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EVALUATION OF COMMERCIAL HUMAN SPACEFLIGHT LAWS AND REGULATIONS IN THE UNITED STATES

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With the end of the Space Shuttle Program, an American commercial spaceflight industry is burgeoning with new aerospace companies vying for a corner of the market. The intent of this paper is to evaluate current human spaceflight regulations in the United States and to provide additional considerations that may be helpful in creating a safe and marketable commercial human spaceflight industry. A brief history of the human spaceflight industry since its inception will be touched upon to set the stage for the current capabilities and challenges in this industry (part I of this paper). Currently, there are four major categories of enterprises identified in the commercial human spaceflight (CHSF) industry: government use through NASA, suborbital tourism, point-to-point access, and research payloads (all described in part II). In the context of emerging industries, government regulation has a powerful influence over industry development – either positively to promote or negatively to threaten its growth. Regulatory themes are described in part III, and the current regulations at the national level are identified (part IV) and evaluated for their ability to meet the FAA's stated goals (part V). Finally, considerations are offered for potential future regulation as well as suggestions for how to implement these considerations (part VI). While this paper is written from a policy perspective and works with concepts in the American legal system, it is meant to be of interest to – and accessible by – both lawyers and non-lawyers alike.

*Views expressed in this paper are the personal views of the authors and are not those of the FAA or any other governmental agency.

I. INTRODUCTION

The first human reached outer space on April 12, 1961 with the launch of the Soviet Union's *Vostok* spacecraft with cosmonaut Yuri Gagarin on board. His flight completed one orbit around the earth in 108 minutes. Since then, humanity has flown over 500 people into space, but it hasn't been a smooth ride.

Throughout history, human spaceflight has been a difficult sell to the public. Human spaceflight began with the Cold War and the United States' need to beat the Soviets to the moon; with the support of a patriotic nation, money poured in from Congress to fund the Apollo program. But having achieved the goal of landing a man on the moon and returning him safely to Earth, the American public quickly lost interest, and in subsequent decades, interest in publically-funded space missions continued to decline. Since the retirement of the Space Shuttle in 2011, the solely-government funded model of human spaceflight is changing as a new commercial human spaceflight (CHSF) industry emerges, with various possible applications.

The government has been actively working to provide the appropriate legal environment for the CHSF industry to flourish. The Secretary of Transportation, department head of the Federal Aviation Administration (FAA), has been tasked with "oversee[ing] and coordinat[ing] the conduct of commercial launch and re-entry operations, issu[ing] permits and commercial licenses and transfer[ing] commercial licenses authorizing those operations, and protect[ing] the public health and safety, safety of property, and national security and foreign policy interests of the United States."[1]

It is important to note that regulation, while promoting safety, can also act as a hindrance to industry development as each regulation often increases the required investments of time, money and innovation. The CHSF industry differs from many new industries because its cost-to-market is fairly prohibitive; it is a highly risky business with a low track record of success for newcomers and the consequences of failure are daunting. The industry understands the need for at least a minimum level of safety regulation, but the question arises as to what level of regulation is actually necessary and how or when to implement the regulations.

To better evaluate the current regulations and to offer suggestions for potential future regulations, this paper describes the context of CHSF, and proposes several regulatory themes before if offers a summary and evaluation of the current regulatory regime.

Explanations of the legal context presented here are simplified for non-lawyers and do not pre-suppose extensive background on the American system of government. In the interests of accessibility, nuances of the American legal structure are not analyzed to their full depth here.

II. POSSIBLE COMMERCIAL APPLICATIONS

This section describes each of the various CHSF applications currently being developed, including governmental, tourist, transportation, research and alternative uses.

II.I Government Uses

With the retirement of the Space Shuttle, the National Aeronautics and Space Administration (NASA) has actively sought different commercial routes for providing transportation to and from the International Space Station (ISS). In 2006, NASA awarded two competitors in the Commercial Orbital Transportation Services (COTS) Program. The purpose of the COTS program is to help the industry develop and to demonstrate cargo space transportation capabilities. Additionally, NASA recently awarded three companies to fund their Commercial Crew Integrated Capability (CCiCap) to ferry astronauts to and from the ISS. NASA is committed to using commercial rocket and spacecraft developers' products to maintain its access to the ISS.

II.II Suborbital Tourism

The vision for suborbital tourism is to provide the spaceflight participant the full experience of taking part in an adventure of a lifetime. As part of the package, companies would train customers in different simulators and immerse them in a life-changing experience from pre-training all the way to post-flight. On the day of the flight, participants would arrive at the designated spaceport, strap into the vehicle, and experience an exhilarating 3g blast-off from Earth. Once in space they would have anywhere from five to twenty minutes (depending on the final altitude) to float around the cabin, take pictures, enjoy the thrilling views and feel the freedom of the microgravity environment. On descent, the space vehicle would dive back into the Earth's atmosphere at astounding speeds, pulling upwards of 5g acceleration, and land (safely) back at the spaceport.

II.III Point-to-Point

This form of commercial spacecraft use can be paralleled to the supersonic transport with the Concorde but also parallels the current air transportation industry. Intercontinental trips for cargo and/or passenger transport that normally take a full day or more on a commercial jet could be accomplished in less than an hour with a suborbital rocket vehicle engaging in point-to-point transportation.

II.IV Research Payloads

Another possible application of CHSF is suborbital microgravity research. Spacecraft providers would configure their spacecraft to be capable of carrying several science payloads with crew members to perform on-orbit science experiments. Suborbital flights would provide less expensive and more frequent access to space, allowing more data collection for researchers.

II.V Alternative Space Stations

Other companies are looking to supply another corner of the market by providing an alternate space station that could act as a commercial orbiting research laboratory. Alternative stations could also serve longer-stay tourism demands in orbit, but at much lower costs than the tourist trips to the ISS in recent years. Sovereign nations have also expressed interest in leasing portions alternative stations for their own national space science labs. A country would have cheaper and easier access to space science research, an especially important way for developing nations to create a space program without requiring the resources necessary to establish the costly infrastructure. There are infinite other commercial applications to the use of space, but the ones listed above capture the more general and currently anticipated uses.

III. REGULATORY THEMES

As mentioned above, the intent of this paper is to offer some suggestions to the FAA as it considers the future of regulation in the emerging human commercial spaceflight industry. When considering regulations, the agency ought to keep in mind several themes that leverage similar historical experiences in the development of various other industries. The following themes stand out as regulation-driven factors that would encourage industry growth:

1) Creating flexible and predictable regulations
2) Determining the role of state regulation
3) Increasing market participation
4) Promoting consumer confidence

This is not meant to be a comprehensive list of all potential themes, but rather a selected set of "guiding lights" that the regulatory agency may wish to keep in mind as it considers further regulation of the commercial human spaceflight industry.

III.I Flexible and Predictable Regulatory Scheme

Regulators might consider the need for a flexible regulatory regime that is predictable, no matter the developmental course of the industry. Here, the lesson can be learned from the regulation of telecommunications services. In the 1970s, in its series

of *Computer Inquiry* decisions, the Federal Communications Commission (FCC) began to look at the question of how to regulate seemingly different sub-industries as they began to converge; that is, as different technologies began to be used for similar purposes.[2] The FCC looked for ways to avoid applying existing regulation (geared at preventing monopolist takeovers by incumbent competitors, especially in the telephony industry) to the nascent data processing industries and Internet service providers. The FCC created a layered model of regulation that resulted in the creation of new regulated and unregulated markets: the phone carriers were subject to regulation, while the Internet service providers were not. The disparate regulatory scheme continued in the statutory paradigm of the Telecommunications Act of 1996. As providers branch into other telecommunications products and the telecommunications industry's service offerings continue to converge – for example, Comcast now provides voice services, broadband access and cable television through its Xfinity product line –the provider must comply with many regulations that are product-specific. As a result, the same provider can be subject to incongruent and inflexible regulatory schemes that make further market development more difficult, as the provider must maintain vigilance to comply with all applicable statutes and regulations.[3]

The lesson here for the FAA is to avoid imposing differing regulations on the various sub-industries of the CHSF industry as the industry matures. After all, "[t]here is a tendency of regulators to automatically impose legacy regulation on new services that appear similar to, substitutes of, or threats to traditional services. The policymaker must always ask why. Why impose legacy regulation on the new service? By framing the question properly, the policymaker can gain better answers."[4] Because CHSF is a new industry, there are no incumbents in the market; more importantly, the FAA can predict with relative certainty the types of applications or sub-industries (see the discussion above in part II) that are likely to develop. Thus, the FAA has an opportunity to ensure the regulations it imposes are uniform across the larger CHSF industry. For example, the requirements for a point-to-point passenger ought to be the same as those for a LEO low-gravity tourist, and the requirements for pilots flying point-to-point ought to the same as those for cargo pilots delivering supplies.

Similar regulatory regimes will assist the industry's participants because companies can branch out beyond their original entry point into other sub-industries. Thus, a company that began as a purely entertainment space tourism corporation could branch out into providing opportunities for scientists to engage in microgravity research. Knowing that both activities will require compliance with the same or substantially similar regulations will give industry members an incentive to grow their market share by entering new sub-industries. A flexible and predictable regulatory will increase the strength of the entire CHSF industry and will serve as a model for other international space agencies to follow.

III.II. Determining the Role of State Regulation

As the American states begin to build spaceports and to regulate them,[5] the FAA should determine if there is a role for state regulation, and if so, how big a role state regulation ought to play. Lessons can be gleaned from the history of the car industry. In the automobile industry, states have a smaller role to play in mandating safety and environmental protections than in other industries. Historically in the United States, states and municipalities took the lead in regulating vehicles: New York was the first state to require all motor vehicles to be registered beginning in 1901; by 1900 the city of Chicago required annual re-licensing of drivers; and by 1906 most states had adopted speed limits or had granted authority to local government to set speed limits.[6] In the mid-1950s, state legislatures began to mandate seat belts[7] as safety was becoming a larger concern among the general population, due to the increase in vehicle-related death rates. However, it was not until the mid-1960s that the federal government became involved in regulating motor vehicles. In 1966, Congress passed the National Traffic and Motor Vehicle Safety Act that authorized the federal government to create the Department of Transportation, a cabinet-level agency. In 1970, Congress authorized the establishment of the National Highway Traffic Safety Administration (NHTSA). NHTSA is tasked with issuing Federal Motor Vehicle Safety Standards and other regulations with which motor vehicle manufacturers must comply. These standards are the minimum safety performance requirements[8] and they cover crash avoidance standards, such as requirements for windshield wipers and pneumatic tires; and crashworthiness standards, such as requirements for seat belts and rear impact guards.[9]

While these requirements are a floor for vehicle manufacturers – meaning that manufacturers can choose to make their vehicles safer than the NHTSA standards – these requirements are a ceiling for state regulators; that is, a state cannot mandate more stringent safety requirements on vehicles for use by the general public: "…a State or a political subdivision of a State may prescribe or continue in effect a standard applicable to the same aspect of performance of a motor vehicle or motor vehicle equipment only if the standard is identical to the standard prescribed under this chapter."[10]

This sort of explicit pre-emption is important in the American legal system because of the federalist structure of the government: in a nutshell, both the federal and state governments have authority to legislate and regulate, though the states' authority is a general one, while the federal government's authority is limited

to those enumerated powers listed in the United States Constitution. At the same time, federal laws trump any conflicting state laws, but federal agencies are not supposed to pre-empt state laws unless Congress clearly intended the agency's regulations to take precedence over state statutes. In the case of motor vehicle safety, Congress explicitly pre-empted state safety regulation of general-use motor vehicle, so only the federal government has authority to promulgate standards and rules in this area.

The concept of federal pre-emption applies to the FAA in CHSF regulation in that the agency may need to determine whether there is a role for state regulation of CHSF. Several state and local governments have created incentive programs to bring CHSF companies to their areas, and it is conceivable that these local governments might branch out beyond incentive programs into actual regulation of the CHSF industry in a variety of arenas: safety, liability, inspection requirements, etc. While Congress could explicitly pre-empt state regulation, the FAA itself could create a field pre-empting regulatory scheme; that is, it can create a regulatory scheme so far-reaching and pervasive as to allow the inference that Congress intended to prevent state entry into this area of regulation. In that situation, the FAA will have to be deliberate in creating its regulations in the areas where its sole regulatory authority is implied by the statute.

The need for determining the states' role in regulating the CHSF industry can be shown in a simple hypothetical: suppose a corporation plans to provide cross-country point-to-point transportation from Alaska to Florida. In that situation, not only would the laws and regulations of the federal government apply, but the Alaskan laws would apply during takeoff and the Florida laws would apply during landing. It is not hard to imagine a situation where the rules promulgated by Alaska and Florida are in conflict with each other: which regulations should the CHSF corporation follow? Providing clarity in demonstrating where states can exercise their general police powers will assist the CHSF industry to develop as regulated entities will know exactly which regulations apply to their situation.

III.III. Increasing Market Participation

Beyond creating a flexible and uniform regulatory scheme and determining if and how to share regulatory duties with the states, the FAA should encourage market participation. Increasing market participation includes creating a larger customer base for the industry. This might entail encouraging more sub-orbital and orbital research proposals, creating government demand with contracts similar to the NASA Cargo and Orbital Transportation System (COTS) and Commercial Crew Development (CCDEV) Programs, and promoting commercial opportunities for space activities.

If the administration believes low-cost access to space is an economic and national security issue that benefits all members of its society, then there may be a role for government in helping to develop the necessary infrastructure. A historical look at the government's role in developing infrastructure for the United States' transportation systems shows examples of how government regulation can dramatically affect the robustness of the industry.

One such example is locomotive, an industry that began in the nineteenth century amidst a landscape of complex relationships embroiled in various political motives; this document does not attempt to address that difficult backdrop. Briefly, before the advent of the railway system in America, the major transportation routes for trade and commerce involved canals and waterway delivery of goods, which limited much of the trade to cities along major rivers and lakes. To move goods away from major waterfront cities, stage coach and turnpike operators offered transportation services, but as time passed, there was a growing need to move goods to and from landlocked cities faster and with a greater capacity than stage coaches could offer. The railroad provided the solution in the form of fast, reliable transportation and the federal government provided infrastructure development through its use of land grants and its support of the transcontinental railway system. The Pacific Railroad Acts issued government bonds to the railroads and granted large tracts of land to the railways; in fact, between 1850 and 1871, the railroads received more than 175 million acres of public land from the national government.[11] Later, as the railroad industry was built out to capacity, the railroad companies sold their extra land for a large profit, thus securing the industry's place in American transportation history.

Another analogue is the airline industry. Since the first controlled flight of the Wright Flyer in 1903, the airline industry has grown into a $700 billion international market over the past century. The airline industry has a lengthy history that is often used as a potential analogy for commercial human spaceflight. But there were other factors throughout the airline industry development that helped push the industry along at a much faster pace. Early aircraft were designed and built by individuals with a passion for aviation and skilled in manufacturing and construction. The use of the airplane for commercial services caught on early starting with the postal system. The first delivered airmail occurred in 1911 only eight years after controlled heavier-than-air flight had been invented. The Air Mail Act of 1925 allowed the Post Office Department (the precursor to the current USPS) to contract with airlines to carry the mail. Additionally, a year after World War I had begun, the National Advisory Committee for Aeronautics (NACA) was

created to promote aviation research to help war efforts. Airplane technology quickly advanced after the war, thus allowing commercial aviation to become more prevalent.[12]

The importance of government support in promoting market participation in new industries can be clearly seen from the foregoing examples, and it is not difficult to imagine that the CHSF industry would benefit from government support as well.

III.IV. Promoting Consumer Confidence

Regulations created by the FAA thus far provide a minimum baseline for spacecraft companies to safely operate their vehicles. There is on-going discussion as to which level of regulation is required for space vehicle qualification, a measure similar to the air worthiness certificates for aircraft that provides a baseline level of quality that can be guaranteed to the user. In a high-risk industry such as CHSF, having an official certification may provide confidence to the consumer in their selection of a higher quality product for the price they are willing to pay. Some examples of this graded certifications include the Better Business Bureau (BBB) ratings, NHSTA automobile crash ratings, and the United States Department of Agriculture's (USDA) gradations of beef. It is not evident whether these ratings help promote the overall industry, but it does appear to provide individual companies a resource for delineating their brand and targeting their product to specific consumers.

Alternatively, rather than mandate a governmental quality certification, private industry can create its own certification regime. As seen in the extreme or adventure sports industries, such as mountaineering and SCUBA diving, adherence to a minimum set of customer and guide/instructor standards, coupled with liability forms, has allowed these high-risk industries to achieve financial viability while maintaining high levels of safety. As such, the two sports serve as useful analogues for the burgeoning commercial human spaceflight industry.

Mountaineering expeditions to the Himalayas were originally funded by governments as a nationalistic enterprise; in the early 1990s, control of these expeditions transitioned over to commercial operators. Although costs vary from operator to operator, a guided trip to Mt. Everest in 2013 is expected to cost upwards of $60,000, with the average price hovering closer to $65,000.[13] Despite the expensive costs and substantial risk (a 2007 report by Fountain indicates that the fatality rates on Everest and the space shuttle are virtually equivalent[14]), roughly 1,500 climbers attempt to scale Mt. Everest every year.[15]

While there are no explicit regulations mandating mountain guide capabilities on either the Tibetan or Nepalese side of the mountain, almost all commercial climbs on Everest are led by a guide or Sherpa certified by either the American Mountain Guides Association (AMGA) or the International Federation of Mountain Guides Association (IFMGA). Acquiring such certification requires extensive experience in mountaineering, rescue techniques, and emergency medicine. Additionally, U.S. operators pre-screen potential customers for both medical conditions and skill level. Clients who meet the medical and experience criteria fill out a comprehensive waiver form releasing the operator from liability on the mountain. Alpine Ascents International (AAI), for example, requires clients to sign a form certifying the signee "assume[s]…the risks of acts or omissions of AAI, and do hereby expressly agree to hold AAI harmless and defend them against any and all liability."[16]

Although SCUBA diving entails significantly less risk than Everest mountaineering (on the order of 1 in 200,000 dives[17]), it also presents a non-negligible risk in an atypical environment. The cost of SCUBA diving is primarily driven by front-end expenditures: introductory SCUBA classes, equipment purchases, and travel to the dive site can combine to exceed several thousands of dollars. Despite these high up-front costs, the Professional Association of Diving Instructors (PADI), the largest diving organization in the world, certified nearly a million divers in 2011.[18]

SCUBA diving in the United States is not *explicitly* regulated. However, PADI requires all new divers to submit both a standard health questionnaire (signed by a physician) and a release form exempting the organization from liability. These forms serve as prerequisites to the Open Water Diver Certification Course, which student divers must complete before they can dive on their own. Without evidence of Open Water Diver Certification, dive shops will not fill a diver's SCUBA tanks. In this manner, PADI *indirectly* regulate SCUBA diving to a set of minimum standards. Regulations for diving instructors are more explicit. The lowest tier of professional diving instructor, the Divemaster, must have a minimum of 60 dives and be trained as both a Rescue Diver and Emergency First Responder. Higher levels of instructor require significantly more diving experience.

As seen in both mountaineering and SCUBA, regulations and standards can effectively be enforced by non-government entities without deterring the market. A pattern from both industries is the industry-wide acceptance of certain standards, which has for the most part grown organically from the community. In both situations – government-based and community-based certification programs – the consumers have more confidence in the industry and are much more likely to purchase its services.

IV. SUMMARY OF CURRENT REGULATIONS

With the previous section's "guiding light" perspectives in mind, this section looks at the current regulatory scheme, before the rest of the paper moves on to an evaluation of the current regulations. Although CHSF is a relatively un-regulated field as of yet, there are a few sources of regulation currently in play: international treaties, federal law found in the United States Code and the Code of Federal Regulations, and various state and local laws. On the international side, several treaties, including the Outer Space Treaty[19], the Convention on International Liability for Damage Caused by Space Objects, and the Convention on Registration of Objects Launched into Outer Space, establish responsibility for each sovereign state to police all space activities that take place within its jurisdiction. This international responsibility implies the necessity of a domestic regulatory regime to make certain all international obligations are met.[20]

The United States has tasked the Federal Aviation Administration (FAA), within the Department of Transportation, to regulate commercial human space flight in accordance with the international treaties as codified in Title 51 of the United States Code (U.S.C.). The Secretary of Transportation is tasked with facilitating private sector involvement in commercial space transportation activity[21] by establishing "procedures for safety approvals of launch vehicles, reentry vehicles, safety systems, processes, services or personnel (including approval procedures for the purpose of protecting the health and safety of crews and space flight participants…) that may be used in conducting licensed commercial space launch or reentry activities."[22] Additionally, the Secretary has the power to waive Title 51 requirements in certain circumstances.[23]

Title 51 creates general requirements for operating and licensing human spacecraft and authorizes the Secretary to issue any other necessary regulations. For example, under Title 51, a license-holder may launch only if the crew has received training and a medical examination, and if the license-holder has informed the crew prior to employment that the launch vehicle has not been government-certified as safe.[24] If the license- or permit-holder wishes to launch or reenter a space flight participant, the holder must have provided written information to the participant regarding the "risks of the launch and reentry, including the safety record of the launch or reentry vehicle type" as well as a statement that the launch vehicle has not been government-certified as safe.[25]

The Secretary of Transportation, as any cabinet-level secretary, has the power to delegate his or her responsibilities to officers and employees within the Department of Transportation.[26] The Secretary has given the FAA and specifically the Office of Commercial Space Transportation (AST) control over commercial space launching activities, particularly over safety and licensing requirements. The FAA's regulations, which incorporate the Title 51 requirements regarding CHSF, are discussed in the following subsection.[27]

Federal regulations elaborate on the national legislature's directives found in the U.S. Code, as discussed above. Title 14 of the Code of Federal Regulations (CFR) lists all rules and regulations promulgated by the FAA, within that title, parts 400 to 499 of Chapter III regulate commercial space endeavors. Parts 400-401 present general organizational considerations, while parts 404-406 address procedural concerns. The remainder of the chapter discusses commercial space licensing as summarized in Table 1.

Part	Topic of Regulation
413	General licensing requirements
414	General safety approvals
415	Launch licenses
417	Expendable launch vehicle: launch safety
420	Launch site operation
431	Reusable launch vehicle: launch and reentry safety
433	Reentry site operation
435	Non-reusable* launch vehicle: reentry safety
437	Experimental permits
440	Financial Responsibility
460	Human space flight

Table 1. Summary of Commercial Spaceflight Regulations from Title 14 of the Code of Federal Regulations.

**Note, the regulations use the terms "re-entry vehicle other than a reusable launch vehicle" and "expendable launch vehicle" but the authors find "non-reusable" a much less cumbersome term.*

V. EVALUATION OF CURRENT REGULATIONS

An evaluative approach to any topic requires an objective metric, but it's important to note that in the case of policy considerations, very little objective data exists.[28] The methodology pursued by the authors involves evaluating the current regulations through the FAA AST's self-stated goals, in order to provide suggestions and perspectives on the future of CHSF regulations. The following is the list of AST objectives used to draw conclusions:

- Regulate the U.S. commercial space transportation industry, to ensure compliance with international obligations of the United States, and to protect the public health and safety,

safety of property, and national security and foreign policy interests of the United States;
- Encourage, facilitate, and promote commercial space launches and reentries by the private sector;
- Recommend appropriate changes in Federal statutes, treaties, regulations, policies, plans, and procedures; and
- Facilitate the strengthening and expansion of the United States space transportation infrastructure.[29]

The following section looks at each AST objective in detail and assesses whether the current regulations help in achieving the intended goals, or points out potential areas of expansion.

V.I Objective 1: Regulate CHSF Industry

There are four stated purposes to explain why the AST regulates the CHSF industry; to fulfill international obligations, to protect public health and safety, to protect property, and to facilitate the United States' national security and foreign policy interests. First, in general, the international *corpus juris spatialis* is fulfilled by the current regulations. As mentioned above in Section III, the major international obligations include launching state responsibility for commercial space activities, liability for harm, and registration of space objects.

Because the American state has assented to the terms of these international treaties, the government has attempted to minimize its risk by requiring licenses and permits for certain space activities. In any situation where the United States could be considered a launching state a license or permit must be obtained, as stated in 14 C.F.R. §413.3. In regards to the liability obligation, each licensee or permitee holds financial responsibility for their activities as specified in 14 C.F.R. §440. Regulations for registering space objects can be found in 14 C.F.R. §417.19 and §431.85.

Second, the current regulations consider various aspects of public health and safety. There are widely varying definitions of public health and safety, but in general, it can be defined as what society does to ensure the conditions for people to be healthy.[30] To protect public health, the FAA requires an environmental impact review to be done prior to getting a license. In addition, a safety approval is required before a licence is granted. The safety approval assesses safety for public health and safety as well as property protection.

The final purpose of the AST's regulation is to ensure compliance with foreign policy and national security interests. As part of the licensing and permitting process, the FAA conducts a policy review to "determine whether it presents any issues affecting U.S. national security or foreign policy interests, or international obligations of the United States."[31] As part of the policy review the FAA consults with the appropriate agencies: Department of Defense, Department of State, NASA, and others. In addition, the FAA maintains discretion to modify license/permit terms upon renewal as necessary to protect U.S. national security and foreign policy interests.[32]

V.II Objective 2: Encourage Private Sector

The second objective of the AST's goals is to encourage, facilitate, and promote commercial space launches and reentries by the private sector. This is a fraught issue as definitions for "encourage, facilitate, and promote" in the context of government's relationship to the private sector are subjective in nature. In this particular evaluation, the authors list ways a government could incentivize private sector activity and compare it with the current FAA regulatory scheme.

Incentives can be applied by different levels of government. In the American system, the federal government, the state governments, and the local and municipal governments have different spheres of regulation, although there is some overlap. The focus of this paper is on specific incentives that can be implemented by the federal government. General categories of incentives include: economic, infrastructure, and relational.

Economic incentives such as tax breaks (including credits, exemptions, and deductions), grants, and loans (both subsidized and unsubsidized) can function to encourage or discourage certain activities and behaviors. One reason for using economic incentives is to help developers lower the cost-to-consumers, allowing more people access to the industry's services, and thus promoting the development of the industry.

Infrastructure incentives that the government could provide include providing less costly access for companies to government launch facilities, creating government markets for the proposed products, and promoting research and development activities. As mentioned above, for example, NASA's COTS program funds new commercial companies to bring American astronauts to the ISS, thus creating a government consumer for the private industry's product.

Relational incentives help build the relationships between the government and industry partners. The government could join public-private partnerships (PPP). PPPs are "[…] the joint approach [that] allows the public sector client and the private sector supplier to blend their special skills […] to achieve an outcome which neither party could achieve alone."[33] In the United States, PPPs are not as common as in other locations, but they are growing in popularity.

Besides government incentives, the FAA's current regulatory approach in encouraging the CHSF industry through regulation has attempted to provide just enough regulation to allow the development of sound business plans, while not being overly burdensome and stifling

creativity and innovation. Toward this end, the atmosphere created by the FAA is one of collaboration, where the regulations outline several processes in place to help spacecraft developers navigate the permitting and licensing process. For instance, before applying for a permit or license, a pre-consultation with FAA officials helps companies map the road to a license or permit; additionally applicants are afforded multiple opportunities to update and correct documentation, and are continually able to ask agency officials for clarification regarding the process.

V.III Objective 3: Recommend Policy Changes

The third objective of the FAA is to recommend policy changes as needed. Congress is the main policy maker according to Article I of the US Constitution, thus offering general direction for the nation and setting priorities. All executive and independent agencies carry out Congress's policy directives and also make policy recommendations that Congress is free to accept or ignore. The FAA, as an executive agency, carries out the directives set out by Congress in Title 51 of the U.S. Code, and also makes recommendations to Congress as needed. When considering both regulation and policy recommendations, FAA takes into account the views of industry, through a variety of processes. In the context of this evaluation of the CHSF regulations, this objective is not designed to be met through regulations, and therefore this criterion is not applicable.

V.IV Objective 4: Strengthen & Expand Infrastructure

The infrastructure required to run a space transportation venture is fairly extensive and complex. The physical infrastructure required includes the launch complex and operations center, ground support equipment, testing facilities, mission operations center, communications and data network, supporting management facilities and offices, a transportation system (for equipment and personnel), and production facilities.

To strengthen and expand space transportation infrastructure, the regulations should address each of the infrastructure needs. One of the ways the FAA has facilitated space transportation expansion is in issuing grants to support the development of spaceports around the United States under their Space Transportation Infrastructure Matching Grant.[34] To date, eight spaceports around the country have been granted a launch site operator license.[35] Though originally, a license for launch site operation was solely a government practice, the legislation has been updated to allow for licensing of commercially operated launch sites. The regulations in 14 C.F.R. §420 detail the scope, process, and applicability of the rules that an operator must comply with to obtain a license.

VI. DISCUSSION

Evaluating the current regulations in light of the goals of the FAA provides one perspective to address the efficacy of the regulations. This goal-centered perspective may not fully address all concerns for regulation development. The authors look at additional considerations that may affect the CHSF industry in the following section.

VI.I Business Concerns

A possible deterrent for building a clear business model is determining when a company is allowed to charge passengers for their flight. The regulations state: "Before receiving compensation or making an agreement to fly a space flight participant, an operator must satisfy the requirements of this section. An operator must inform each space flight participant in writing about the risks of the launch and reentry, including the safety record of the launch or reentry vehicle type."[36] Though the regulations allow an operator to charge after an informed consent form is signed, it is not clear at what point in the process this occurs. For example, do companies have to require informed consent from all potential participants and those that are just 'shopping'. In addition, how frequently must the forms be updated for current passengers; or put another way, do the forms expire? If a spaceflight participant signs a consent form several months before his/her flight, will he/she need to sign a new one reflecting the latest launch vehicle safety records?

Another concern is that regulations are too specific, including one requiring launch operators to know the vehicle safety record of "all launch or reentry vehicles that have carried one or more persons on board, including both U.S. government and private sector vehicles."[37] Having a detailed log of other launch vehicles safety records can be unnecessarily burdensome and may not be meaningful information for the spaceflight participant.

VI.II Terminology

One aspect of the CHSF infrastructure includes standardized definitions for general terms used in contracts and agreements. Standardized definitions are important in understanding and stating obligations of each party within a contract or agreement. Space flight terminology comes in many flavors and has several influences from different corners of the space industry. For example, there are several definitions for "launch vehicle," depending on the specific document reviewed. The recommendation here is to establish standardized terminology that can be easily understood by all stakeholders in the process. Even at this stage, the definition of "outer space" and its specific demarcation is not well-established. The airspace above the United

States is controlled up to 60,000 feet.[38] It is unclear whether the activities occurring above that altitude are part of the suborbital regime and would then fall under the international Outer Space Treaty. There are several contentious reasons for its lack of established definition, but regardless, this is a term that must be defined for clarity on future space activities.

Another critical definition that must be clarified is the meaning of a "space flight participant," as opposed to crew or astronauts. States party to the OST have the obligation to ensure the safe and timely return of astronauts to the State of registry of their space vehicle. But if a space flight participant or crew member is not considered an astronaut, the implication is that states do not have an obligation to return them or render them immediate assistance. Though the intent of cooperation and collaboration regarding space activities would not be upheld, it may be something that needs to be clarified through the legal framework and agreed upon by all countries interested in providing protection to their space flight participants. Logistics regarding how a commercial enterprise will retrieve its crew and passengers should be required prior to a launch. Though in the case of suborbital flights, this may not be as critical, similar flight plans and back-up scenarios should be developed to ensure the safe return of all people aboard the spacecraft.

VI.III Spacecraft Design

Another major area that has limited regulations, thus far, is the vehicle design and its impact on crew and passenger safety. Even with decades of experience in human spaceflight, the Columbia Space Shuttle disaster illustrates the dangerous and highly complex nature of space flight. The question arises as to what regulations should be enforced to ensure a safe and reliable vehicle. Though arguably the spacecraft developers consider these regulations as additional burden to their already difficult task, and could hinder the industry development. It is important to consider what type of safety considerations should be in place to ensure safety of all participants.

NASA brings a plethora of standardized design practices for human space flight that can be used as the basis for many of the design requirements. NASA's Human Integration and Design Handbook[39] documents detailed requirements for the type of cabin environment that should be provided for optimal human performance including lighting schemes, the type of molecular composition of the cabin atmosphere, the optimal noise and vibration ranges, and temperature and humidity ranges that are most comfortable for humans. For short flights, the more important considerations include cockpit design, and displays that a pilot would use during launch and re-entry. Human factor engineering aspects are captured to provide guidelines for designers on the optimal display settings and designs. This area is a consideration for future regulation. The FAA could follow NASA's lead in providing guiding documentation for human spacecraft design.

Beside infrastructure, personnel, and space vehicle design, there are several other considerations that need to be captured as future regulations for the CHSF industry. Additionally, an important aspect for regulation development is the timing and manner of implementation. Regulations are often implemented after a serious accident. For example, in the famous Ford Pinto case, regulations regarding the placement of the fuel tank came about as a result of the public outcry caused by several high-profile accidents and consumer watchdog reports.[40] But at this stage of the industry's life, it is too early to impose stifling regulations that could curtail innovation and creativity.

VII. CONCLUSION

With the rise of commercial human spaceflight, there is a growing need for government support to encourage and promote the industry. Thus far, the human commercial spaceflight industry has not "taken- off" as was expected. A major reason for this lack of development is the fact that quite simply, this is rocket science. Spaceflight develops slowly. But this allows a little time for the FAA and other governing bodies to better explore future options with regulations and maintain a fine balance between promoting the industry and stifling industry growth through over-regulation.

VIII. ACKNOWLEDGEMENTS

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IX. REFERENCES

[1] 51 U.S.C. §50901 (b)(3).

[2] For an in-depth explanation of the significance of these three decisions, see Cannon, R. The Legacy of the Federal Communication Commission's Computer Inquiries. 55 *Federal Communications Law Journal* 167 (2003).

[3] Within the context of telecommunications the disparate regulatory scheme made sense, as the FCC's goal was to prevent (another) monopoly takeover of the new data industries. At that time, AT&T was the powerful wireline phone carrier that could cross-subsidize its entry into data processing and using its already massive size to crowd out new competitors. Thus, the FCC arguably made the correct decision to create differing regulatory schemes that did not apply to new entrants to the market.

[4] Cannon, R. The Legacy of the Federal Communication Commission's Computer Inquiries. 55 *Federal Communications Law Journal* p. 205 (2003).

[5] As of September 2012, eight states have active launch site operator licenses. Two sites are in California, two in Florida, and one each in New Mexico, Alaska and Virginia. Several

other sites are in the process of applying for a site operator license. See FAA AST Active Commercial Space Licenses. http://www.faa.gov/data_research/commercial_space_data/current_licenses/http://www.faa.gov/about/office_org/headquarters_offices/ast/launch_data/current_licenses/ Accessed 10 September 2012.

[6] Flink, J. J. *America Adopts the Automobile, 1895-1910*, MIT Press Cambridge, MA, pp. 166, 174-5, 186. (1970).

[7] Shapiro, David M., Casenote, *Insurance Co. of North America v. Pasakarnis, 451 So. 2d 447 (Fla. 1984)*, 12 Fla. St. U. L. Rev. 669,670 (1984).

[8] Department of Transportation. Federal Motor Vehicle Safety Standards and Regulations, part 571. http://www.nhtsa.gov/cars/rules/import/fmvss/index.html. Accessed 20 June 2012.

[9] *See generally* Title 49 of the Code of Federal Regulations, in part 571.

[10] 49 U.S.C. §30101.

[11] Digital History: Pacific Railway Act. http://www.digitalhistory.uh.edu/disp_textbook.cfm?smtID=3&psid=4004 Accessed 11 September 2012.

[12] See the FAA's website for a history of American aviation, including a text version and a PowerPoint presentation: http://www.faa.gov/about/history/brief_history/#origins and http://www.faa.gov/about/history/historical_perspective/. Accessed 1 July 2012.

[13] This value is based on the listed prices of the four principle Everest guiding services in the United States: Alpine Ascents International (AAI), Rainier Mountaineering Inc. (RMI), International Mountain Guides (IMG), Mountain Madness, and Mountain Trip.

[14] Fountain, H. (2007), "*In Climbing Everest, Survival Rates Favor 40-and-Under Crowd"* (2007). http://www.nytimes.com/2007/08/21/science/21obclim.html. Accessed 12 June 2011.

[15] These findings suggest there is a strong potential market for an "extreme" activity like commercial spaceflight, particularly if prices drop below the $100,000 range. Indeed, one such commercial operator, XCOR Aerospace, is already marketing sub-orbital flights for $95,000, a price that is a similar order of magnitude as a typical Everest expedition. *See* http://www.xcor.com/contact/ticket.php. Accessed 14 June 2012.

[16] *See*, for example, an application at http://www.alpineascents.com/pdf/application-print.pdf Accessed 12 September 2012.

[17] ScubaSite.com Scuba Diving Accident Statistics. http://www.thescubasite.com/Scuba-Diving-Resources/scuba-diving-accident-statistics Accessed 11 July 2012.

[18] PADI Worldwide Corporate Statistics 2011. http://www.padi.com/scuba/uploadedFiles/Scuba_--Do_not_use_this_folder_at_al/About_PADI/PADI_Statistics/2011%20WW%20Statistics.pdf. Accessed 18 June 2012).

[19] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. Available online at http://www.oosa.unvienna.org/*oosa*/SpaceLaw/outerspt.html. Accessed 20 January 2012.

[20] For more information on state responsibility, see Spencer, R.L. State Supervision of Space Activity. 63 Air Force L.Rev. 78.

[21] 51 U.S.C. §50903(a)(1),(2).

[22] 51 U.S.C. §50905 (a)(2).

[23] 51 U.S.C. §50905 (b)(2)(C).

[24] 51 U.S.C. §50905(b)(4).

[25] 51 U.S.C. §50905 (b)(5).

[26] 49 U.S.C. §322.

[27] Of course, the FAA is not the only regulatory agency with power to affect CHSF endeavors. Because commercial endeavors are commercial by definition, the Internal Revenue Service has authority to collect taxes from the company, and the Equal Employment Opportunity Commission can look into employment discrimination reports, while several other agencies have authority over other aspects of the business side of CHSF. However, because these authors are is interested in safety regulations, this paper will focus on the FAA's specific regulations for commercial human spaceflight.

[28] There is a difference of approach between scientific investigation and policy consideration, where science draws conclusions from objective experimental data, while lawyers find supporting data to "encourage" others to adopt their policy position.

[29] FAA AST About the Office. http://www.faa.gov/about/office_org/headquarters_offices/ast/about/. Accessed 29 August 2012.

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[31] 14 C.F.R. §415.23 (2012).

[32] 14 C.F.R. §413.23 (2012).

[33] Akintoye, A., Beck, M., Hardcastle, C. (ed). *Public-Private Partnerships Managing risks and opportunities.* Blackwell Science Ltd., UK. 2003.

[34] FAA AST. *2011 U.S. Commercial Space Transportation Developments and Concepts: Vehicles, Technologies, and Spaceports.* http://www.faa.gov/about/office_org/headquarters_offices/ast/media/2011%20devcon%20report.pdf. Accessed 6 September 2012.

[35] FAA AST Active Commercial Space Licenses. http://www.faa.gov/data_research/commercial_space_data/current_licenses/. Accessed 10 September 2012.

[36] 14 C.F.R. §460.45(a) (2012).

[37] 14 C.F.R. §460.45(c) (2012).

[38] FAA Order JO 7400.2J February 9, 2012 Procedures for Handling Airspace Matters. Chapter 14. Designation of Airspace Classes. Available athttp://www.faa.gov/air_traffic/publications/atpubs/AIR/air1401.html. Accessed 11 September 2012.

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