



Is one man's Zinfandel another man's pain?

Fadi Fatallah's BAE team researches the ergonomics of farm workers...

We are in the University's vineyard on a warm, sunny October afternoon, standing in front of several poles-and-wires trellis systems—very much like the supports used to tie up grapevines. However, instead of bunches of Zinfandel or Cabernet grapes ready to be harvested, there are plastic bags filled with pre-weighed amounts of rice tied to the wires. It's an unusual sight.

The presence of **Dick Hoenish**, the vineyard manager, is, of course, not at all unusual. However, he normally doesn't work with quite so much equipment attached to him. He is wearing something that looks like a cross between a back support and a backpack, with monitoring equipment mounted on it. There are monitoring electronics attached to his wrists, as well.

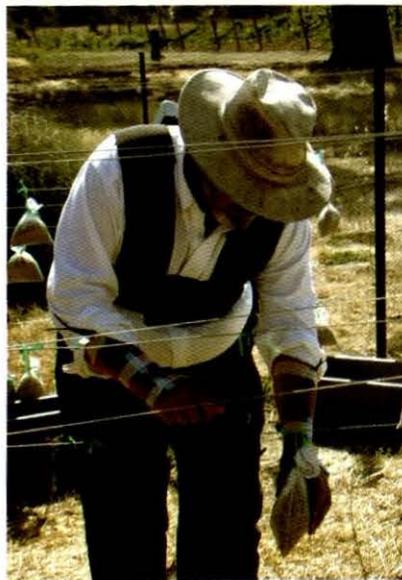
Hoenish is about to take part in an ergonomic experiment run by **Fadi Fathallah** (BAE) and his research team. Fathallah is trying to make quantitative measurements of the back and wrist motions used in grape harvesting with the goal of coming up with an objective way to describe the motions that can create musculo-skeletal problems in workers and then devising processes by which these motions—and the problems they bring—can be remedied or prevented. The purpose of this particular part of the experiment is to measure mathematically the ways in which different heights affect the level of stress and motion that are required of the harvester. Fathallah has already worked on measuring the motions associated with pruning grapes (he describes pruning as being “hard on the hands” with characteristic understatement) and is now turning his attention to the harvesting process.

The rice bags, which are substituting for the valuable and variable grape clusters, are hung so that they are between twenty and fifty inches from the ground; the levels have been calculated to mimic the various levels at which grapes are grown. Before we begin, Hoenish jokes that it's really an

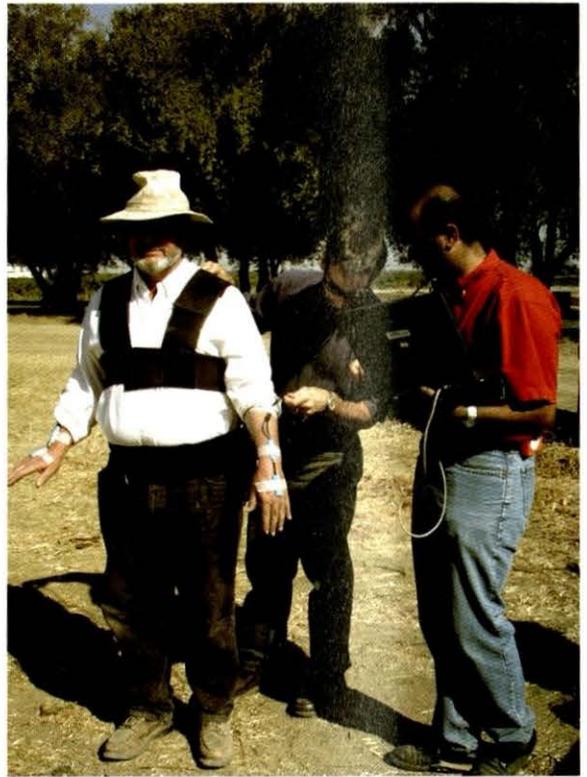
experiment to see how fast he can cut himself with the harvesting hook: he hasn't used one since he was eight years old, preferring shears himself. He is being asked to use a hook instead because it's what the grape pickers in the Napa Valley use, and because wrist motion is one of the things that Fathallah is looking at.

This part of the experiment itself goes fairly quickly—and safely, since Hoenish proves quite adept with the hook. The wires that Hoenish is wearing send the data via a transmitter to the laptop in Fathallah's pickup truck. There's no cable connecting Hoenish to the computer, so he can move naturally.

After taking a measurement of the vineyard manager standing still—to establish the neutral setting—Fathallah measures his



Rice bags hung from wires approximate the size and weight of grape clusters. Hoenish severs the bags from the wire, emulating the repetitive motion needed to perform the grape harvest.



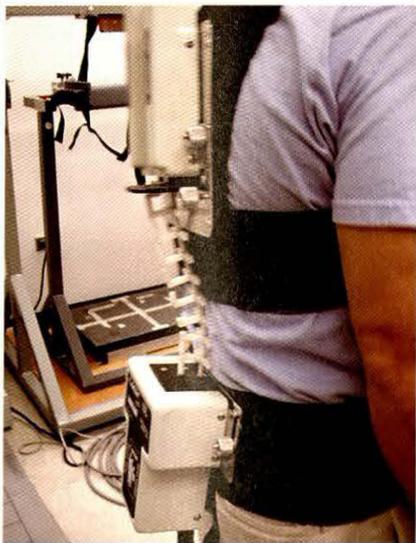
back movements in three dimensions: back and forth, side to side, and twisting. The more motion, and the more extreme the posture, the greater the likelihood of repetitive stress injuries. As Hoenish methodically severs the rice bags along the row, the yellow, red, and green lines tracing on the computer screen measure the motions that his back and wrists make. Fathallah is collecting this data on back motion, which is directly related to occupationally induced lower-back disorders.

Back in the laboratory, Fathallah describes the experiment in more detail. The run with Hoenish is just one of twelve such trials; the people involved represent a cross section of the population and they are helping to establish the differences in motion in the population.

Fathallah, who directs the Occupational Biomechanics Laboratory, indicates that the goal is to figure out what the optimal design would be for the vineyard from the ergonomic perspective.

Grapevines can be positioned in various ways. Some configurations, such as the Scott-Henry and Smart Dyson positions, are felt to be optimal for grape quality. Some, like the 4 x 4 vertical shoot positioning (VSP), are “really bad for workers,” Fathallah says.

While it might seem that grape growers would automatically favor the trellises that improve grape quality, such is not the case, according to Fathallah. Trellis design may not make “a huge difference” in grape quality; other factors have much greater



Measurements of back motion in the laboratory with graduate student David Reiter.

influence. And, he indicates, he finds that people in agriculture are surprisingly "open to non-traditional approaches" and have a real interest in making vineyard labor less likely to lead to occupational injury.

Fathallah is systematically addressing the risk factors involved in agricultural work and assessing the risks quantitatively. The quantitative measurement is important, he says. The traditional approach—to intervene to make a change, essentially at random, and then to see if the injury rate goes down—has drawbacks. "We can't just make changes haphazardly," he emphasizes, because it's possible to fix one problem and create another problem, which might be larger or more intractable. And it is far too slow.

A quantitative method, on the other hand, can "pretty much guarantee" the efficacy of a change. It's possible to make an intervention and measure its effect quantitatively right away.

Fathallah started doing work on ergonomics for industry, some of it for insurance companies, who have a natural interest in reducing injury. When he came to Davis, he continued to be interested in occupational biomechanics, but started to apply his techniques to agricultural work, a traditionally dangerous occupation.

He's working on small portable devices to capture the trunk postures of workers over longer periods of time to figure out the effects of the time of day and the day of the week on postures. About his technically intensive approach, he says, "It's a tool to convince people."

<http://bae.engineering.ucdavis.edu/people/Fathallah.html>

Ensuring the safety of the food supply...

It's a problem that has recently taken on new and more ominous dimensions. Food, air, and water can be maliciously contaminated with biological agents or chemical toxins.

In fact, such contamination has already happened. In Oregon in 1984, salad bars were deliberately contaminated by salmonella; in 1995, the Aum Shinrikyo cult released nerve gas into the confined air of the Tokoyo subway system, killing twelve people.

Such attacks require early and accurate detection so that the emergency response can be deployed rapidly to limit the spread of agents and reduce the ensuing casualties.

Professors **Ian Kennedy** (MAE) and **Bruce Hammock** (Entomology) are looking at this problem. Their biosensor research group is working on systems that can be used to analyze a large number of samples for biological agents or chemical toxins. The tests have to be highly sensitive and capable of working against a food background—since food itself is highly complex biologically and chemically.

The group members are working on achieving this goal by combining immunoassays that already exist with new reagents, miniaturization techniques, and detection technologies.

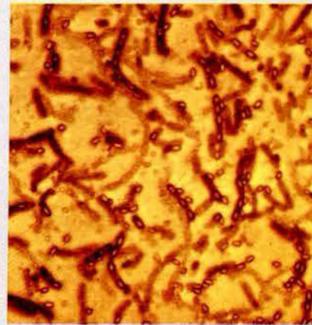
The group has worked on immunoassays, based on microplates, that have the sensitivity required to detect toxins in this challenging environment. Already used for the detection of fungal toxins or pesticides in the food supply, these could also be used to look for chemical or biological weapons.

When the researchers can miniaturize the assays, they can increase the productivity of the tests and develop small devices that can be used in practical field conditions. In conjunction with colleagues **Rosemary Smith** and **Scott Collins** (ECE), they plan to build minia-

turized systems that can carry out assays on a small scale.

Using very small droplets, they can take advantage of their physical and optical properties. Small droplets can actually act as tiny lasers. That adds information about the sample, especially if it contains a living cell, such as an anthrax spore.

They have also used nanotechnology to make new fluorescent materials, with superior properties for their immunoassays. Along with colleagues Valerie Leppert and Subhash Risbud (ChEMS), they have found that Europium oxide nanoparticles give long-lasting, narrow-band light emission after being illuminated. They also use a microwave treatment to add a coating that allows the particles to be linked to biological molecules.



Anthrax spores

Kennedy presented the research findings to the Council on Competitiveness, a national organization of industrial, governmental, and academic leaders. The Council invited the University of California to participate in their meeting in Pittsburgh, which dealt with issues of national security and the role of technology. ■