



Ariel Dynamics Inc. Media Library - Video

Human Factors



Code	adi-vid-01020
Title	Human Factors
Subtitle	Analysis of Motion in Space
Description	Analysis of human movement in space at the NASA Johnson Space Center, Texas.
Subject	NASA;Science;Space
Duration	00:07:29
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Synopsis



The video discusses the importance of special equipment in protecting football players and astronauts in their respective harsh environments. It highlights the role of NASA's Anthropometry and Biomechanics Lab in designing protective gear for astronauts. The lab studies the human body's measurements and movement, and uses this data to understand the limits of human strength, power, and endurance. This information is crucial in designing equipment for astronauts, including spacesuits and living areas inside spacecrafts. The lab uses an integrated biomechanics data acquisition system, consisting of dynamometry, electromyography, force plates, and 3D motion mechanics, to gather data. This data is then used to design equipment that can withstand the harsh conditions of space. The lab has played a significant role in the design process for NASA's next-generation space station EVA suit and is also involved in the development of a lunar suit and the Mars space suit.

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Audio transcription

Frame	#	Time	Spoken text
	0.	00:00:00	<i>A lot of time and thought goes into improving a football player's chance of survival in</i>
	1.	00:00:20	<i>such a violent sport.</i>
	2.	00:00:30	<i>Special equipment helps the player adapt to the hostile elements of the playing field.</i>
	3.	00:00:36	<i>Since the human head wasn't meant to crash into other objects, it didn't physically evolve to withstand such a force.</i>
	4.	00:00:43	<i>So, the helmet was designed.</i>
	5.	00:00:46	<i>Years of improvement have refined the helmet to where it protects a player on the playing field.</i>
	6.	00:00:52	<i>The harsh vacuum of space is another environment where the human body is not designed to function.</i>
	7.	00:00:58	<i>But special equipment has allowed humans to exceed the limitations of their bodies.</i>
	8.	00:01:04	<i>Since space is more unforgiving than the grid iron, the equipment which protects humans there must be designed with intricate precision.</i>
	9.	00:01:13	<i>Each individual body must be measured, tested and examined here on Earth in order to design a suit which will protect it in space.</i>
	10.	00:01:22	<i>At NASA's Johnson Space Center, the Anthropometry and Biomechanics Lab investigates many of the biomechanics issues that go into the human factors design of protective space gear for astronauts.</i>

Frame	#	Time	Spoken text
	11.	00:01:35	<i>The lab's name clearly describes its function.</i>
	12.	00:01:38	<i>Anthropometry is the measurement and classification of the human body.</i>
	13.	00:01:43	<i>Biomechanics is the study of how living creatures move the way they do.</i>
	14.	00:01:48	<i>When designing equipment for astronauts to use in space, the limits of skeletal muscle strength, power and endurance must be understood in order to plan realistic EVA performance.</i>
	15.	00:02:01	<i>Data concerning these areas is collected in several different settings by the Biomechanics Lab.</i>
	16.	00:02:06	<i>In the controlled one gravity setting of the ABL itself, in the neutral buoyancy of the weightless environment training facility,</i>
	17.	00:02:15	<i>on the two-dimensional zero gravity of the precision air bearing floor,</i>
	18.	00:02:20	<i>and in the actual three-dimensional zero gravity, created aboard the KC-135 research aircraft.</i>
	19.	00:02:28	<i>This data is then fed back to the engineers who designed spacesuits for extra-vehicular activity, also the living area inside a spacecraft,</i>
	20.	00:02:38	<i>and the soon-to-be-built space station freedom.</i>
	21.	00:02:42	<i>The bulk of ABL's operational investigations are requested by the Crew and Thermal Systems Division, which develops spacesuits,</i>
	22.	00:02:50	<i>the EVA Crew Training Branch, which plans astronaut training, and the Space Biomedical Research Institute, where space preventative medicine is developed.</i>
	23.	00:03:00	<i>In addition to collecting anthropometry measurements for all astronaut candidates,</i>
	24.	00:03:05	<i>the ABL has also played a major role in the design process for NASA's next-generation space station EVA suit.</i>
	25.	00:03:13	<i>Both the Mach 3 and the AX5 prototype space station suits have undergone extensive testing by the ABL.</i>
	26.	00:03:21	<i>The lab is also involved in the development of a lunar suit and the Mars space suit.</i>
	27.	00:03:27	<i>To gather this information, the ABL uses an integrated biomechanics data acquisition system.</i>
	28.	00:03:35	<i>This system consists of four components, dynamometry, electromyography, force plates, and 3D motion mechanics.</i>
	29.	00:03:44	<i>Let's look at each a little closer.</i>
	30.	00:03:48	<i>Dynamometry measures mechanical forces and torques using the Cybex dynamometer, the hand-grasp breakaway,</i>
	31.	00:04:03	<i>and the treadmill.</i>
	32.	00:04:05	<i>With the Cybex, researchers can determine the mechanical power an astronaut is able to exert in various body positions.</i>
	33.	00:04:13	<i>The hand-grasp breakaway device measures the maximum force it takes to pull an object out of a person's hand.</i>
	34.	00:04:21	<i>Information gathered with this piece of equipment helps designers to make sure the astronaut's hand will let go of an object before the suit ruptures.</i>
	35.	00:04:31	<i>A load cell instrumented treadmill is used to measure the impact forces acting on the body's skeleton during locomotion.</i>
	36.	00:04:38	<i>It produces information concerning lower torso mobility limits, which can be incorporated into designs for a Mars lunar suit.</i>
	37.	00:04:47	<i>The treadmill can be used in both the ABL and the KC-135.</i>
	38.	00:04:53	<i>Moving about in a pressure suit is hard work, so muscle endurance is important.</i>
	39.	00:04:59	<i>Through electromyography, an electrode can be used to monitor the electrical activity of a specific muscle, such as the timing and sequence of contractions.</i>
		40.	00:05:08
41.		00:05:15	<i>First plates are another method of testing used at the ABL.</i>
42.		00:05:19	<i>They register the X, Y, and Z reaction forces in moments that are exerted around the plate.</i>
43.		00:05:27	<i>This helps determine how factors such as force, vibration, sound, and material strengths affect design.</i>
44.		00:05:35	<i>All of this is important when determining how strong or how weak a certain piece of equipment needs to be.</i>
45.		00:05:42	<i>One of the more recent additions to the ABL is the Ariel performance analysis system.</i>
46.		00:05:48	<i>The Ariel is actually a computer that works in conjunction with a video player and monitor.</i>

Frame	#	Time	Spoken text
	47.	00:05:54	<i>Through frame-by-frame analysis, body joints are manually digitized from video recordings.</i>
	48.	00:06:00	<i>The points can then be graphed and analyzed, or used to create an animated figure.</i>
	49.	00:06:06	<i>This helps determine how far the subject can stretch his or her arms.</i>
	50.	00:06:11	<i>We call this the distance reach envelope.</i>
	51.	00:06:15	<i>The anthropometry and biomechanics lab is the only facility of its kind.</i>
	52.	00:06:22	<i>While other labs may specialize in one area, JSC has the instrumentation and expertise to conduct human factors we search simultaneously in all four areas we discussed.</i>
	53.	00:06:34	<i>With assets like the ABL and the specialists who work there, NASA is adapting humans to the hostile environment we call space.</i>
	54.	00:07:21	<i>NASA Jet Propulsion Laboratory, California Institute of Technology</i>

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