look at the cultural aspects of the Qhapaq ñan.

The researchers that come together for the workshop will be contributing to the Smithsonian's efforts by explaining the engineering and construction aspects of the Inka Road. You can contribute by confirming by measurements what was built, recording the construction techniques (stone bonding, dressed stones, and field stones bases as examples) and materials, and make comparison to other types of

Inka structures (foundations, rubble, packed clay). Studies that have looked closely for clues as to how the Inka handled hydraulic issues, geotechnical issues (particularly of building on the side of mountains, retaining walls), and techniques to mitigate damage from earthquakes, are being sought.

The research question is about the Inka's basic knowledge of the laws of nature that govern how man constructs his structures to withstand the forces of nature.

These ancient engineers, who lacked a written language, succeeded in building roads and other structures on terrain that experiences major flooding from El Niño rains and on the steep and unstable mountains of the Andes. It must be remembered that each year Perú experiences about ten important seismic events. The Spanish builders, however, did not take into account the physical environment of Perú and soon many of their important buildings of stone and brick crumbled. The Inka and other peoples of Perú, however, often used quinchá for multistory communal buildings because of its ability to withstand earthquakes. From the proposed workshop it is our hypothesis that a better fundamental understanding of how natural forces act on structures can be discerned and applied to modern engineering practice.

Much has been written by academics about the Qhapaq ñan and the organization of the Inka Empire, but little has been published that considers how the Inka planned, engineered, and built their roads. Our knowledge about the construction technology used by the Inka is still obscure. Therefore, the workshop will concentrate on the engineering and construction in an effort to discover and explain how the Inka executed such grand infrastructure that has stood the test of time.

Of the 106 different ecological niches existing on earth, 80 are present in the Andes. An ecological niche is defined as a contained space bounded by spatial and/or temporal parameters favoring a specific group of members. This is a useful way of describing what a species requires from and the impacts it has on its environment. Niches are identified by the physical conditions of an area and those conditions support only specific types of life or living creatures. As an example, consider ascending a mountain, you pass into a different ecological niche every 1,200 ft until at 17,000 ft you are in a perpetual snowfield. Consequently, the

characteristics of the road are varied. A goal of the workshop is to compare construction characteristics in the different regions to determine if there were imperial standards for roadway construction in the empire. Comparisons between Inka construction techniques and those used by modern engineers are also of interest.

Information covering all engineering aspects of the Qhapaq ñan construction – geotechnical, hydraulic, and materials – plus a methodology for studying these issues is solicited.

DISSEMINATION OF PAPERS

The research papers from the workshop will be posted on the workshop website, hosted by the Myers-Lawson School of Construction at the Virginia Tech University. The information will be available for a minimum of one year after being posted. The Smithsonian hopes to produce from the workshop and later seminars a scholarly level book on the Qhapaq ñan, which will be published in English.

Through the exhibit at the Smithsonian museum we will have a chance to reach a very large audience and explain what engineering and construction is about to an audience which will be much more diverse than that which normally considers the achievements of engineering.

BROADER IMPACTS

The focus of the workshop is to create a unique collaboration of civil engineering disciplines with the Smithsonian's non-engineering team. It provides an exceptional opportunity to demonstrate how multi-disciplinary teams can work together to provide a holistic view engineering works.

LOCATION AND PROBABLE DATES

There will be two venues for the workshop. First, organizational and working sessions will be conducted in Lima at the campus of the Universidad de Piura (Miraflores, Lima). Second, from Cusco the participants will visit Inka road sites in the Sacred Valley of Peruvian highlands. Arrangements and the exact dates have not been finalized but it will probably be conducted in July 2011.

REFERENCES

John Hyslop (1984). *The Inka Road System*, Academic Press, Inc.