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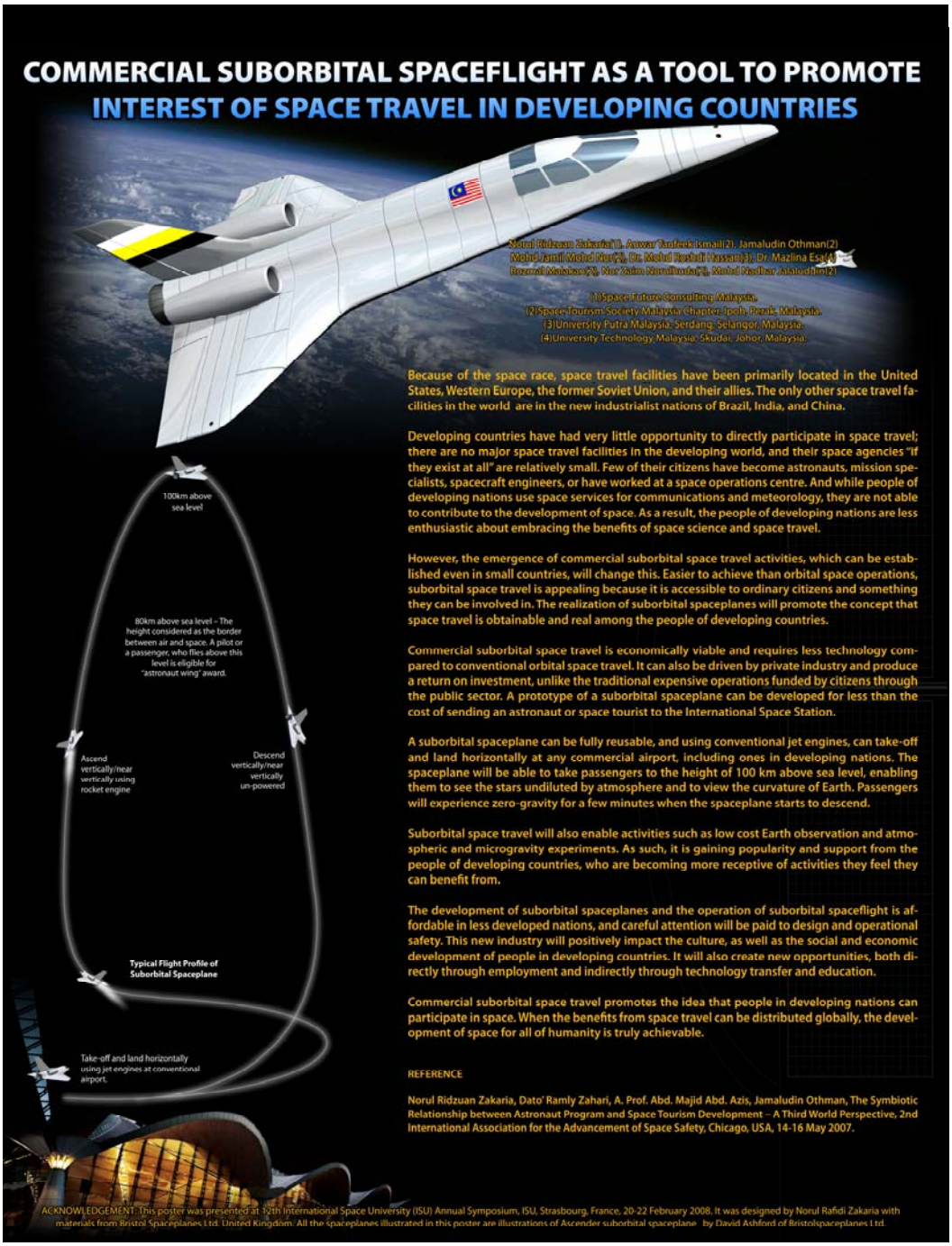

Following is the text version of the poster as appeared on the Proceeding of the 12th ISU Annual Symposium:

COMMERCIAL SUB-ORBITAL SPACEFLIGHT AS A TOOL TO PROMOTE INTEREST OF SPACE TRAVEL IN DEVELOPING COUNTRIES

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ABSTRACT

Because of the space race, space travel facilities have been primarily located in the United States, Western Europe, the former Soviet Union, and their allies. The only other space travel facilities in the world are in the new industrialist nations of Brazil, India, and China.

Developing countries have had very little opportunity to directly participate in space travel; there are no major space travel facilities in the developing world, and their space agencies “if they exist at all” are relatively small. Few of their citizens have become astronauts, mission specialists, spacecraft engineers, or have worked at a space operations centre. And while people of developing nations use space services for communications and meteorology, they are not able to contribute to the development of space. As a result, the people of developing nations are less enthusiastic about embracing the benefits of space science and space travel.

However, the emergence of commercial suborbital space travel activities, which can be established even in small countries, will change this. Easier to achieve than orbital space operations, suborbital space travel is appealing because it is accessible to ordinary citizens and something they can be involved in. The realization of suborbital spaceplanes will promote the concept that space travel is obtainable and real among the people of developing countries.

Commercial suborbital space travel is economically viable and requires less technology compared to conventional orbital space travel. It can also be driven by private industry and produce a return on investment, unlike the traditional expensive operations funded by citizens through the public sector. A prototype of a suborbital spaceplane can be developed for less than the cost of sending an astronaut or space tourist to the International Space Station.

A suborbital spaceplane can be fully reusable, and using conventional jet engines, can take-off and land horizontally at any commercial airport, including ones in developing nations. The spaceplane will be able to take passengers to the height of 100 km above sea level, enabling them to see the stars undiluted by atmosphere and to view the curvature of Earth. Passengers will experience zero-gravity for a few minutes when the spaceplane starts to descend.

Suborbital space travel will also enable activities such as low cost Earth observation and atmospheric and microgravity experiments. As such, it is gaining popularity and support from the people of developing countries, who are becoming more receptive of activities they feel they can benefit from.

The development of suborbital spaceplanes and the operation of suborbital spaceflight are affordable in less developed nations, and careful attention will be paid to design and operational safety. This new industry will positively impact the culture, as well as the social and economic development of people in developing countries. It will also create new opportunities, both directly through employment and indirectly through technology transfer and education.

Commercial suborbital space travel promotes the idea that people in developing nations can participate in space. When the benefits from space travel can be distributed globally, the development of space for all of humanity is truly achievable.

SUBORBITAL SPACEFLIGHT

Suborbital spaceflight is the flight, which exceed the height of 80km from sea level, but does not has enough momentum to escape the gravity of Earth to remain in orbit around Earth. The suborbital vehicle will descend to Earth as soon as its momentum becomes less than the gravity of Earth. When the spaceplane starts to descend its passengers will be able to experience zero-gravity.

The altitude of 80km is considered the border between air and space, since pilots and passengers who fly above this level are eligible to be awarded with the "astronaut wing" by Federal Aviation Administration (FAA).

Suborbital Spaceplane

Suborbital spaceplane is the vehicle, which performs suborbital spaceflight, and looks and operates like aeroplane. It has fixed wing, and take-offs and lands horizontally on conventional runway.

A common operation of suborbital spaceplane involves being carried onboard bigger aeroplane. The carrier aeroplane takes the spaceplane to an altitude before releasing it to fly on its own. The most common method is carrying it under the fuselage or wing of the carrier aeroplane and releasing it below the carrier aeroplane. The spaceplane later ignite its rocket engine and fly vertically or near vertically towards space.

However, the new concept of suborbital spaceplane will not be using carrier aeroplane, but the spaceplane will be using its own jet engines to reach a certain altitude and rocket engine to reach into space. The jet engines are for taking-off and landing and also to reach an optimum level for the operation of the engines. The rocket engine is for flying vertically or near vertically to an altitude above 80km.

A very potential and promising market for suborbital spaceplane is space tourism. Therefore, suborbital spaceplane should be designed to be able to carry passengers comfortably and safely. The passengers who fly onboard suborbital spaceplane will be able to view the curvature of Earth and space environment and also experience zero-gravity.

Typical Operation of Suborbital Spaceplane for Space Tourism

A suborbital spaceplane take-offs horizontally carrying passengers from an airport using its jet engines. The spaceplane cruises to 10km above sea level. After the passengers are informed, the pilot aligns the spaceplane near vertically, turn-off the jet engines and ignites the rocket engine.

The spaceplane ascend near-vertically and then vertically. At 80km altitude, the rocket engine is turned-off automatically due to fuel depletion, but due to its momentum, the spaceplane continue ascending.

The spaceplane's momentum becomes zero due to gravity at 100km altitude. Using small rocket thrusters, the pilot aligns the spaceplane horizontally to enable the passengers to clearly view the curvature and surface of Earth through the windows on the sides and floor. The passengers will also be able to view the space environment through the windows on the sides and roof. While doing this, the passengers may be using potable video-camera, which will be made available as souvenirs for them at the end of their flight. During this relatively short time, the spaceplane is maintained at the 100km altitude using rocket thrusters under its fuselage and wing.

The thrusters then turned-off automatically and the spaceplane starts descending. It dives near-vertically un-powered until it reaches 10km altitude. At this level, the pilot ignites the jet engines again, and flies back to land the spaceplane horizontally at the airport.

THE SPACE RACE

The space race was the competition between the government and people of the United State of America (USA) and Union of Soviet Socialist Republics (USSR) from the late 50s to the early 70s to become the first in space exploration. The most significant development during the space race is the expendable launch vehicles, which were developed based on the design and operation of intercontinental ballistic missile. These launch vehicles were the workhorse of the intense space travel activities during the race.

Space Travel Infrastructures and Opportunities in the Developed Countries

Huge facilities were built to support the operation of these launch vehicles in the USA and USSR. The launch vehicles and their infrastructure operations had involved many sectors of employment, including administration, engineering, design, supplying and servicing, creating opportunities to various level of society. The operation of these space travel infrastructures were also given huge publicity by the media not only in the USA and USSR but also the whole world, creating the pride and interest among the people of the USA and USSR and the countries under the political influence of the USA and USSR.

Some of the countries now, such as those in the Western Europe have become the develop countries, and they inherit the space travel culture and opportunities originated from the space race. Some other countries, such as those which were the former countries of the USSR, inherit infrastructures and technology from the space race.

LACK OF SPACE TRAVEL INTEREST AND OPPORTUNITY IN DEVELOPING COUNTRIES

The developing countries in Asia, Africa and South America did not involve in the space race, and therefore do not inherit any space travel infrastructures and technology from the race, even though countries like Brazil, India and China have successfully developed their own expendable launch vehicle and operate launch centers.

Most of the developing countries involve only as users of basic space technology such as for communication and meteorological services. Even if some of the developing countries do have space agencies, the organizations are relatively small and insignificant compared to other government organizations of theirs.

Therefore, the opportunity for the people of the developing countries to be involved in space travel activity is very slim, if it exists at all. These people will not be able to have the opportunity of becoming astronauts, mission specialists, spacecraft engineers, mission operators, space project managers or spacecraft technicians. Although very few developing countries may be able to participate in astronaut programs and space exploration activities, the number of their people who will be able to participate is very small, due to economic factor, since such programs are very costly.

The lack of space travel infrastructures and technology among the developing countries contribute to the lack of interest and opportunity of space travel among its people. Unfortunately, it is very difficult if not unpractical for the developing countries to develop similar scale of space travel infrastructures and opportunities as in the develop countries due to economic, political and cultural reasons.

With such lack of interest and opportunity in space travel among the people of the developing countries, there will be big possibility of unfairness among the developing countries in benefiting from development of space science, technology and economy. To avoid such possibility, the lack of interest and opportunity should be overcome.

SUITABILITY OF SUBORBITAL SPACEFLIGHT IN DEVELOPING COUNTRY

Suborbital spaceflight using suborbital spaceplane is less in cost and lower in technology compared to conventional orbital space travel employing expendable launch vehicle, because the operation of suborbital spaceplane does not require facilities of the scale required by launch vehicle.

Suborbital spaceplane can operate from an existing airport, carrying passengers for suborbital tourism and astronaut qualification. A developing country, which host the operation of a suborbital spaceplane does not has to build extra major infrastructures, but only need to prepare facilities for the spaceplane passengers and their families.

A suborbital tourism package will last for many days if not weeks, meaning that the space tourists will be required to stay for few weeks at or around the spaceport location, because the package will involve medical certification and training for safety, physical and psychological preparation of them. Such package will contribute to economic activities such as local tourism and hotel industry.

Such tourism package can be enhanced and make more interesting by including visits and activities at local tourist destinations. Furthermore, developing countries in Asia, Africa and South America do have very attractive destinations to be included in the suborbital tourism package.

Operation of suborbital spaceflight in a developing country by a foreign or local operator will also bring investment to the country, because such space tourists will require facilities of international standard if not luxurious standard. Such requirement will bring investment for the development of first-class facilities for accommodation, medical and leisure to the country.

If a developing country hosts the development of suborbital spaceplane, its people will be able to directly benefit from the industry through employment and indirectly through technology transfer and educational activities. The qualified ordinary people will have the opportunity to work as pilots, engineers, programmers, designers, traffic controllers, and technicians for a space travel industry. Wealthy citizens of the country and government astronauts can fly onboard the spaceplane.

There will also be opportunities for indirect involvement of others in supplying and servicing to the operation and/or development of the spaceplane. Even students will feel the involvement and benefit through educational activities.

With such involvement from multiple level of society, various opportunities and interests will be generated among the people of the country.

Suborbital Tourism as the New Economy

Developing countries also require new economy to overcome the economic monopoly of China and India due to the exploitation of low cost labour and lack of safety standard. Suborbital tourism can be the new economy for this purpose because operation and/or development of suborbital spaceplane require well-trained professional human resources and high safety standard, which are more available at some developing countries other than China and India.

Functions of Suborbital Spaceplane and Their Possible Commercial Funding

Suborbital spaceflight using suborbital spaceplane is the simpler and low cost version of spaceflight, but it can contribute significantly to space science, technology and economy. A suborbital spaceplane can effectively function as the commercial carrier of educational and scientific experiment, industrial products, space tourists and advertisement.

A suborbital spaceplane is a reusable sounding rocket, which can perform atmospheric and meteorological experiments for educational and scientific purposes. Few minutes of zero-gravity environment can also be created in a suborbital spaceplane, enabling zero-gravity and micro-gravity experiments to be conducted onboard it. Such experiments can be useful not only scientifically, but also for the development of industrial products.

Not only the suborbital flight will be the interest of space tourists, but also it will be attractive for commercials and advertising campaigns. The flight will receive attention from various sectors such as scientific, technological, academic communities and businesses and industries, and therefore, the spaceplane will be an attractive platform for commercials and advertisement campaigns similar to Formula 1 racing car.

Even a prototype of suborbital spaceplane can play significant roles in performing suborbital flight for education, experiment, advertising and astronaut qualification, and it can be developed with a cost less than the cost of sending an astronaut to the International Space Station. However, only FAA certified suborbital spaceplane will be able to carry passengers.

All such functions of suborbital spaceplane can be exploited commercially to enable economic funding of its operation. Such funding will free suborbital spaceflight from the general perception of space travel, which usually associate with high operating cost.

CONCLUSION

Many of the developing countries did not involve in the space race, and therefore do not inherit the infrastructures and culture from the space race. These countries do not have to own such infrastructures to be part of international space travel community, which is very expensive, but can develop low-cost suborbital spaceflight instead.

By developing suborbital spaceflight, the developing countries can promote the interest, culture and opportunity in space travel to its people, enabling them to be more beneficial of the development of space science, technology and economy. A developing country can operate or develop suborbital spaceplace because the requirement to do so is not that expensive and complicated as operating or developing expendable launch vehicle, and suborbital flight activities will be very suitable to its economy.

Suborbital spaceflight will enable the people of the developing countries to participate directly and indirectly in the development of space science, technology and economy. Such involvement is unpractical and not possible with conventional space program in the developed countries.
By participating in such development, the people of the developing countries will have the opportunity of being part of human space travel. They will appreciate human achievement in space travel, because they will no longer be the users, but also the contributors to human space travel. Only such phenomena will guarantee the true and fair global distribution of the benefit from human space travel.

Unlike expendable launch vehicle, suborbital spaceplane can be made fully reusable, hence possible for commercial operation. Therefore, suborbital spaceflight can be developed commercially, which is vital for its operation and/or development in the developing world, which usually preferred such development compared to government-funded activities. Economically and culturally, commercial suborbital spaceflight is an effective tool to promote the interest of space travel in the developing world and contribute to the global development of space science, technology and economy.

REFERENCE

Norul Ridzuan Zakaria, Dato' Ramly Zahari, A. Prof. Abd. Azis Abd. Majid, Jamaludin Othman, *The Symbiotic Relationship between Astronaut Program and Space Tourism Development – A Third World Perspective*, 2nd International Association for the Advancement of Space Safety, Chicago, USA, 14-16 May 2007.

The poster, "Commercial Suborbital Spaceflight as a Tool to Promote Space Travel in Developing Countries" is being exhibited and receiving attention due to its unique illustration and subject contents at the 12th International Space University (ISU) Annual Symposium, ISU, Strasbourg, France, 20-22 February 2008.