VIRTUAL REALITY TECHNOLOGY AS A TOOL TO ENHANCE COLLABORATION BETWEEN SPACE EXPLORATION AND PUBLIC OUTREACH: THE CASE USING THE MARS EXPLORATION ROVER IMAGES. Jun Uno[1,2] and Akiko K. Mikouchi[1,3], [1]Human Space Systems Utilization Program Office, JAXA (Japanese Aerospace and Exploration Agency), Tsukuba Space Center, 2-1-1 Sengen Tsukuba, Ibaraki 305-8505, Japan (uno.jun@jaxa.jp), [2]IHI Scube Co. Ltd., [3]Anthropology and Education, Teachers College, Columbia University, 525 West 120th Street, New York, NY, 10027-6696, USA (akikomk@attglobal.net).

Introduction: A great variety of high-quality images of Mars from the rovers Spirit and Opportunity recently provided an opportunity for the public to experience the red planet as never before. However, visual observation of these images is not enough to fully appreciate their scientific relevance. Here we present computer-based outreach material, "Mission Specialist 4 –Mars Rover," developed by the VR (virtual reality) team at the Japanese Aerospace Exploration Agency (JAXA). The goal of this material is to provide tools to expand the appreciation of martian geology and rover engineering and to provide public outreach about Mars exploration.

Development: Applying VR technology that was originally adapted for astronaut training, the material was developed as a comprehensive CG rover mission video game for an agency open house in April 2004. This is one of a series of mission specialist simulation materials for the public developed by the VR team under the Public Affairs Office (kibo-pao@jaxa.jp) and allows the "specialist" to move the rover around the surface of Mars to find flags. The goal of each simulation game is to reproduce some aspect of the training of a mission specialist.

The team converted photo images from Spirit and Opportunity on the NASA web site (http://marsrovers.jpl.nasa.gov/mission/spacecraft_surface_rover.html) into CG martian landscapes and surfaces. With two joysticks, the "specialist" remotely operates the rover (Fig. 1). As the rover moves, users have changing views of Mars. The simulation included other sensory information, for example, vibrations from the sticks as if they drove the rover over a sandy surface with rocks, which encourages users to feel the movement of a rover and to carefully, observe surface. In order to enhance the observers' simulated exploration mission experience, the game was located in a room with a Lego model of the Mars Exploration Rover and a rock chip from the martian meteorite Yamato 000593 that was kindly borrowed from National Institute for Polar Research (NIPR) (Fig. 2).

The team originally worked with the Japanese International Space Station (ISS) project and developed and used VR technology to produce a demonstration version of "Kibo", the Japanese experiment module that is under construction for the ISS. Even though the demonstration is full CG and literally virtual, the module and its movement are simulated accurately using blueprints with detailed information of how to manipulate the module in order to train astronauts for a real mission.

In the development of the material for the public, VR technology allowed this material to include detailed information about the martian landscape and to make the rover move in accordance with the surface conditions even though the web site images were the only resources. Computer simulation also allowed the team to customize some parts of the simulation to enhance the educational experience. For example, in order to avoid boredom, the teams made the rover move faster than reality and enlarged rocks and pebbles.

Practice and Findings: These games were popular at the open house. The Lego model and the martian meteorite that were displayed in the same room received comparatively less attention. Based on these experiences, the team developed these computer-based simulations into an effective outreach tool. For convenience at functions external to the agency, a game controller version was developed without a vibration function. Because many users were familiar with the game controller, they needed fewer trials than with the original joystick version, however, the game controller version was not received as favorably as the joystick version complete with vibration. The reception of these games points out that hands-on activities are an integral part of any public-outreach educational program. Various types of displays, including those based on hands-on activity, should be integrated into the material to introduce the desired concepts. However, at the same time, hands-on activity does not always bring fruitful results, as in the case of the game controller without a vibration function. With a vibration function, comparable to that due to the actual surface roughness of Mars, people appreciate the surface morphology of the planet and enjoy operating the rover much more.

Prospects as educational resources: This case illustrates that VR technology for human space flight can be a strong tool to produce a unique outreach material, which allows the public to personalize space exploration. This case also suggests that unique and strong outreach materials could be produced by good collaboration between space exploration and public outreach (Fig. 3). Furthermore, global collaboration beyond space agencies would be fruitful.

With some improvements, based on martian science and rover engineering, these games will be excellent educational resources. For example, if the team can obtain and add more precise real data from NASA, such as colors of sky, locations of craters, and information of cameras to view, the improved material will allow users conduct more precise observations. By adding information about martian rocks and terrestrial rocks, users can compare planets. Introducing the VR material with information about terrestrial rocks and soil, people will be able to imagine the martian environment more concretely. These games might be a good introduction to the existing NASA educational packages for the Mars missions. Initially, users might explore Mars by operating the rover and choose an object of interest, such as a rock, and then learn about it with the other educational information packages [e.g., 1,2]. If these packages are available on the Internet and the user can post information, a significant group of amateur scientists will track ongoing and future missions and will share information and ideas.

All these devices will hopefully arouse interest in Mars exploration and inspire new missions in various places with new types of vehicles. The VR team welcomes any suggestions, requests, questions, and ideas for new VR outreach materials. Contact person is: Yoshiya Fukuda at the Public Affairs Office (fukuda.yoshiya@jaxa.jp).

Reference: [1] Kadel S. D. et al. (2004) *LPS XXXV*, Abstract #1614. [2] Lindstrom M. M. (2004) *LPS XXXV*, Abstract #2081.

Fig. 1. A child operating a rover with two joysticks at the open house.

Fig. 2. Display of martian meteorite Yamato 000593.

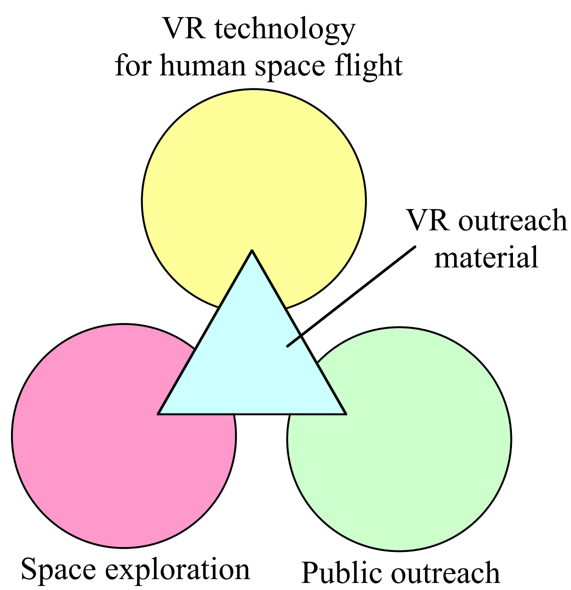

Fig. 3. Schematic illustration showing the relationship among VR technology for human space flight, space exploration, and public outreach.