**Human Factors Scenario Based Examination Questions**

**Brian Peacock, April 7, 2013**

# Introduction

# The old Chinese proverb: “Tell me and I'll forget; show me and I may remember; involve me and I'll understand” is incomplete. It is appropriate to add “test me and you’ll know that I understand” to complete the educational process of evaluation, assignment of credit, certification and licensing. There are various descriptions of human knowledge and abilities that may be assessed during or after a period of instruction or learning as in a college course. First, Bloom described a hierarchy of cognitive abilities: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation, later the ability to Create was added to this list. Reason described knowledge, rule, and skill based behavior as a progression from novice to expert. A third classification (Hanchana) of human abilities is cognitive (knowledge), affective (emotional, attitude) and psychomotor (physical skills). Specific application of these concepts to the development of tests usually involves the use of key words, many of which are found in articles about the Bloom taxonomy.

1. Scope

In the context of a general human factors course it is appropriate to teach and test a broad spectrum of knowledge, to require students to apply this knowledge, and to use their acquired knowledge in the processes of analysis, synthesis, evaluation and creativity. The broad scope of human factors or ergonomics is articulated clearly in the Edwards SHEL model. The “liveware” element of this model includes physical (anthropometry, biomechanics, physiology, motor skills), informational (sensory processes, attention, perception, memory, and various aspects of cognition, communication and control.) Next it is appropriate to address contextual factors such as the physical, operational and social environment that may be amenable to mitigation if not design. Finally, in the applied context of human factors, it is appropriate to address the design of technology (hardware and software) and processes (the interactions between people and technology,) to match the human physical and information handling capabilities and limitations described earlier. Extensions of human factors into the affective domain require that designed systems and processes should be likeable and motivating.

1. Approach to scenario based examination questions
	1. These questions usually address the higher levels of cognitive skills
		1. Apply, Analyze, Evaluate, Develop
		2. They also reflect the lower levels of Knowledge and Comprehension / Understanding
		3. Design and Create are usually assessed outside the examination room
	2. Read the questions
	3. If there is a choice, select those questions with which you feel most comfortable.
	4. Check the time available and allocate an appropriate amount of time to each question: no answer no marks!
	5. Underline or circle key words:
		1. Verbs – what you have to do
		2. Nouns – the particular context, what you must produce
		3. Tools - the identified HF process
	6. Develop a concept map (mind map), list or other framework of your answer
		1. Use the blank left hand sheet in the answer book
		2. This is not a formal part of your answer, but the examiner may be impressed by your systematic approach to the problem
		3. Use this framework to structure your answer
	7. Check that you have chosen the best questions to answer
	8. Respond to every key word in the question
	9. Compile your answer
	10. Read your answer
	11. Modify or amplify where necessary
	12. Leave time at the end of the exam to reread your answers and correct / modify where necessary
	13. For example if your exam has 10 short questions to be answered in 2 hours, you should allocate 10 minutes to a preliminary read through (120 – 10 = 110), 2 minutes planning your answers (110 – 2 X 10 = 90), 8 minutes for each answer (90 – 8 X 10 = 10) leaving10 minutes at the end to check your answers. Of course there will be some variability, but not too much, remember no answer no marks!
2. Given this background the following scenario based examination questions, which address scope, breadth and depth, will be analyzed and discussed:
	1. Physical Ergonomics
		1. Anthropometry and workplace design
			1. *Describe how you would obtain and apply anthropometric and operational data to design and evaluate an auditorium to seat 100 students.*
				1. *Data collection*
				2. *Data analysis*
				3. *Design approach*
				4. *Design evaluation*
			2. *Repeat for a computer workstation, supermarket checkout, bus driver’s cockpit*
		2. Biomechanics and manual materials handling
			1. *Analyze epidemiological and incident report evidence as a basis for the redesign of an airport baggage handling process*
				1. *Injury reports*
				2. *Incident reports*
				3. *Process design*
				4. *Stage manual handling activities (Passenger, check in clerk, baggage handler)*
				5. *Physical layout(s), equipment, handling aids*
				6. *Motions and moments analysis*
				7. *Design recommendations*
			2. *Repeat for UPS / FedEx driver, Park / garden maintenance worker*
		3. Physiology and job design
			1. *What methods would you use to assess and manage the physiological stress of a waitress in a busy restaurant that serves meals from 6 am to midnight?*
				1. *List the methods:*

*Physiological: oxygen consumption, heart rate, body temperature*

*Discuss process, and ease of use*

*Reported stress (Borg scale)*

*Incident reports*

*Interviews and focus groups*

*Diaries*

*Shift schedules*

*Rest breaks*

*Job rotations*

* + - * 1. *Repeat for security guard, nurse, professional athlete*
		1. Psycho-Motor Skills
			1. *You have been asked to manage the line balance of an electronics equipment production line, given a high turnover of operators. Discuss what steps you would take to measure the individual task elements, group them into feasible, balanced tasks, assign tasks according to motor skill ability and redesign the product to facilitate assembly.*
				1. *Operations flow / sequence chart*
				2. *Micro motional analysis*
				3. *Element grouping*
				4. *Individual skills assessment*
				5. *Job cycle design*
				6. *Task assignment*
				7. *Training, job rotation and job enlargement implementation*
				8. *Product and process evaluation to redesign assembly tasks– target size, postures and motions, forces, visual conditions, error checking and error proofing*
			2. *Repeat for food preparation employees, drivers*
	1. Information Ergonomics
		1. Sensory factors
			1. *Many tasks such as reading instructions, fine assembly and inspection work or complex tasks such as driving depend on good visual performance which is facilitated by good lighting. Describe how visual acuity is affected by individual differences and lighting conditions. Describe how visual acuity and lighting can be measured. How would you design a facility for hand phone repair?*
				1. *Eye anatomy and function*
				2. *Visual acuity measurement*
				3. *Lighting and acuity*
				4. *Lighting environment design*

*General and local task lighting*

*Glare factors*

*Color factors*

* + - * 1. *Work station design, including postures and lighting*

*Vision aids*

* + - * 1. *Selection and job design*

*Knowledge and visual capability*

*Rest pauses*

* + - 1. *Repeat for proof reader, driver, classroom, lighting*
		1. *Attention*
			1. *You have been asked to investigate and evaluate the performance of security guards in a shopping mall. Describe how you would measure behavior, performance and vigilance decrement. How would you redesign the job to raise the level and increase the sustainability of performance?*
				1. *Task analysis*
				2. *Behavior measurement*
				3. *Performance measurement*
				4. *Vigilance decrement measurement*
				5. *Reliability*
				6. *Resilience under abnormal conditions*
				7. *Design, including technology, operations and training.*
		2. *Repeat the exercise for customs and immigration officers, drivers, pilots, air traffic controllers, process controllers*
		3. Perception
			1. *Our perception and understanding of the meaning of information presented to us through our eyes or ears requires that that information is matched with some more or less sophisticated template, set or framework. As we gain familiarity with the information source, form and content our perceptual capabilities increase and our understanding improves. So perception and understanding require a coincidence of external information and an internal framework. Where mismatches occur we may see or hear what we expect to see or hear, which may lead to perceptual errors or illusions.*
				1. *Describe the challenges of a conversation in a foreign language*
				2. *How does redundancy improve perception and understanding?*
				3. *When we look at a mathematical model how do we visualize the physical realization of that model?*
				4. *When we see the face of a person in a crowd how do we recognize it as belonging to a friend or acquaintance? Why do we sometimes make recognition mistakes?*
				5. *When we read or listen to complex instructions, such as how to go to a location in a strange town or campus, how to operate the ATM, how to taxi back to the ramp in a strange airport, how to make a meal or how to assemble new piece of furniture, why do we make mistakes?*
				6. *What are illusions? Describe some examples of illusions.*
				7. *Suggest ways in which misperceptions can be prevented:*

*By improving the perceptual set or eliciting the correct set by preamble*

*By improving the message content*

*By adding redundancy*

* + 1. Cognitive factors
			1. *Driving a car, flying an airplane and cooking a meal all require continuous attention to changes in the operational environment, recall of procedural knowledge, ongoing operational memory and situation awareness, decision making, control and communication inputs, and outcome monitoring and evaluation. Describe the operational and cognitive demands required to make a meal. Analyze the opportunities for error. Identify the cognitive resource(s) responsible for the errors. Suggest ways of preventing errors, detecting errors and mitigating the effects of errors.*
				1. *Describe operational sequence*
				2. *Describe cognitive demands*
				3. *Analyze error possibilities*
				4. *Identify cognitive resource basis for the error*
				5. *Suggest ways of preventing errors by materials, equipment or process design*
				6. *Suggest ways of detecting errors and intervening to reduce the effect of error (mitigation)*
			2. *Repeat for driving, flying, crane operation, exam script grading*
		2. Memory
			1. *Operational memory requires the retention of pertinent facts and procedures as a task is conducted. The capacity of operational memory is limited. Irrelevant information is discarded. Relevant information may be retained by rehearsal. Failure of operational memory is often due to interference from competing sources or overload. Analyze your use of operational memory for a series of your daily tasks.*
				1. *Identify the information sources*
				2. *Estimate the duration of retention*
				3. *Describe competing / interference sources*
				4. *Specify the required outcome*
				5. *Analyze the causes of forgetting*
				6. *Design memory aids for each task*
			2. *Repeat for a call center / help desk operator, shopping*
		3. Situation awareness
			1. *Situation awareness is a necessary human capacity (and limitation) in flying an airplane, controlling an electricity generating plant or playing a game of football. The key components of situation awareness are perception, comprehension and prediction.*
				1. *Analyze a familiar sequence of events in a football (or similar) game.*
				2. *Identify the human resources needed to achieve and maintain situation awareness.*
				3. *Discuss the possible cognitive causes for lost situation awareness and the implications of this performance failure.*
				4. *Suggest ways of improving situation awareness by*

*Operator behavior*

*Task design*

* + 1. Communications
			1. *Communication is a key activity in most human activities. Communications may be between people or between people and technology. Communications may fail due to semantic or physical encoding, transmission, physical or semantic decoding, memory, lost information, added information or noise. Consider the context of an air traffic controller and a pilot or a restaurant client, waitress and a cook. Describe the nature of communications involved in approaching and landing at an airport or ordering and delivering a meal. Identify the opportunities for error, and their implications. Describe mitigation procedures when errors occur. Design a process to prevent errors in.*
				1. *ATC – Pilot communication*
				2. *Ordering at a restaurant*
		2. Control
			1. *Manual control operations involve inputs, external conditions, system outputs, time lags and feedback. Improved performance may be due to anticipation of external force effects, rule based adaptation to outputs or learning based modulation of inputs based on memory. Consider four scenarios*
				1. *Controlling room temperature by altering the amount of heating / cooling, or by setting a desired temperature and relying on automatic control.*
				2. *Driving a car or bicycle and keeping within the white lines in a road with many bends*
				3. *Landing an airplane by controlling heading, altitude and speed through adjustments to pitch, power, rudder and flaps*
				4. *Playing Angry Birds by manipulating trajectory and force*
				5. *Describe the control elements of these tasks, the opportunity for error, mitigation of error effects and design of equipment or procedures to prevent error.*
	1. Affective ergonomics
		1. Motivation
			1. *The motivation to carry out an activity is related to the payoff associated with success or failure in terms of effectiveness, efficiency, ease of use, emotional appeal, safety security, satisfaction and sustainability. There are always tradeoffs among the importance, likelihood and desirability of these outcomes. Often affective considerations dominate other outcomes. Consider the following scenarios:*
				1. *Going to the gym or out for a run every day. The activity may be uncomfortable, even painful, the time may be inconvenient, the immediate rewards may appear negative, but you know that the long term outcome is better shape, enhanced fitness and greater self esteem.*
				2. *Going to a restaurant and ordering an exotic and expensive meal or to a food stall and ordering simple chicken and rice. Both meals may have equivalent nutritional value but will vary considerably in cost.*
				3. *Buying an expensive gold Rolex or a $2 watch from a sidewalk stall. Both will tell the time accurately.*
				4. *Studying for a boring Human Factors exam or going out to the cinema with your friends.*
				5. *Discuss the informational and affective factors, and their weighting, that contribute to your decision in each of these cases*
		2. Attitude
			1. *The attitude to work may differ among company owners, who profit from high quality inexpensive products or services, and employees who get a fixed wage irrespective of deviations in quality and productivity. Discuss ways in which the attitudes of employees to work can be changed.*
			2. *The attitude of students to a course is related to course content, course difficulty, quantity of work, the delivery methods (lecture, seminar, eProcess or laboratory), the characteristics and behaviors of the lecturer and the perceived value of a grade in the course in the context of an educational program. Discuss ways in which students’ attitudes are affected and may be changed.*
			3. *How are your attitudes to a service from a waiter, bank teller, shop assistant, taxi driver affected by their behaviors over and above the functional delivery of the service?*
	2. Decision making
		1. *Decision making is an element of all human behavior and usually affects task performance. Decisions are made out of habit (rule based behavior), evaluation of the costs (effort, money etc.), consideration of all the consequences (negative or positive benefits), the likelihood of the outcomes given alternative decisions, and the opportunities to reverse or tolerate erroneous decisions. Consider the following decision scenarios*
			1. *Should you walk, ride your bicycle, take the bus or drive your car to work?*
			2. *Should you gamble or invest your savings if you know that the long run probability of losing is greater than that of winning?*
			3. *Should you drive faster than the posted speed limit if you know the likelihood of getting caught is remote and the penalty for getting caught is minimal?*
			4. *How are your decisions affected by the packaging and esthetic design of a product over and above the products function and reliability?*
	3. Contextual factors
		1. Physical Environment
			1. Heat
				1. *The thermal environment has a substantial effect on human comfort, behavior, performance, health and safety. Extremes of temperature can be fatal. Sub extreme temperatures are modulated by behaviors such as choice of clothing or physical activity, or physiological responses such as change in heart rate, cutaneous blood flow, shivering etc. These responses are dependent on the consumption of sufficient fluids and nutrients. A certain degree of acclimatization occurs in these physiological processes. External responses include shelter from radiant heat, fans to increase convective heat loss and heating and air conditioning to control temperature and humidity. Totally controlled micro environments may be observed in astronaut suits.*

*Describe how you would measure the thermal environment*

*Describe how you would observe the physiological responses to changes in the thermal environment.*

*Outline the design of a thermal environment protection program for outdoor workers in tropical regions.*

* + - 1. Light
				1. *Light is essential for visual performance. However the visual system is very adaptable to variations in lighting. Consider the contexts of recognition of color coded electrical wires, driving in the dark, reading labels and instructions on a medicine bottle or the placement of a computer monitor in an office.*

*Describe the major structures of the eye and their functions*

 *How would you measure visual acuity?*

*How would you measure color discrimination defects?*

*What are the effects of glare?*

*What is adaptation?*

*What is accommodation?*

*Develop guidelines for lighting in a computer repair shop.*

* + - 1. Noise
				1. *Sound may be defined as an acoustic signal generated at a source and received at the ear. Often these signals are meaningful and useful. However on other occasions they may be classified as noise – perhaps meaningful but contextually not useful. The ratio of signal to noise determines the effectiveness of a communication channel. Excessive sound levels cause temporary or permanent hearing damage. Consider the following scenarios:*

*A conversation in a busy restaurant*

*An emergency vehicle in busy traffic*

*Listening to music during a lecture*

*Communication between Air Traffic Control and a Pilot in the context of ambient airport / air plane noise and static (white noise)*

*Working in a bottle processing or metal fabrication factory*

* + - * 1. *How would you measure sound frequency and intensity?*
				2. *How would you measure hearing ability?*
				3. *What is the effect of aging on hearing?*
				4. *How would you protect workers from excessive noise in a factory?*
				5. *What are the essential elements of a hearing conservation program?*
			1. Vibration and acceleration
				1. *Mechanical vibrations can be harmful to anatomical structures and may interfere with performance and comfort. The vulnerability of anatomical structures is related to their size / mass and the frequency / intensity of the imposed vibrations. Accelerations may be described as sudden changes in velocity of an object or person. A jerk is a change in acceleration. Consider the following scenarios:*

*A bus or fork truck driver spends 10 hours a day driving a vehicle and being subject to “whole body vibration” through the seat (or feet if he is standing)*

*A forestry worker operates a chain saw all day*

*A foundry worker operates a chipping hammer to clean the flashings off castings*

*A construction worker operates a tampering machine all day long to compress asphalt repairs*

*A manufacturing employee uses a power drill or screwdriver all day while fastening components together*

*A passenger on a bus fell and was severely injured when the bus departed from the stop erratically*

* + - * 1. Answer the following questions
1. *How would you measure vibration?*
2. *How would you measure the effects of vibration on people?*
3. *How would you develop a guideline for the protection of workers from vibration transmitted from tools and vehicles*
4. *How would you prevent accidents due to jerks on public transport?*
	* 1. Operational context
			1. Time factors
				1. *Time is an inevitable contributor to all human experience. Time factors include the time to react to a signal, the time to complete a task, the time spent at work, the time to travel to work or abroad. The time of day and night when you are awake or asleep. How old you are, and so on.*
				2. *What factors affect your response time to a signal such as a traffic light?*
				3. *How long can you sit in a chair without moving?*
				4. *What are your usual waking / sleeping habits?*
				5. *Why do you feel fatigued after a period of physical (mental) activity?*
				6. *How long does it take to decide between two(or more) alternative choices or actions?*
				7. *How long can you focus on a boring lecture?*
				8. *How long should the shift be for an aviation security officer?*
				9. *Describe another 100 ways in which time affects your life*
			2. Autonomy
				1. *Many jobs such as those on a production line or in a call center do not allow the operator any discretion regarding his or her activities. The job cycle is precisely analyzed and prescribed. In other jobs external incidents dictate individual responses and actions. Some people have considerable autonomy regarding their activities although they are usually constrained by some required deliverables. Consider the following scenarios:*

*A pilot is landing an airplane, he can’t stop. How does he manage information, action and time?*

*A shop attendant or bank teller waits for the customer request before offering a response, usually from a rule based set of alternatives. How is his / her behavior affected by pressures for productivity and customer service?*

*How should a student manage his / her time between studying, projects, recreation and relaxation?*

*How should a person on a paced production line respond to a damaged tool or faulty materials?*

* + 1. Social Context
			1. Team behavior
				1. *A team is a collection of people with a common purpose that is usually achieved by cooperation. People normally work in teams of varying levels of structure. Team work normally requires communication, collaboration and situational leadership. Consider the following scenarios:*

*Air Traffic Control and pilots must operate as a team to navigate through congested airspace and land safely.*

*City car drivers must collaborate to avoid collisions.*

*A sports team assigns different role to different players at different times with the purpose of optimizing resources and winning the game.*

*A surgical team consists of a surgeon, assistant surgeon, scrub nurse, anesthetist and a patient. At various times different team members take leadership and decision roles, although the surgeon (or patient) may have the final say.*

*A project team in a university course may have assigned responsibilities, leadership roles and a requirement to collaborate in brainstorming for report / poster design ideas.*

* + - * 1. *Respond to the following questions:*

*How would you measure team behavior?*

*How would you improve team efficiency by allocation of duties?*

*How are difficult decisions made?*

* + - 1. Crew resource management
				1. *Crew resource management is a formalized way of managing team based activities with appropriate situational allocation of responsibilities. The concept of “resource” goes beyond the team members to include all the technological support facilities, such as maps, instruction books, computer simulations and so on. Develop concept maps to describe the human and technological resources in the following situations, show the key communication links:*

*Emergency approach and landing of an airplane*

*A search and rescue operation for a missing scuba diver*

*A food court*

*A study team*

* 1. Technology Design
		1. Mechanical aides
			1. *The development of the lever, wheel and pulley greatly expanded human abilities to perform mechanical work. The addition of mechanical power - internal combustion engine, steam and electrical- added another order of magnitude. Nuclear and solar energy add different opportunities and challenges. These inventions also produced control, efficiency, safety, security and sustainability questions.*
				1. *Sketch a lever, wheel and pulley, indicate the magnitudes and directions of the forces*
				2. *Compare the advantages and disadvantages of motor vehicles*
				3. *What are the costs and benefits of walking or riding on a bicycle, or in a car, bus or airplane?*
				4. *Discuss the issue of Inertia in crane design and operation*
				5. *Compare the advantages and disadvantages of manual and powered small tools*
		2. Sensory Aides
			1. *Immediate sensory aids include spectacles and hearing aids, however sensor technologies such as X Ray, radar, sonar, ultrasound, electrical conduction, electron microscope etc vastly expanded the human ability to observe great detail and at a great distance. The addition of computers to store, analyze and respond to the information from sensors and telecommunications to transfer this information are the foundations of automation and robotics. As with mechanical aids, the development of sensory aids brought questions related to efficiency, safety and security.*
				1. *List and describe the functions of as many sensing aids as you can*
				2. *Discuss the safety and security issues that these technologies bring*
		3. Information aides
			1. *Writing greatly extended the human ability to store information; the invention of the printing press expanded our abilities to communicate large amounts of information. The computer, telecommunications and recently the Internet, smart phones and tablets created another giant leap in information communication and analysis. But these devices bring significant challenges.*
				1. *Discuss the challenges of privacy created by contemporary information systems*
				2. *Discuss the challenges of system safety and security that a large information system failure would cause*
				3. *Develop a system to safeguard the information that you need for your job*
				4. *Should we use open or closed book exams? Explain your answer.*
		4. Interfaces
			1. Displays
				1. *Sensor technology uses displays to keep humans in the control loop. The clock tells us the time, a GPS display tells us where we are, a speedometer tells us how fast we are going, the tape measure and weighing scales tell us about our size and shape; road signs tell us where to go and the labels on the box tells us what is inside. Now the computer can translate, analyze, reduce and display any kind of information a meaningful form on a screen we can carry with us. Computers can also display integrated, representational, synthetic and predictive information. The next generation of displays will go straight to our brains and bypass our eyes and ears. Display technology has been the cornerstone of Human Factors and Ergonomics in the attempt to present the right information at the right time. HCI (Human Computer Interaction) is a major industry.*
				2. *Make a list of as many computer based and non-computer based displays you can think of*
				3. *Discuss the relevance of precision, accuracy and utility / pertinence of these displays.*
				4. *Examine what we would do without these displays*
				5. *Describe some criteria for display evaluation*
				6. *Describe the human challenges of too much information, and noise.*
			2. Controls
				1. *Controls allow us to communicate information to some external system. Handlebars and steering wheels control our direction. Switches turn the lights on, knobs and sliders turn the music up. Mice allow us to point, click and move a cursor on our computer screen. Key boards add enormous versatility to our abilities to send messages. As controls become more powerful the implications of a click of the mouse can be monumental.*
				2. *Discuss the issue of control display relationships*
				3. *What is a population direction of motion stereotype?*
				4. *Discuss the importance of the “back” button on a computer keyboard.*
				5. *What should be the diameter of a steering wheel?*
				6. *How big should a button be on a smart phone?*
				7. *What are the advantages and disadvantages of “word anticipation” software?*
		5. Facilitators: Instructions, labels, warnings, procedures
			1. *Typical facilitators include labels, warnings, instructions and procedures. A facilitator is a temporary device that allows us to understand how to interact with a system; with practice we can throw away the facilitator. Because the possible users of a system may range from the novice to the expert it is not wise to throw away the facilitator. Without facilitators the chance of an inappropriate human action is greater. Analyze the following scenarios:*
				1. *You arrive at the curb with the intention of crossing the street and avoiding the traffic. How useful are the traffic lights?*
				2. *You arrive at the store and find that all the commodities are packaged. How useful are the labels?*
				3. *You buy a “some assembly required” product. Should you throw away the instructions?*
				4. *You come across a man in the street having a heart attack. Somebody passes you an AED device. What should you do?*
				5. *How is color used to differentiate Danger, Warning, Caution and Information signs?*
				6. *What information should be contained in the label on a medicine bottle?*
	2. Process Design
		1. Time / operational factors
			1. Production lines
				1. *Production line offer a considerable improvement in productivity over traditional craft work, by having a sequence of well defined tasks carried out by highly trained (in a limited set of activities) operators. However paced production lines imply repetitive work that may be physically harmful and mentally numbing.*

*How would you assess a production line?*

*How would you develop a production line?*

*What are Work Related Cumulative Trauma Disorders?*

*What can be done to reduce repetition stress?*

* + - 1. *Shift work*
				1. *Shift work interferes with your Circadian Rhythms which are driven by Zeitgebers. This disruption is compounded by sleep loss. Adaptation occurs after a few days / weeks. Short term effects are interference with mood and performance and frequent changes can have serious domestic, social and health effects in the long term.*

*Make a list of occupations that involve shift work*

*What are circadian rhythms?*

*How can they be measured?*

*Why are one week rotations the worst schedule?*

*Compare long and short rotation schedules.*

* + - 1. Time stress
				1. *Time stress in physical work produces physical fatigue. Time stress in cognitive work reduces our ability to obtain and process information, time stress reduces situation awareness. In both cases the result may be “system failure” due to overload. Experts (physical and cognitive) can handle time stress better than novices. Optimal levels of stress produce optimal levels of performance. (Yerkes Dodson Law)*

*Describe some jobs that produce physical time stress*

*Describe some jobs that produce cognitive time stress*

*Describe technological and operational interventions for time stress.*

* 1. Human Factors Processes:
		1. All of the questions above may be addressed by Human Factors or Ergonomics specialist at any stage of the life cycle of HFE, from basic research to accident investigation. The profession has tools applicable to each of these stages.
		2. Research (methods)
			1. *HFE research involves the development and testing of general statements (laws) about human characteristics, capabilities, limitations, attitudes, behaviors and performance. The methods ideally involve “representative samples” of the target population, appropriate instruments, controlled experiments and statistical analysis of the data. Some brilliant examples of research products are the Weber Fechner Law, The Hick Hyman Law, Fitts Law, The Yerkes Dodson Law, The Drillis and Contini proportions and the NIOSH Lift Equation.*
			2. *List some more examples of laws that have been generated by Human Factors and Ergonomics researchers*
		3. Applied research
			1. *It is often argued that “Human Factors and Ergonomics” is an applied science. The difference between basic and applied science is that the former aspires to be general whereas the latter usually applies to a limited population in a constrained context. For example the research question “How do drivers behave when approaching traffic lights” is a specific subset of general behavior. Often applied HFE research takes place in field settings, such as the road, shop or in front of a computer.*
				1. *Identify applied HFE research topics in the areas of: workplace design, manual materials handling, airplane landing, consumer behavior, attention and vigilance, warnings design, team collaboration etc.*
		4. Simulation
			1. *Simulation is usually much less expensive and much more flexible that research in real conditions. The caveat is that of validity. For example the certification of the Airbus A380 depended on a demonstration of emergency evacuation. This demonstration was a very elaborate event. Taking four years to plan, costing millions of dollars to implement and causing injuries to some of the subjects. The demonstration only dealt with one configuration of door availability. An alternative approach is discrete event simulation which can explore many configurations and many variations of passenger behavior in just a few seconds. Of course the simulation model must be valid.*
				1. *Describe other uses of simulation in HFE applied research*
		5. Design
			1. *HFE is an applied subject that usually investigates the relationships between human behavior and technological designs. The purpose of HFE is to offer advice, based on good evidence to technology designers. Without technology there would be no need for HFE. Argue the case that Technology Design needs HFE*
		6. Evaluation
			1. *HFE often arrives on the scene after the technology has been developed and is on the market or about to be launched. The HFE practitioner walks in and “calls the designer’s baby ugly.” No wonder we are not always a popular profession. Ideally the HFE should work with the designer, engineer, manufacturing, marketing and where appropriate the regulatory bodies to ensure the product launched has an HFE stamp. This process however will require that the HFE practitioner is timely in his advice – “come back in six months when I have completed my experiments” - will not go down well. On occasion HFE practitioners get to manage the design process and sometimes wishes he was back on the other side of the table.*
			2. *Identify a range of consumer products and services; evaluate them for effectiveness, efficiency, ease of use, elegance, safety, security, satisfaction and sustainability.*
		7. Ergonomics Toolkit
			1. *The profession over the past few decades has developed a wide range of tools and techniques that are aimed at collecting reliable evidence and offering useful advice. These tools vary from sophisticated simulators to checklists and ethnographic observations. Describe and evaluate tools for each of the following areas of human factors and ergonomics:*
				1. *Physical*
				2. *Sensory*
				3. *Cognitive*
				4. *Social*
				5. *Behavioral*
				6. *Affective*
				7. *Environmental*
				8. *Temporal*
				9. *Performance assessment*
	2. Big Picture Ergonomics
		1. Complexity: People, Technology, Operations, Contexts
			1. *Describe the Edwards SHEL model*
			2. *Rearticulate the SHEL model*
		2. Integration: Interfaces, interactions, interdependencies, interruptions
			1. *Expand the Edwards SHEL model*
		3. Use: Utility, Users (misusers), Usage (misusage), Utilization, Usability, User error
			1. *Apply the 6 Us and 2Ms to a kitchen appliance, a smart phone, an ATM and a college course in Human Factors*
		4. Scope: Physical, Sensory, Cognitive, Social, Affective, Contextual (Environmental and operational)
			1. *When someone comes to a job he brings all these features which constantly interact. Describe your own job with regard to these categories*
		5. Lifecycle: Research, Applied Research, Analysis, Simulation, Design, Evaluation Investigation(Errors and Accidents)
			1. *Consider the life cycles of a car, an airport, a shopping center, Singapore or a meal. Describe the opportunities for different forms of Human Factors involvement*
		6. Stakeholders: Management, Design, Engineering, Production, Use, Maintenance, Disposal
			1. *Consider the different stakeholders in the life cycle of a taxi, a smart phone, or a university. What are their requirements? What are the tradeoffs?*
		7. Voice of the customer: Must have, More the better, Excitement
			1. *How would you determine the different requirements of a customer for a product such as a TV set or a chair, or a service such as a hairdresser or waiter?*
		8. Objectives: Requirements, Guidelines, Specifications
			1. *Requirements are functional – verbs qualified by adverbs. Specifications are physical – nouns qualified by adjectives. Requirements can be validated, specifications can be verified. Describe the requirements and specifications for a home, a chair, a mouse, a coffee cup*
		9. Outcomes: E4S4: Effectiveness, Efficiency, Ease of use, Esthetics, Safety, Security, Satisfaction, Sustainability (reliability and resilience), Tradeoffs
			1. *Describe the multiple outcomes and tradeoffs of a university, bus service, examination, pair of shoes*
		10. Analysis: Outcomes, Operations, Decisions, Interventions, Mitigations
			1. *Systems and process present many opportunities for data capture. Consider a recreation center, a theme park, an IT system, a fast food restaurant, a political campaign or an examination question. Analyze the system or process from multiple viewpoints.*
		11. Error: Incident and Accident reporting
			1. *How should we collect data about aviation accidents and incidents, consumer products, hotel services*
		12. Continuous Improvement
			1. *The world never stops, what is exciting today will be expected tomorrow. Continuous improvement is a control process, it needs feedback. Discuss how a manufacturing process or a bus service can “continually improve.”*