R. M. TOWILL CORPORATION

Planning • Engineering • Environmental Services • Photogrammetry • Surveying • Construction Management

IN MOTION

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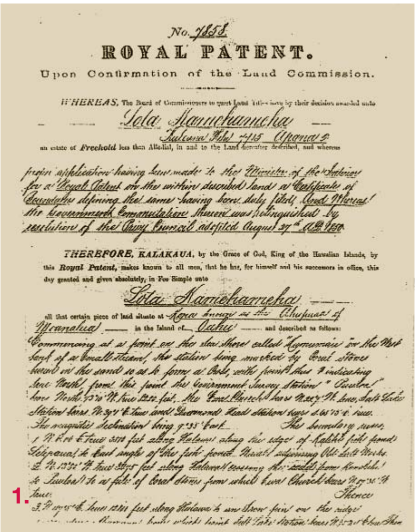
Mapmakers: Then & Now



No. 7858

ROYAL PATENT.

Upon Confirmation of the Land Commission.

WHEREAS, The Board of Commissioners to quiet Land Titles have by their decision awarded unto Lota Kamehameha an estate of Freehold less than Allodial, in and to the Land hereafter described, and whereas

THEREFORE, KALAKAUA, by the Grace of God, King of the Hawaiian Islands, by this Royal Patent, makes known to all men, that he has, for himself and his successors in office, this day granted and given absolutely, in Fee Simple unto Lota Kamehameha

all that certain piece of land situate at ... in the Island of Oahu and described as follows:

1.

2.

3.

Left to right:
1. Royal Patent document granting land to Lota Kamehameha
2. Surveying monument from the 1800s on the Island of Hawai'i.
3. RMTC's third aerial photography airplane, a twin-engine Cessna, circa 1970.

Surveying, aerial photography and photogrammetry are the heritage and backbone of the R.M. Towill Corporation's consulting practice. This issue of IN MOTION talks about some important synergies — between history and land surveying, and between aerial photography and digital mapping.

Retracing Historical Boundaries

Imagine lands not surveyed since the Great Mahele in 1848. Then imagine being the surveyor in 2003 assigned to find those boundaries — to prepare a "retracement" survey.

"It's interesting work, but very challenging," says Gary Takahashi, P.E., who is still learning retracement surveying from RMTC President Russell Figueiroa. "Extensive research and interpretation of historic land records are required before any physical surveying can begin." Land grant records and Land Commission Awards (*see photo* 1 *above*) were often written in Hawaiian, and require translation to decipher how land boundaries were determined at the time of the survey. Even when records are written in English, says Takahashi, it can be frustrating.

When documents appear to have yielded all their clues, it's time for a field survey to confirm the data. In field work, surveyors search for monuments at the property site. Monuments may be carved symbols on rocks that are unique to a particular survey (*photo* 2). Takahashi recalls, "We have spent days walking through brush or lava fields searching for monuments that were left 160 years ago. It may not look like much to the average person, but finding such a monument is a defining moment for a modern surveyor in Hawai'i."

After five years in retirement, former Photo-grammetry Manager Douglas Mukai has returned to RMTC as a Senior Consultant. He will assist in promotional work because of his numerous contacts within the A&E community.

When documents yield no retraceable clues, surveyors are forced to expand the survey outward from a central point until the ground yields information useful in recreating the survey. This can take a very long time.

It's a painstaking process to piece together the document research and field survey information to mark boundaries and prepare a map. "You're like Sherlock Holmes," concludes Takahashi, "You use clues found in the field and relate them to the recorded data." A completed retracement survey is a "deceptively simple boundary map" that just doesn't reflect the amount of effort that went into preparing it.

Aerial Photography

In 1947, firm founder Roswell Towill initiated RMTC's extensive aerial photo collection by purchasing a military surplus airplane and aerial cameras. Now boasting over 150,000 photo images, the collection contains extensive and continuous Hawai'i coverage, as well as many areas of Asia and the Pacific.

The "flight map" for each aerial photography mission includes the flight direction, altitude above sea level and the number of photographic exposures needed. Placed on the ground are visible control points used in the triangulation (survey) process. The flight map is referenced to a known coordinate system so latitude and longitude values can be entered into an aerial camera equipped with an airborne Global Positioning System unit.

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Right: Topographic map detail of Kalakaua Ave. for the Ala Wai Canal project.

Mapmakers

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Photogrammetry: A Big Fat Greek Word

How do you map an ecosystem or survey a nearly inaccessible lava field? Or explain a complicated land use project to a public audience? How can you show what a project will look like in 3-D? The answer could be photogrammetry, the process of making surveys and maps through the use of aerial photographs. Merging aerial photography with land surveying and digital technology, photogrammetry (from the Greek word root *phot* for "light," *gramma* for "image or graphic record" and *metricos* for "measuring") is most often used to create aerial topographic maps.

The greatest advantage of photogrammetry is its cost-effectiveness in mapping and/or surveying large or inaccessible areas like mountains, forests, freeways and lava fields. It's also useful for capturing urban environments with limited vegetation. For example, in planning the restoration of the watershed flowing into the Ala Wai Canal on O'ahu, the U.S. Army Corps of Engineers needed to map a wide area for the State Department of Land and Natural Resources. "The solution was aerial topographic mapping," says Steve Yamamoto, ACOE Hydraulic Engineer. "We had a large area, little vegetation and a limited budget. RMTC's digital aerial surveying was the most time- and cost-effective method."

The resulting high-resolution, digital ortho [Greek for "straight"] photos were used to present flood plain information to the public. "The aerial orthophotography turned out to be a valuable communications tool," continues Yamamoto. "The breadth, depth and clarity of the photo images helped people identify landmarks. The superimposed elevation contours made it easier to show and explain areas within the flood plains."

In response to Island of Hawai'i concerns about safety and congestion on Kawaihae Highway, the State Department of Transportation engaged civil engineers Edward Noda & Associates to evaluate a possible bypass road linking Waimea town and Kawaihae Harbor. "The contract required mapping 2-foot contours throughout the project area," explains Noda Vice President Brian Ishii. "Aerial topographic mapping was the fastest and best way to accomplish that. It solved the problems of inaccessible terrain and lava flows that make land surveying difficult."

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Noda engineers also found the color digital orthophoto useful in public presentations. "When you go to public meetings, people can readily see what you're planning. For this project, landowners could readily grasp how different road alignments would relate to their property," added Ishii. "We were very pleased with the impact of the color map. To simulate visual impacts of road alignments, we are thinking about using the color mosaic as a base for a 3-dimensional model."

To create digital topographic maps, RMTC uses the Wild Aviolyt BC3 Stereo Restitution plotter on a Sun Solaris platform. The system uses two overlapping photos to form a 3-D "model." Using a combination of ground control and aerotriangulated (aerial-surveyed) values, the operator converts the model to a digitized map by digitizing points, lines or arcs with an x, y & z value in 3-dimensional geometry. The last step is to convert it to a format easily imported into AutoCAD or Microstation.

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