



The Space Congress® Proceedings

2000 (37th) Space Means Business in the 21st Century

May 3rd, 2:00 PM

Paper Session II-B - National Spaceport Testbed

Kevin R. Brown

Command and Control Technologies

Carey M. McCleskey

NASA John F. Kennedy Space Center

Follow this and additional works at: <https://commons.erau.edu/space-congress-proceedings>

Scholarly Commons Citation

Brown, Kevin R. and McCleskey, Carey M., "Paper Session II-B - National Spaceport Testbed" (2000). *The Space Congress® Proceedings*. 16.

<https://commons.erau.edu/space-congress-proceedings/proceedings-2000-37th/May-3-2000/16>

This Event is brought to you for free and open access by the Conferences at Scholarly Commons. It has been accepted for inclusion in The Space Congress® Proceedings by an authorized administrator of Scholarly Commons. For more information, please contact commons@erau.edu.

EMBRY-RIDDLE
Aeronautical University™
SCHOLARLY COMMONS

National Spaceport Testbed

Kevin R. Brown

Command and Control Technologies
1311 N. U.S. Highway 1, Suite 129
Titusville, Florida 32796 USA
brownkr@cctcorp.com

Carey M. McCleskey

NASA John F. Kennedy Space Center
Mail Code PH-K
KSC, Florida 32899 USA
Carey.McCleskey-1@ksc.nasa.gov

Editor's note: This is an abridged version of the original paper. The full paper may be found at <http://www.cctcorp.com/testbed>

Abstract

The U.S. space industry continues to struggle to turn space business into successful business. Sensing this, both NASA and the state of Florida are exploring ideas for engaging their technological and economic resources in solving this grand challenge. This paper proposes just such an idea: a revolutionary new facility called the National Spaceport Testbed that would be dedicated to testing new space transportation technology. The one-of-a-kind testbed would allow space entrepreneurs to carry out ground and flight tests at reduced costs; allow NASA to apply resources to technical risk reduction; and allow Florida to attract and retain new space business.

Introduction

The entire space industry is galvanized in its pursuit of cheap and reliable access to space but fractured in its approach. For years, NASA has been experimenting with a variety of flight concepts and multi-phase roadmaps. Florida is now mapping out its future in retaining and growing the regional economic impact of the space industry. New space transportation entrepreneurs are struggling to finance and develop the technology needed to launch a commercially viable enterprise. Established companies are partnering with the federal government to build new space transportation architectures in the hope of reducing costs. This multifaceted approach brings the benefit of applying diverse perspectives to solving the problem, but is also leading to tremendous expenditures and duplicity that congress and private investors are increasingly reluctant to support. Therefore, identifying and developing opportunities to align these interests in achieving the common goal of affordable space access while preserving an environment that encourages diverse technical approaches will become an increasingly essential part of the industry. The national spaceport testbed proposed in this paper is an early example of how shared investment could benefit all without stifling innovation, competition, or further private investment.

The testbed would be a government-funded facility built at the Cape Canaveral Spaceport in Florida that supports ground and flight testing of new space transportation technologies. Open to all space transportation companies, the National Spaceport Testbed, or NST, is a dedicated flight test facility akin to flight test ranges used for testing of experimental aircraft. Constructed at one of the 28 abandoned launch pads at the Cape Canaveral Spaceport (CCS), the testbed would be used to demonstrate reliability of new technology, systems, and procedures through actual ground and flight testing. Users gain access through innovative joint research partnerships in which costs are shared by industry and government. The facility will be suitable for both flight and ground technology experiments. Upon “graduation” from the testbed, users will have the convenient option of re-locating to the nearby operational area of the CCS.

National Spaceport Testbed Concept

The proposed NST is a designated facility at CCS comprised of a simulation center, launch pads, landing strip, a launch control center, and off-line vehicle maintenance facility. Many of the inactive or dismantled pads at the CCS could serve as a starting point for the facility; Spaceport Florida has expressed interest in designating Complex 20 as an NST site.

The facility would allow new flight vehicle technologies to be tested and demonstrated in a variety of flight test environments. New vehicles and new technologies would be tested using equipment, instrumentation, and data links that were provided by the test bed facility. Use of the testbed would be restricted to ground and flight tests of new and modified launch vehicles not involving paying payloads. The spaceport testbed would also provide the facility for experimenting and demonstrating new ground system and operations technologies.

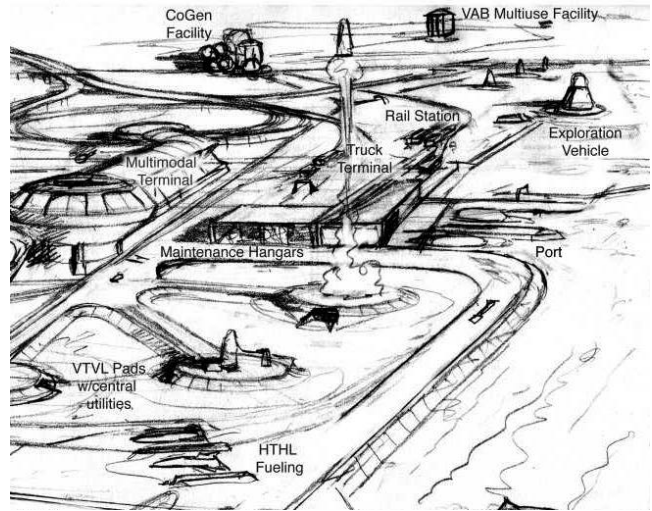


Figure 1. National Spaceport Testbed – Notional concept of a facility for pooling and focusing the resources of the United States, government, commercial and academic, on solving the challenge of affordable space access. Courtesy Vision Spaceport/SAIC.

Stages of Certification

The NST concept is based on a series of certification stages, listed in Table 1, that allows technology developers to progress from laboratory testing to flight demonstrations. A testbed user would begin at the stage most appropriate for the maturity of the technology. As the technology matured, testing would move from early demonstration facilities to more advanced operations facilities. The process would culminate in a comprehensive series of certification flights, successful completion of which would result in appropriate licensing of the vehicle, at which point the user would “graduate from the testbed and be allowed to move newly certified systems and procedures to the operational area of the spaceport or other compatible spaceport.”¹

Table 1. Testbed Stages

	Stage	Purpose	User
Simulation	1 PILS Simulation	Laboratory flight simulation for component technologies	Early stage technology developers requiring operations simulations for prototype components
	2 HILS Simulation	Hangar simulation of flight conditions for prototype systems	Ground and flight system developers requiring simulated flight conditions for complete systems
Operations	3 Pad/Field Demonstrations	Operational testing of systems not yet ready for flight	System developers requiring tests in a realistic ground operational environment
	4 Flight Demonstrations	Flight testing new systems	System developers ready for sub-orbital or orbital flight testing
	5 Operational Demonstration	Certification of operational effectiveness	Advanced systems developers ready for operational deployment

Simulation Facilities

A simulation capability for the NST is provided in two stages. The first stage involves computer simulation of missing elements including generation of appropriate stimuli to the test article. Referred to as processor-in-the-loop simulation (PILS), this activity is typically used to repeatedly test and adjust individual system components to ensure they meet specifications. PILS testing is useful in exploring operations concepts, verifying communications interfaces, software development and test, command and control system testing, ground system modeling, mission planning, and operator training.

The second simulation stage would consist of a high fidelity ground based simulator commonly known as hardware in the loop simulation (HILS). A HILS facility typically consists of communications gear, navigation equipment (INS and GPS), real-time computer electronics that emulate flight computers, vehicle subsystem interfaces, and flight software. The simulation facility would allow a complete set of operations, including a flight profile, to be executed on the ground to test all components of the space transportation system.

Both the simulation and the operations facilities would have extensive internet-based connections allowing the user's engineering team to monitor and analyze testing activities. This communications arrangement could be based on the recently proposed Global Spaceport Network² and a well-planned spaceport information system.³

Ground Systems Technology

The spaceport testbed would provide an ideal facility for experimenting and certifying new ground systems technologies. Free from strict operational or regulatory limitations associated with operational launch facilities, the testbed could be configured in an endless variety of ways to test and certify new ground technologies without impacting operational missions. Further, at an advanced stage the testbed could offer simulated flight conditions including simulated countdown missions that could be used to demonstrate how new ground technologies would interact with the flight segment and improve spaceport and launch operations.

New Operations Concepts

Just as new ground systems technologies could be tested at the new facility, so could new operations concepts. Operation approaches that demonstrate how flights can be prepared and launched reliably and safely with fewer personnel, fewer ground facilities or other changes are simply too risky or unaffordable to be demonstrated without being evaluated at operational facilities. For instance, many in the industry would like to see a commercial airport engage with the testbed to show how airport flight operations methods could be applied to spaceport operations. No place other than a spaceport testbed can safely host such an experiment.

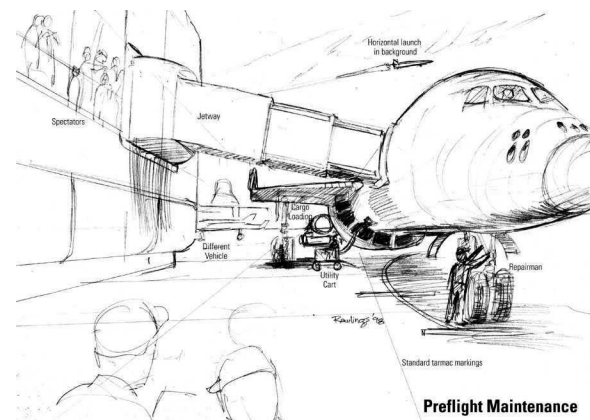


Figure 2. Operations tests would demonstrate the feasibility of conducting space transportation operations in a manner similar to airport operations. This notion has been discussed for years, but has yet to be proven.

Stakeholders

Fundamental changes at the spaceport

The major organizations involved at the Cape are each exploring profound changes in the structure of the spaceport and its functions. With the NST, NASA's role can quickly change so that spaceport operations can be turned over to the private sector and NASA scientists and engineers re-focused on the R&D associated with overall agency goals. Today, the U.S. Air Force is examining its involvement in the day to day operations of the launch range at the Eastern Range and searching for a means to engender space launch growth in the emerging commercial space transportation industry. In addition, the White House, through the Office of Science and Technology Policy, is exploring fundamental changes to the operation of the spaceport and the role that federal agencies currently play. The state of Florida, sensing a new day in the space launch business, recognizes the opportunity that these changes pose for the state. Coming at the same time as the startup of several entrepreneurial launch vehicle designs as well as the VentureStar™ initiative, this opportunity frames a high stakes economic game that the state simply cannot afford to ignore. There's no better time to consider the feasibility of a major new spaceport component such as the proposed National Spaceport Testbed as such broad and profound levels of change are unfolding at the Cape and throughout the industry.

NASA

NASA Administrator Dan Goldin is seeking revolutionary new launch systems. The agency maintains it is ready and willing to fund the technical risk reduction once private industry steps up and provides the "spark" for revolutionary risky change. He has also put out a loud and clear call for industry to bring new ideas that NASA can work with.⁴

The NST is a bold new idea. The facility would be set up to fund technical risk reduction without subsidizing industry or picking winners. The mere existence of an NST would make it far easier for companies to justify experimentation with revolutionary new technologies and new ideas in partnership with NASA. Technologies that are demonstrated in testbed flights would be available to companies building new space systems. The facility would also provide a ready conduit for applying NASA expertise and technologies to companies developing new launch systems through strategic public-private partnerships. And to ensure the successful experiments do not stop at the laboratory stage but are fully commercialized and turned into successful business, the NST will maintain an entrepreneurial spirit at its heart. Companies will share the risk and commit private funds before using the NST.

NASA has developed an integrated space transportation plan based on a series of projects from shuttle upgrades, to a second generation RLV, leading to a third generation vehicle. *At some point, each of these projects will require simulation and flight testing to demonstrate progress toward the desired capabilities.* The NST would be the ideal facility for carrying out these demonstrations, including the Spaceliner 100 technology development program.

Closer to home, the Kennedy Space Center envisions an evolving role as the nation's "Spaceport Technology Center" (STC). According to the STC Concept paper,⁵ "the STC, comprised of a knowledgeable and experienced workforce utilizing world-class facilities and equipment, will provide technologies and processes to private business and government agencies

who propose to build and operate spaceports and associated ranges.” To successfully experiment and demonstrate the resulting technologies, the STC will require world-class testbed facilities that leap well beyond current capabilities such as the Launch Equipment Test Facility.

At the recent U.S. Chamber of Commerce Forum on the Future Development of Space, Mr. Goldin used an example of how NASA is successfully partnering with industry to push the frontiers of technology in what serves as a precedent for the NST: “Under the leadership of the NASA Ames Research Center, we are putting together a high-tech research park in Sunnyvale, the heart of Silicon Valley. We will partner with the unbelievable talents in the area to develop the next generation electronics and information technologies. We will work with customers, clients, and other stakeholders from day one. We will make is a joint development with each party being able to concentrate on what they do best. This is synergy at work from the get go.”

With NASA’s Pathfinder/Trailblazer⁶ strategy applied to three generations of NASA launch vehicle development, the advent of the STC concept, the blossoming entrepreneurial space community that remains hungry for financial assistance to reduce the tremendous technical risks, and the availability of land and equipment at the Cape Canaveral Spaceport, the time has come for a high-tech space transportation research facility on the Space Coast.

U.S. Air Force

While NASA is determined to reduce space access costs for its exploration and science missions, the U.S. defense department strives to reduce those costs to integrate earth orbit into strategic and battlefield operations. Spacelift 2025, an Air Force initiative to define how space assets will be used in future conflicts, calls for the ability to “launch on demand.”⁷ Maintaining quick access to space is a critical aspect of national security; reducing its cost is just as critical in the face of reduced defense budgets.

The drive to reduce launch costs is occurring at the same time the federal government considers changes to the fundamental precepts governing federal launch ranges. Both the White House Office of Science and Technology Policy⁸ and the National Academy of Sciences⁹ are conducting studies on the future use and organization of the launch ranges. The results of these studies, combined with the Air Force vision of turning most range operations over to private industry, could lead to some of the most dramatic changes at the ranges in a generation.

The proposed NST would provide at least two key benefits to the military that current test ranges cannot. First, the NST would be dedicated to space-related activities. There would be no conflict with aircraft or missile testing, as is commonly the case at existing test ranges. Secondly, and perhaps more importantly, the juxtaposition of military space testing with commercial space technology R&D at the NST could lead to new partnerships and synergies between the defense department and private industry beyond the traditional defense industry

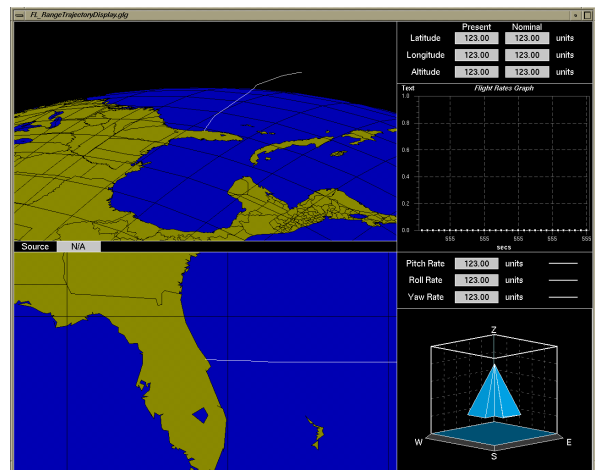


Figure 3. Standard missile test range safety technology will be used for expendable vehicle test. Tests of reusable and piloted vehicles will require specific safety features similar to that used for piloted test aircraft.

contractors. This potential synergy is precisely the aim of the recent Air Force Commercial Space Opportunities Study¹⁰ and other initiatives to apply commercial space capability to military applications.

Dr. John Borky, vice chairman of the Air Force Scientific Advisory Board, reported to congress on the Air Force roadmap developed last year¹¹ that calls for consideration of national or regional spaceports, potentially including “the creation of a National Spaceport Authority analogous to the FAA.” Major changes are brewing in the Pentagon relative to the military role in space range operations; the proposed NST would be an ideal facility for exploring many of the proposed technological and operational changes.

Federal Regulatory Agencies

The U.S. Department of Transportation is very interested in establishing a spaceport launch licensing mechanism that provides maximum flexibility to spaceport launch operations while ensuring the safety of the surrounding personnel and property. Today, the agency licenses spaceports and launch vehicles independently on a case by case basis. The NST could be used by the FAA to more formally structure the process of granting commercial space operations licenses. The demonstration of key onboard safety and ground system technologies in the testbed environment could be a criterion of the licensing process. Demonstrated flight capability in the testbed might also be licensing criteria.

RLV Companies

Many of the space transportation entrepreneurs in the United States are having difficulties raising capital to complete their development efforts. Some of them cite NASA’s funding of the X-33 as a stumbling block with potential investors because the investors are reluctant to finance enterprises that compete with a government funded program such as the X-33. Many of these same entrepreneurs have expressed interest in government financed facilities that were equally accessible to all of them in a way that did not favor any one particular concept. The testbed facility, for example, would provide the opportunity for the government to assist in technology development across the industry without discouraging investment in any one particular enterprise. In fact, government support in such an equal access fashion would be seen as a means of leveraging private investment and therefore make the space transportation enterprises more appealing to potential investors.

Today, developing a commercial space launch vehicle is one of the most difficult business plans to sell to private investors. The upfront investment requirements are tremendous. Launch vehicle firms that have reached the stage of developing a vehicle prototype suitable for flight testing have demonstrated their owner’s commitment to the program and the assumption of a large portion of the technological risks associated with the enterprise; many such companies would welcome a partnership with government that leveraged additional private investment to fund their final flight testing program leading directly to revenue generating operations.

With a package of government provided test facility time and cash contributions, the entrepreneur will hold a strong hand in approaching private investors to fund the high-risk flight test portion of the development program. Plans to conduct the flight test from a proven, safe, and state-of-the-art facility leading directly to certification would also strengthen his case.

Established Launchers

Companies that conduct launch operations today with proven vehicles are continuously striving to engineer more efficient subsystems, more affordable components, and more productive operations. The NST offers these companies the opportunity to experiment with proposed improvements to their vehicle and operations without risking one of their operational vehicles or interfering with manifested schedules.

Ground Systems Companies

The importance of ground systems and related technologies is often overlooked when devising new space transportation architectures. Companies that focus on spaceport technologies, such as Command and Control Technologies Corporation, have long recognized the opportunity to build a business around products and services that streamline launch and mission operations. The challenge these companies face is to develop affordable products and systems that truly offer long-term benefits to spaceport and launch vehicle operators. With today's limited market for such products (there are about 20 operational launcher families in the world), it is very difficult to raise private capital to develop them.

The NST concept offers an ideal solution to this dilemma. Joint industry/government funding helps overcome the financial hurdles; demonstration of the technology at an actual launch site shows the benefits of employing resulting products to operational spaceports, thus helping to create a potential customer base for the developer; the availability of a simulation facility lowers the risk of development; and the opportunity to demonstrate the technology during actual testbed flights, say, by another testbed user demonstrating flight technologies, substantially boosts its credibility if successful.

Florida

Florida is already home to one of the premier launch sites in the world. The state, however, recognizes that its premier position is by no means guaranteed as the space shuttle program enters its sunset period in the next decade. A recent study by a U.S. Department of Transportation think tank echoed these observations and recommended the state adopt a two-fold strategy: build a world-class spaceport and diversify industry by investing in space R&D.¹² With the Air Force and NASA diminishing their operational roles at the Florida launch site, the state recognizes the need for substantial state level involvement to maintain recognition of the world class facility at the launch site. Creation of a national spaceport testbed facility – the only one of its kind in the world dedicated to commercial launch vehicle and ground system testing – would boost the global prominence of the Florida launch site and form a catalyst for new R&D activity. Such a facility could well provide the cornerstone of a comprehensive “world class” Cape Canaveral Spaceport as envisioned by the state's spaceport authority.¹³

With careful master planning, the proposed testbed could evolve into an incubator of sorts in which launch vehicle entrepreneurs who successfully completed their test flight program would graduate from the test area and move their operation just a few miles to the commercial operations area of the spaceport, giving Florida a mechanism for capturing new space launch operators in a very economical way.

Financiers

Current space launch performance has made it clear to the space financial community that a means for creating higher standards for safety, reliability, and throughput are desperately needed. The NST concept fulfills this critical national requirement.

A relationship between investors and the NST could take any of a number of forms to open up unprecedented opportunities in the fledgling space entrepreneur community. The NST would provide space companies an opportunity to demonstrate their technology to potential investors. The investment community would have an opportunity to observe other companies involved at the NST, some of which may represent promising investment opportunities. Partnerships that are already in place such as the agreement between NASA and SpaceVest,¹⁴ a private equity organization, could serve as the foundation upon which to forge more aggressive and productive pacts. Venture capitalists and other financiers would get to see their management teams in action for perhaps the first time in an operational environment. And as professional dealmakers, investors may find opportunities to create partnerships between independent NST users to create more robust enterprises, or fill key management positions with individuals who demonstrate special abilities during NST operations. Perhaps most importantly, the NST offers the investor an opportunity to learn more about the space industry.

Universities and Academic Research

The NST could provide an ideal vehicle to engage the academic research capacity of the entire state in space technology. With a variety of ground and flight experiments taking place at various levels of advancement, opportunities for university researchers to join forces with private industry would proliferate.

Funding

In what could be the most revolutionary aspect of this concept, a new NASA partnership arrangement would be used to combine government and user funding for NST projects. NASA has recently created an innovative partnership mechanism that is proven to be ideally suited to joint research and development activity in the space and aircraft industry. The mechanism, known as the Joint Sponsored Research Agreement, is a partnership between NASA, private firms, and other organizations in which each participant contributes resources to a common goal and where each participant realizes certain benefits from the common effort. The JSRA mechanism, for instance, has been used successfully on the Vision Spaceport project administered out of NASA's Kennedy Space Center in which spaceport transportation system analysis technology has been produced by a government/industry/ academia consortium.¹⁵ The mechanism has also been used on a much large scale at Langley Research Center.

Conclusion

This paper introduces a concept for a dramatic new use of the assets at the Cape Canaveral Spaceport. Events unfolding today in the commercial space transportation industry call for bold ideas and bold leadership to keep hold of U.S. prominence in this vital area of commerce and technology. The proposed NST is such a bold idea. It is up to government and industry leaders to embrace the idea and make it happen before most space transportation business relocate out of the state, or worse, out of the country.

References

- ¹ Zapata, E., “Reusable Launch Vehicle Certification,” 33rd Space Congress, Canaveral Council of Technical Societies, Cocoa Beach, Florida, April 1996. (See <http://www.ksc.nasa.gov/shuttle/nexgen/rlvhq14.htm>)
- ² Brown, K.R., “Linking Information Systems Between Independent Spaceports,” Technology 2009 National Conference, Miami Beach, Florida. November 3, 1999.
- ³ Brown, K.R., “A Ground Information Infrastructure for Spaceport Operations,” First International Symposium on Reduce the Cost of Ground Operations, Oxfordshire, U.K. 1995.
- ⁴ Dan Goldin, remarks at AIAA luncheon, May 3, 1999.
- ⁵ NASA-KSC, *Spaceport Technology Center Concept*. 1999.
- ⁶ Rogacki, Dr. Row, *Overall Approach/Organization* briefing, NASA Space Transportation Day. October 27, 1999.
- ⁷ See <http://fas.org/spp/military/docops/usaf/2025/v2c5/v2c5-1.htm> and <http://fas.org/spp/military/program/launch/lodi/sld011.htm>
- ⁸ White House Office of Science and Technology Policy, “Future Management and Use of U.S. Space Launch Bases and Ranges,” *Commerce Business Daily*. May 11, 1999.
- ⁹ National Academy of Sciences, “Space Launch Range Safety Study Overview,” Project ASEB-J-99-02-A. National Research Council Aeronautics and Space Engineering Board. Washington DC. May 21, 1999.
- ¹⁰ U.S. Air Force, “Commercial Space Opportunity Study Final Report” to be released. See <http://www.losangeles.af.mil/SMC/XR/CSOS/main.htm>.
- ¹¹ U.S. Air Force, “A Space Roadmap for the 21st Century Aerospace Force.” See http://www.house.gov/science/borky_062999.htm.
- ¹² U.S. Department of Transportation John A. Volpe National Transportation Systems Center, “Building on Florida’s Strengths in Space.” December 6, 1999.
- ¹³ Spaceport Florida Authority, *Next Steps to the Stars*. February 1999.
- ¹⁴ SpaceVest/NASA Memorandum of Understanding. October 14, 1997.
- ¹⁵ NASA John F. Kennedy Space Center, *Joint Sponsored Research Agreement: The Vision Spaceport Project*, NCC10-0030. January 1998. See <http://www.VisionSpaceport.org>.

The authors would like to acknowledge Pat Rawlings and the Vision Spaceport partnership for the artwork included in this paper.