

People & Places

Engineer works on robotic apple picker

Frank Moore uses technical background to develop harvester

By DAN WHEAT
Capital Press

PASCO, Wash. — A retired Hanford Site mechanical engineer has for 11 years been seeking the holy grail of the apple industry — a robotic picker.

At least three companies envision robotics as an answer to the apple industry's labor shortages and increasing labor costs.

"If the migrant worker thing blows, I could see a \$3 billion (tree fruit) industry going up in smoke real quick. That would be devastating to the state and particularly Central Washington," says Frank Moore, 71, who retired in 2006 after 33 years in design and application of remote systems for contractors at the Hanford Site, a nuclear production site that has been nearly completely decommissioned. The contractors included Westinghouse, Fluor and Duke Power.

What he's done

Moore's accomplishments included programming thermal hydraulics code for Babcock & Wilcox for the 1,000-megawatt nuclear power plant at Hanford known as WNP-1. He programmed the plant's automated plutonium and uranium fuel lines and specialized in remote operations of fuel and radioactive material.

In the 1980s, Moore patented an automated nuclear fuel inspection system. He built the in-core materials test assembly for a test reactor to develop a breeder reactor program that was canceled by the Carter administration. He made cesium capsules for irradiating blood for surgery and managed a team building shipping casks and trailers for nuclear batteries for deep space probes.

He's even patented a shock-absorbing hitch for tractor fork lifts to haul bins of fruit with less bouncing.

"I have a depth of experience in remote handling that no one else has that's working on this (robotic apple picker). I have access to retired and working engineers I could utilize if I had the funding," Moore says.

Working on the idea

Needing something to do upon retirement, he picked up the idea of an automated apple harvester that he began pondering in 1993 when his son-in-law owned apple and cherry orchards in Wenatchee.

"Labor was way too expensive back then and the



Dan Wheat/Capital Press

Frank Moore demonstrates a Granny Smith apple entering his robotic picker at Goose Ridge orchard west of Kennewick, Wash., on Dec. 3. He is one of several inventors hoping to have a robotic apple picker ready for commercial use in the next year or two.

electronic side was too expensive for it to work," he said.

But those impediments has been reduced by 2006 when he retired and returned to the idea.

He looked at the intricacies and needs of apple harvest, including picking speed and gentle handling to avoid bruising. He decided suctioning apples off trees with vacuum tubes created too much velocity and increased bruising. His idea is an automated stem-cutting picker with a lower-velocity vacuum inside tubes to move apples to a decelerator and automated handling area where they are washed, culled, sorted out and good fruit goes into bins.

Some field sorting saves money at packing houses and washing removes sunburn protectant dust or film and chills the fruit, which can be important in hot weather, he said.

Decelerators have been bottlenecks in previous non-robotic harvest assist equipment, but Moore said he doesn't think his decelerator, washing and sorting will slow picking because his design and technology are already proven in his system that inspects 6,000 nuclear fuel pellets per minute.

'Big advantage'

What really sets his system apart from others, he said, is early spring imaging and data collection. Imaging for leaf buds assists in pruning with a pruning head on the robotic arms. Later, with different heads, the robotic arms will clip stems to pick the fruit.

After pruning, a second round of imaging before leaves emerge logs the locations of fruit buds on a vector-based image.

"The big advantage of this is I have from April to August to generate all the pick programs for the robotics so it increases my speed significantly on going and finding fruit,"

Moore said.

Pre-programming reduces the need for a lot of light to find fruit, so the picker can operate about 18 hours per day.

Moore received a patent priority date on Aug. 25, 2009, his patent in 2016 and created HarvestMoore LLC.

He is working to finish a crude prototype on his "hobby budget" but envisions a machine 15 to 18 feet long, 8 feet wide and with three to four robotic picking arms on each side to pick low, medium and high fruit on trees on both sides of a row.

The GPS-guided self-propelled machine will pick up empty bins in front and deposit full bins out the back and be capable of having one to three bins on board at a time. A low-profile model will work with V-trellis fruit tree systems.

His goal, like that of his competitors, is one apple picked per second per robotic arm because that's about the speed of a human picker using both hands.

Oxbo interest

He believes his machine will be able to detect 99 percent of fruit buds but he has no field data on picking rate and bruising percentages because he hasn't done much field testing.

He applied for a grant from the Washington Tree Fruit Research Commission but says Abundant Robotics of Hayward, Calif., beat him to it. The commission recently turned him down for a pruning grant.

Mike Willett, commission manager, declined to say why. Willett said the commission has given Abundant Robotics nearly \$500,000 in grants and is strongly supportive of its work. He said he doesn't know how realistic the 2018 or 2019 goals are for commercialization.

Moore also is trying to work with Oxbo International Corp., a Byron, N.Y., manufacturer of harvesters for seed corn, coffee beans, berries, peas, green beans, olives, citrus fruit and grapes.

"I want durable hydraulics. I like their hydraulic designs and see them as the best option. They are the No. 1 choice for me. I just have to convince them I'm the No. 1 choice for them," Moore said.

With Oxbo's help a full prototype could be built and tested next year with a goal of commercial release in 2019, he said.

Scott Korthuis, Oxbo berry and tree fruit product manager, said Oxbo is interested in Moore's effort and thinks his fruit mapping system has merit but wants to see the machine work.

Hydraulic advice

"We've given him some parts and hydraulics advice, so we are encouraging him but not jumping in feet-first," Korthuis said.

Oxbo may buy Moore's patent and company but it's too early to know, he said.

"He hoped to have it running this (past) harvest, but it didn't happen," Korthuis said.

Oxbo spent at least \$2 million building an apple harvest-assist machine several years ago but abandoned it because it wasn't that much faster than good pickers on ladders, Korthuis said.

"I was only as fast as the slowest picker of four on the platform. One guy just doesn't pick as fast or he runs into lots more apples than the other three. It's hard to keep it productive," he said.

While Abundant Robotics of Hayward, Calif., and FFRobotics in Israel say their goals are robotic pickers on the market by the 2018 fall harvest or early 2019, Korthuis said university experts say it's "a ways off yet" because it is difficult for a robot to find



Western Innovator

Frank Moore

Age: 71

Origins: Born in Lakin, Kan., grew up on a cattle and wheat ranch in western Kansas.

Family: Wife, Nancy, two daughters, two grandchildren.

Education: Bachelor of science degree in mechanical engineering, Kansas State University, 1969.

Occupation: Owner of HarvestMoore LLC, Pasco, Wash.

Work history: 33 years working for U.S. Department of Energy contractors at Hanford Site, Richland, Wash.

an apple, reach out and pick it and get it into tubes or conveyors in one second without bruising.

Non-robotic shaker systems are used successfully for nuts and berries.

"We've solved the simple ones. It's only the tough ones that are left like apples, strawberries and peaches," Korthuis said.

Viable systems

Moore believes his system and those of Abundant Robotics and FFRobotics are viable, but his patent includes a large amount of detail covering picking and removing fruit. It covers mechanical aspects of the pruner and harvester including imaging, fruit deceleration and a unique system that locates each tree trunk by latitude and longitude.

He expects to get a second patent soon for his imaging system.

He believes the Israeli mechanical prongs picking fruit and placing it on a conveyor will be slower than clip picking and apple transport by vacuum tubes.

The three systems, he said, have yet to prove they are economically feasible at the harvest speeds that are needed.

"I think I have the best chance on economics," Moore said. "It will cost \$300,000 to \$350,000 to build a six- to eight-arm machine and sell it for close to \$500,000. That's a lot so I have to have a pick rate that pays off in five years."

Moore said he's invested \$100,000, mostly in attorney fees for patents and would like to recoup that and 50 percent of his hours if he were to sell his firm.

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Thursday, Jan. 4
Ag Tech Boot Camp. 9 a.m.-4 p.m. Roy F. Christensen Building, Idaho State University campus, Pocatello, Idaho. Presenters will feature the latest innovations in crop and livestock production. Sponsored by University of Idaho Extension officials, private industry representatives and state commodity group leaders. Cost: \$30

Friday, Jan. 5
Fruit Tree Pruning Workshop. 10 a.m.-noon. How to prune apple trees in the tall spindle system and how to prune peach trees. Details about location will be provided to those who RSVP. Jeff Choate at jeff.choate@oregonstate.edu or 541-344-1709. Cost: Free

Friday-Wednesday Jan. 5-10
2018 American Farm Bureau Federation Convention and IDEAg Trade Show. Gaylord Opryland Re-

sort and Convention Center, 2800 Opryland Drive, Nashville, Tenn. CEExplore the IDEAg Trade Show floor to gain a stronger industry network, shop featured products, learn about innovative technologies, and enjoy talks on the Cultivation Center stage. Website: http://bit.ly/2iJS9i3

Tuesday-Wednesday Jan. 9-10
Eastern Washington Ag Expo. 9 a.m.-5 p.m. Tuesday, 9 a.m.-4 p.m. Wednesday. Trac Center, 6600 Burden Blvd., Pasco, Wash. The expo features exhibitors, pesticide classes, livestock handling demonstrations, precision ag and the second annual Cattlemen's Connection. Website: www.easternwaagexpo.com

Tuesday-Thursday Jan. 9-11
N. Willamette Horticulture Society Conference and Trade Show. 8

a.m.-4:15 p.m. Clackamas County Event Center, 694 NE Fourth Ave., Canby, Ore. This year's conference will include a vegetable crops section on Jan. 9, an organic section on Jan. 10 and a berry section on Jan. 11. Website: http://mwhortsoc.com

Wednesday, Jan. 10
Developing or Expanding Your Farm Stand or Agritourism Operation, Part 3. 5-8 p.m. OSU Extension, Auditorium, SOREC, 569 Hanley Road, Central Point, Ore. Are you interested in developing or expanding a farm stand or agritourism operation? Jan. 10 is Accepting Food Stamps/SNAP/EBT at a Farm Stand or CSA and Feb. 6 is Starting a Farm Stand/Agritourism Operation. Website: http://bit.ly/JacksonSmallFarms

Wednesday-Friday Jan. 10-12
Potato Expo 2018, 7:30 a.m.-9 p.m. Rosen Shingle Creek, 9939 Universal Blvd., Orlando, Florida. Over the last 10 years, the Potato Expo has gained the reputation as the best setting for conducting business and getting caught up on industry issues. Website: potato-expo.com

Thursday-Friday Jan. 11-12
Oregon Essential Oil Growers League Annual Conference. Salishan Lodge, 7760 US-101, Glenden Beach, Ore. Featuring industry up-

dates. Website: oregonmint.org

Monday, Jan. 15
Sheep Producer Workshop. Etchamendy Sheep Company, 24394 Highway 46, Wasco, Calif. The California Wool Growers Association is hosting four interactive workshops focusing on improving lamb marketing and quality as well as producer profitability by applying innovative management practices and technologies. To register contact the CWGA office at info@woolgrowers.org or (916) 444-8122.

Tuesday, Jan. 16
Sheep Producer Workshop. Emigh Livestock, 2838 Goose Haven Road, Suisun City, Calif. California Wool Growers Association is hosting four interactive workshops focusing on improving lamb marketing and quality as well as producer profitability by applying innovative management practices and technologies. To register contact the CWGA office at info@woolgrowers.org or (916) 444-8122.

Wednesday, Jan. 17
Soil Health Workshop Featuring Brendon Rockey & Wendy Taheri. 8 a.m.-3 p.m. Holiday Inn, 1100 5th St. S, Great Falls, Mont. Cost: \$20. Website: http://bit.ly/2BpzYNT

Wednesday-Thursday Jan. 17-18
2018 Northwest Hay Expo. 8 a.m.-4 p.m. Three Rivers Convention Center, 7016 W. Grandridge Blvd., Kennewick, Wash. Featuring 90-plus exhibitors, top speakers and breakout sessions covering industry updates. Website: http://wa-hay.org/nwhayexpo/

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