

Section A

Observations from 2022-23 M.Des Major Project

Project Name	Design Subject?	Product/Service/PSS?	Smart? If yes, data application (for Product, For Customer)	If smart, data application (for Product or for Customer)	Civil/Mech/Elect/Both(mech+elec)	UI Design (GUI, Internet/Mobile, Voice, Gesture/Eye/Brain, other)	Inspiration?	Source of Inspiration?	Reasoning?	Process of Inspiration?	Design Representation	Concept Abstraction?	Concept Evaluation	sk: Sketches GM: Game img: images TS: Technical System wd: words InF: Interface F: Function PSS: Prod-Svc B: Behavior S: Structure NR: Not Reported BS: Brain Storming
Comments														
Smart Board Game for Real Estate Education	GM	Prod	No		both	Internet/ Mobile	NR	NR		NR	sk,wd	No	No	Game design. What should be the abstract representation?
Semi-Automatic Car Cover	TS	Prod	No		both	No	NR	NR		NR	sk, img, wd	No	No	Design of Technical System
kalākār - An eye gaze-controlled desktop robotic system for rehabilitation of users with SSMI (Severe Speech and Motor Impairment)	InF	Prod	No		both	GUI, Gesture/Eye/ Brain	NR	NR		NR	sk, img, wd	No	No	Interface design for differently abled children. Technical System. What should be the abstract representation?
Assistive Device for Peripheral Intravenous Access	TS	Prod	No		both	GUI	NR	NR		NR	sk, img, wd	No	No	Design of Technical Systems, Human

														Factor, but is the control process defined?
Auto Cleanly: Efficient Car Washing Device	TS	Prod	No		Mech	No	NR	NR		NR	sk, wd	No	No	Design of Technical System
Smart Assistive Device for Elderly using Walker	TS	Prod	No		both	No	NA	NA		NA	sk	No	No	Design of Technical System
Podular Living	?	Prod	No		Archi	No	NA	NA		NA	sk	No	No	Could be a PSS, service design not reported
SOLOTRIM - A PRODUCT FOR HAIR TRIMMING FROM BACKSIDE	TS	Prod	No		both	No	Yes	Engg	Function	NR	sk, wd	No	No	Weak mention of inspiration (Chain link). No Source Representation and what is common is not explained. Function Similarity (adopting the shape of the surface contour) and adopting the structure and behavior (chain links)
Personal Device for Sanitary Waste Disposal	?	Prod	Yes (Product)	No	both	GUI	NA	NA		NA	sk, wd	No	No	Could be a PSS, service design not reported
FIL+: MAKING 3D PRINTING FILAMENT BY RECYCLING AND REPURPOSING PLASTIC WASTE	?	Prod	No		both	No	NA	NA		NA	sk, img, wd	No	No	Could be a PSS, service design not reported
Outdoor Micro Mobility Device for Geriatric People	?	Prod	No		both	No	Yes	NA		NR	sk, img, wd	No	No	Brainstorming for Ideation

List of Abbreviations used in the above table:

sk: Sketches	GM: Game
img: images	TS: Technical System
wd: words	InF: Interface
F: Function	PSS: Product-Service
B: Behavior	
S: Structure	
NR: Not Reported	
BS: Brainstorming	

Section B

Results of the System Function Identification Rules Validation

Document/Technical Summary:

This mechanism transmits power and allows variable output speed in the following steps:

The adjustable roller is fixed on the input shaft, which is threaded and is attached to the motor. Thus, the adjustable roller forms a screw pair with the frame. The motor applies a torque to the input shaft which activates Newtonian laws of motion, and rotates the adjustable roller. This requires a 1 degree of freedom of motion between the shaft and the adjustable roller in the direction of rotation. The first friction disk can be made to contact the adjustable roller. As the adjustable roller rotates, the first friction disk rotates as well due to the friction developed between the contacting friction surfaces. The two friction disks form a fixed pair with the shaft. The rotation of the friction disks causes the output shaft to rotate as well, because of Newtonian laws of motion. The rotation requires a one degree of freedom of motion in the direction of motion to exist between the two bodies. As the second friction disk is fixed to the output shaft, when the output shaft rotates, the second friction disk rotates as well activating Newtonian Laws of motion and due to the single degree of freedom of motion between the bodies. Since the adjustable roller is fixed to the input shaft, and the input shaft forms a screw pair with the frame, the position of the roller on the disk can be changed. This is achieved by applying a force on the roller which raises or lowers it along the disk, obeying the Newtonian Laws of motion. There is frictional contact between the friction disk and the adjustable roller. Thus, as the position of the adjustable roller on the disk is changed, there is a difference in the diameter of the disk at the point of contact with the adjustable roller. Newtonian Laws of motion apply and thus the speed of the output shaft is altered. In order to stop rotation of the output shaft, though the input shaft rotates continuously, the contact between the disks and the roller must be broken. This is achieved by applying a force on the disk in order to move it away, activating Newtonian Laws of motion. If the direction of rotation of the output shaft needs to be reversed, the contact should be changed from one friction disk to the other. This is possible again by applying a force on the disk in order to move it away, activating Newtonian Laws of motion. The direction of rotation of the output shaft thus depends on which friction disk it is in contact with.

Action Verbs detected	Rule (1-8)	Does the action verb hint to a Valid Interaction to become a <i>Physical Phenomenon</i> (Y/N)	Is the verb detected Manually or by the Program?
This mechanism transmits power and allows variable output speed in the following steps: The adjustable roller is fixed on the input shaft, which is threaded and is attached to the motor.			
transmits	7 (is a valid action verb but the sentence implies further reading into the summary to understand the working.)	N	Manually
allows	6	N	Program
following	2	N	Program
fixed	2	N	Program
threaded	3	N	Program
attached	3	N	Program
Thus, the adjustable roller forms a screw pair with the frame.			
forms	3	N	Manually
screw	8 (noun)	N	Program
The motor applies a torque to the input shaft which activates Newtonian laws of motion, and rotates the adjustable roller.			
applies	1	Y	Program
activates	4	N	Manually
rotates	1	Y	Program
This requires a 1 degree of freedom of motion between the shaft and the adjustable roller in the direction of rotation.			
requires	5	N	Manually
The first friction disk can be made to contact the adjustable roller.			

made	3	N	Program
As the adjustable roller rotates, the first friction disk rotates as well due to the friction developed between the contacting friction surfaces.			
rotates	7 (is a valid action verb but it implies the <i>INPUT</i> to the next instance of the <i>SAPPhIRE</i> model.)	N	Program
rotates	1	Y	Manually
developed	4	N	Program
contacting	2	N	Program
The two friction disks form a fixed pair with the shaft.			
form	3	N	Program
fixed	2	N	Program
The rotation of the friction disks causes the output shaft to rotate as well, because of Newtonian laws of motion. The rotation requires a one degree of freedom of motion in the direction of motion to exist between the two bodies.			
causes	1	Y	Program
rotate	1	Y	Manually
requires	5	N	Manually
As the second friction disk is fixed to the output shaft, when the output shaft rotates, the second friction disk rotates as well activating Newtonian Laws of motion and due to the single degree of freedom of motion between the bodies. Since the adjustable roller is fixed to the input shaft, and the input shaft forms a screw pair with the frame, the position of the roller on the disk can be changed.			
fixed	2	N	Program
rotates	7 (is a valid action verb but it implies the <i>INPUT</i> to the next instance of the <i>SAPPhIRE</i> model.)	N	Manually
rotates	1	Y	Manually
activating	4	N	Program
fixed	2	N	Program
forms	3	N	Manually
screw	8 (noun)	N	Program
changed	3	N	Program
This is achieved by applying a force on the roller which raises or lowers it along the disk, obeying the Newtonian Laws of motion.			
achieved	2	N	Program
applying	1	Y	Program
raises	3	N	Program
lowers	3	N	Manually
obeying	4	N	Program
There is frictional contact between the friction disk and the adjustable roller. Thus, as the position of the adjustable roller on the disk is changed, there is a difference in the diameter of the disk at the point of contact with the adjustable roller.			
changed	3	N	Program
Newtonian Laws of motion apply and thus the speed of the output shaft is altered . In order to stop rotation of the output shaft, though the input shaft rotates continuously, the contact between the disks and the roller must be broken.			
apply	4	N	Manually
altered	1	Y	Program
rotates	7 (is valid action verb but it implies the <i>OUTPUT</i> of one instance of the <i>SAPPhIRE</i> model.)	N	Program
broken	3	N	Program
This is achieved by applying a force on the disk in order to move it away, activating Newtonian Laws of motion.			
achieved	2	N	Program

applying	1	Y	Manually
move	3	N	Program
activating	4	N	Program
If the direction of rotation of the output shaft needs to be reversed, the contact should be changed from one friction disk to the other.			
reversed	3	N	Program
changed	3	N	Program
This is possible again by applying a force on the disk in order to move it away, activating Newtonian Laws of motion. The direction of rotation of the output shaft thus depends on which friction disk it is in contact with.			
applying	1	Y	Program
move	3	N	Program
activating	4	N	Program

Highlighted action verbs used:

This mechanism transmits power and allows variable output speed in the following steps:

The adjustable roller is fixed on the input shaft, which is threaded and is attached to the motor. Thus, the adjustable roller forms a screw pair with the frame. The motor **applies** a torque to the input shaft which activates Newtonian laws of motion, and **rotates** the adjustable roller. This requires a 1 degree of freedom of motion between the shaft and the adjustable roller in the direction of rotation.

The first friction disk can be made to contact the adjustable roller. As the adjustable roller rotates, the first friction disk **rotates** as well due to the friction developed between the contacting friction surfaces.

The two friction disks form a fixed pair with the shaft. The rotation of the friction disks **causes** the output shaft to **rotate** as well, because of Newtonian laws of motion. The rotation requires a one degree of freedom of motion in the direction of motion to exist between the two bodies.

As the second friction disk is fixed to the output shaft, when the output shaft rotates, the second friction disk **rotates** as well activating Newtonian Laws of motion and due to the single degree of freedom of motion between the bodies.

Since the adjustable roller is fixed to the input shaft, and the input shaft forms a screw pair with the frame, the position of the roller on the disk can be changed. This is achieved by **applying** a force on the roller which raises or lowers it along the disk, obeying the Newtonian Laws of motion.

There is frictional contact between the friction disk and the adjustable roller. Thus, as the position of the adjustable roller on the disk is changed, there is a difference in the diameter of the disk at the point of contact with the adjustable roller. Newtonian Laws of motion apply and thus the speed of the output shaft is **altered**.

In order to stop rotation of the output shaft, though the input shaft rotates continuously, the contact between the disks and the roller must be broken. This is achieved by **applying** a force on the disk in order to move it away, activating Newtonian Laws of motion.

If the direction of rotation of the output shaft needs to be reversed, the contact should be changed from one friction disk to the other. This is possible again by **applying** a force on the disk in order to move it away, activating Newtonian Laws of motion. The direction of rotation of the output shaft thus depends on which friction disk it is in contact with.

The observations given below were done in comparison with the defined *Physical Phenomena* in the IDEA INSPIRE data of VARSPEED05.

TEXT CONSIDERATION	UNDER	Physical Phenomena identified in the IDEA INSPIRE database	Potential Physical Phenomena identified manually
-----------------------	-------	---	---

<p>The adjustable roller is fixed on the input shaft, which is threaded and is attached to the motor. Thus, the adjustable roller forms a screw pair with the frame. The motor applies a torque to the input shaft which activates Newtonian laws of motion, and rotates the adjustable roller. This requires a 1 degree of freedom of motion between the shaft and the adjustable roller in the direction of rotation.</p>	<p>Only 1 <i>Physical Phenomenon</i> is reported</p> <ul style="list-style-type: none"> rotation of adjustable roller connected to the input shaft. <p>Application of torque to the input shaft by the motor is not categorized as <i>Physical Phenomenon</i> but is considered to be the <i>Input</i></p>	<p>2 candidate <i>Physical Phenomena</i> identified:</p> <ul style="list-style-type: none"> Application of torque to the input shaft by the motor rotation of adjustable roller connected to the input shaft.
<p>Since the adjustable roller is fixed to the input shaft, and the input shaft forms a screw pair with the frame, the position of the roller on the disk can be changed. This is achieved by applying a force on the roller which raises or lowers it along the disk, obeying the Newtonian Laws of motion.</p>	<p><i>Physical Phenomenon</i> reported:</p> <ul style="list-style-type: none"> Position of the roller on the disk can be changed. <p>Observation/suggestion: "Position of the roller on the disk can be changed." Should be considered as <i>State</i>.</p>	<p>Candidate <i>Physical Phenomenon</i> identified:</p> <ul style="list-style-type: none"> A force is applied on the roller which raises or lowers it along the disk.
<p>In order to stop rotation of the output shaft, though the input shaft rotates continuously, the contact between the disks and the roller must be broken. This is achieved by applying a force on the disk in order to move it away, activating Newtonian Laws of motion.</p>	<p><i>Physical Phenomenon</i> reported:</p> <ul style="list-style-type: none"> The output shaft stops rotating when contact is lost between the roller and any of the two disks <p>Observation/suggestion: Rotation of the output shaft coming to a halt should be considered as <i>State</i>.</p>	<p>Candidate <i>Physical Phenomenon</i> identified:</p> <p>A force is applied on the disk to move it away and lose contact with the roller</p>
<p>If the direction of rotation of the output shaft needs to be reversed, the contact should be changed from one friction disk to the other. This is possible again by applying a force on the disk in order to move it away, activating Newtonian Laws of motion. The direction of rotation of the output shaft thus depends on which friction disk it is in contact with.</p>	<p><i>Physical Phenomenon</i> reported:</p> <ul style="list-style-type: none"> The direction of rotation can be reversed when the roller contact is changed from one friction disk to the other <p>Observation/suggestion: Direction of rotation of output shaft being reversed should be considered as <i>State</i>.</p>	<p>Candidate <i>Physical Phenomenon</i> identified:</p> <p>A force is applied on the disk to move it away and break contact.</p>

Example 2:

The next example taken here is *GAS-TURBINE* under *FLOW-DEVICES*, in the IDEA INSPIRE database.

Document/Technical Summary:

Gas turbine engines are generally used for power generation. It rotates its output shaft whose power can be harnessed for some other purpose. It has compressor, combustion chamber, and turbine. It is explained below, Compressor compresses the air. This is due to energy imparted by the compressor blades to air, which actuates Bernoulli's law and requires the proper design of the compressor and sufficient energy given by it. Compressed air is heated in combustion chamber. This is due to heat energy generated by the combustion of fuel, which actuates the laws of thermodynamics, and combustion and requires the maintaining of flame in the combustion chamber. Turbine shaft is rotated by the high velocity and high temperature air passing through it. This is due to

force applied by the moving working fluid, which actuates Newtonian laws of motion and requires the correct flow passage and turbine blade design.

Action Verbs detected	Rule (1-8)	Does the action verb hint to a Valid Interaction to become a <i>Physical Phenomenon</i> (Y/N)	Is the verb detected Manually or by the Program?
Gas turbine engines are generally used for power generation.			
used	2	N	Program
It rotates its output shaft whose power can be harnessed for some other purpose.			
rotates	7 (it is a valid action verb but it does not add to the technical process of the system in this sentence. It talks of the overall function of the system.)	N	Manually
harnessed	7 (it is a valid action verb but it does not add to the technical process of the system in this sentence. It talks of the overall function of the system.)	N	Program
It has compressor, combustion chamber, and turbine. It is explained below, Compressor compresses the air.			
explained	2 ("Explained" is derived from the verb "explain," but in this context, it functions as an adjective modifying the pronoun "it." It describes the state or condition of "it". As a participial adjective, "explained" provides additional information about the subject.)	N	Manually
compresses	1	Y	Program
This is due to energy imparted by the compressor blades to air, which actuates Bernoulli's law and requires the proper design of the compressor and sufficient energy given by it.			
imparted	7 (valid action verb but it symbolizes the subject/object of the compression of air because of the word "due", indicating conditions (prepositions, conjunctions, etc.). Hence, it is input to the system)	N	Manually
actuates	4	N	Program
requires	5	N	Manually
given	2	N	Program
Compressed air is heated in combustion chamber.			
compressed	2	N	Program
heated	1	Y	Program
This is due to heat energy generated by the combustion of fuel, which actuates the laws of thermodynamics, and combustion and requires the maintaining of flame in the combustion chamber.			
generated	7 (valid action verb but it symbolizes the subject/object of the compression of air because of the word "due", indicating conditions (prepositions, conjunctions, etc.). Hence, it is input to the system)	N	Program
actuates	4	Y	Program
requires	5	N	Manually
Turbine shaft is rotated by the high velocity and high temperature air passing through it.			
rotated	1	Y	Program
This is due to force applied by the moving working fluid, which actuates Newtonian laws of motion and requires the correct flow passage and turbine blade design.			

applied	7 (valid action verb but it symbolizes the subject/object of the compression of air because of the word “due”, indicating conditions (prepositions, conjunctions, etc.). Hence, it is input to the system)	N	Program
moving	2	N	Program
working	2	N	Program
actuates	4	N	Program
requires	5	N	Manually

Highlighted action verbs used:

Gas turbine engines are generally used for power generation. It rotates its output shaft whose power can be harnessed for some other purpose. It has compressor, combustion chamber, and turbine. It is explained below,

Compressor **compresses** the air. This is due to energy imparted by the compressor blades to air, which actuates Bernoulli's law and requires the proper design of the compressor and sufficient energy given by it.

Compressed air is **heated** in combustion chamber. This is due to heat energy generated by the combustion of fuel, which actuates the laws of thermodynamics, and combustion and requires the maintaining of flame in the combustion chamber.

Turbine shaft is **rotated** by the high velocity and high temperature air passing through it. This is due to force applied by the moving working fluid, which actuates Newtonian laws of motion and requires the correct flow passage and turbine blade design.

Example 3:

The next example taken here is *AIR-CONDITIONER* under *COOLING*, in the IDEA INSPIRE database.

Document/Technical Summary:

Air conditioner basically keeps the air cool. It uses the fact that in the process of evaporation, liquids absorb heat. It has compressor, condenser, expansion device, evaporator and working fluid that is called as refrigerant. It is explained below, Refrigerant is compressed by the compressor. This is due to energy provided by the reciprocating pistons in the compressor, which actuates Newtonian laws of motion and requires the outlet pressure of the compressor smaller than that of the delivery pressure. Condenser cools the compressed refrigerant. This is due to heat released to the environment, which actuates the laws of conduction, convection and radiation and requires the temperature of surrounding lower than that of condenser. Expansion device reduces the pressure and cools the condensed refrigerant. This is due to frictional loss if the expansion device is capillary tube of longer length in the condenser, which actuates the Bernoulli's equation and requires correct design of expansion device. Evaporator absorbs heat from the space, which is to be cooled. This is due to the evaporation of the refrigerant, which actuates laws of heat transfer and requires the cabinet space to be hotter than the refrigerant.

Action Verbs detected	Rule (1-8)	Does the action verb hint to a Valid Interaction to become a <i>Physical Phenomenon</i> (Y/N)	Is the verb detected Manually or by the Program?
Air conditioner basically keeps the air cool.			
keeps	7 (it is a valid action verb but is a linking verb here. In this case, "keeps" links the subject "air conditioner" with the subject complement "the air cool," As a linking verb, "keeps" does not express a physical action but rather a state or condition.	N	Program

It uses the fact that in the process of evaporation, liquids absorb heat.			
absorb	7 (it is a valid action verb but it talks of the overall mechanism and science behind Air conditioner and not a specific phenomenon.)	N	Program
It has compressor, condenser, expansion device, evaporator and working fluid that is called as refrigerant.			
working	2	N	Program
called	2	N	Program
It is explained below, Refrigerant is compressed by the compressor.			
explained	2 ("Explained" is derived from the verb "explain," but in this context, it functions as an adjective modifying the pronoun "it." It describes the state or condition of "it". As a participial adjective, "explained" provides additional information about the subject.)	N	Manually
compressed	1	Y	Program
This is due to energy provided by the reciprocating pistons in the compressor, which actuates Newtonian laws of motion and requires the outlet pressure of the compressor smaller than that of the delivery pressure.			
provided	7(is a valid action verb but grammatically, it is a past participle verb that acts as part of a passive construction. It symbolizes the subject/object of the compression of air because of the word “due”, indicating conditions (prepositions, conjunctions, etc.). Hence, it is input to the system)	N	Program
reciprocating	2	N	Program
actuates	4	N	Program
requires	5	N	Manually
Condenser cools the compressed refrigerant.			
cools	1	Y	Manually
compressed	2	N	Program
This is due to heat released to the environment, which actuates the laws of conduction, convection and radiation and requires the temperature of surrounding lower than that of condenser.			
released	7(is a valid action verb but grammatically, it is a past participle verb that acts as part of a passive construction. It symbolizes the subject/object of the compression of air because of the word “due”, indicating conditions (prepositions, conjunctions, etc.). Hence, it is input to the system)	N	Program
actuates	4	N	Program
requires	5	N	Manually
surrounding	8 (noun)	N	Program
Expansion device reduces the pressure and cools the condensed refrigerant.			
reduces	1	Y	Manually
cools	1	Y	Manually
condensed	2	N	Program
This is due to frictional loss if the expansion device is capillary tube of longer length in the condenser, which actuates the Bernoulli's equation and requires correct design of expansion device.			

actuates	4	N	Program
requires	5	N	Manually
Evaporator absorbs heat from the space, which is to be cooled.			
absorbs	1	Y	Program
cooled	2 (could also be considered a past participle verb: Participial Adjective: "cooled" modifies the noun "space" and describes the state or condition of the space. It indicates that the space is intended or designated to be in a cooled state. Past Participle Verb: "cooled" is part of the passive verb phrase "is to be cooled." It suggests that the action of cooling will be done to the space.)	N	Program
This is due to the evaporation of the refrigerant, which actuates laws of heat transfer and requires the cabinet space to be hotter than the refrigerant.			
actuates	4	N	Program
requires	5	N	Manually

Highlighted action verbs used:

Air conditioner basically keeps the air cool. It uses the fact that in the process of evaporation, liquids absorb heat. It has compressor, condenser, expansion device, evaporator and working fluid that is called as refrigerant. It is explained below,

Refrigerant is **compressed** by the compressor. This is due to energy provided by the reciprocating pistons in the compressor, which actuates Newtonian laws of motion and requires the outlet pressure of the compressor smaller than that of the delivery pressure.

Condenser **cools** the compressed refrigerant. This is due to heat released to the environment, which actuates the laws of conduction, convection and radiation and requires the temperature of surrounding lower than that of condenser.

Expansion device **reduces** the pressure and cools the condensed refrigerant. This is due to frictional loss if the expansion device is capillary tube of longer length in the condenser, which actuates the Bernoulli's equation and requires correct design of expansion device.

Evaporator **absorbs** heat from the space, which is to be cooled. This is due to the evaporation of the refrigerant, which actuates laws of heat transfer and requires the cabinet space to be hotter than the refrigerant.

Section C

Illustrations of the proposed process to check completeness of system descriptions in a technical document

Example 1:

A **thermocouple circuit** is made up from joining two wires A and B made of dissimilar metals. Due to the Seebeck effect, a net EMF is generated in the circuit which depends on the difference in temperature between the hot and cold junctions and is, therefore, a thermometric property of the circuit. This EMF can be measured by a microvoltmeter to a high degree of accuracy. The choice of metals depends largely on the temperature range to be investigated, and copper constantan, chrome-alumini, and platinum-platinum-rhodium are typical combinations in use.

Information Gaps in Example 1:

Phenomenon Identified	For the given Phenomenon				
	Associated Part	Governing Physical Law	External Input	State Change Produced	Applicable Organ
Generation of EMF	Thermocouple circuit made up of two wires with a junction	Seebeck Effect	Not Given	Change of Potential Difference	Two wires of different materials (material properties), Temperature difference at the junction
Measuring EMF	Micro-voltmeter	Not Given	Not Given	Not Given	Not Given

Note: Measuring EMF is happening outside of System; hence can be ignored

Example 2:

Bourdon tube is a mechanical pressure measurement device. Bourdon tube consists of a hollow metal tube bent like a hook whose end is closed and connected to a dial indicator. When the tube is open to the atmosphere, the tube is undeflected and the needle on the dial at this state is calibrated to read zero-gauge pressure. When the fluid inside the tube is pressurized, the tube stretches and moves the needle in proportion to the pressure applied.

Information Gaps in Example 2:

Phenomenon Identified	For the given Phenomenon				
	Associated Part	Governing Physical Law	External Input	State Change Produced	Applicable Organ
Calibrating	Calibration is an external process, hence can be ignored				
Pressurizing	Pressurizing is an external process of applying external pressure to the system, hence can be ignored				
Stretching of tube	Bourdon tube	Not Given	pressure	Tube Stretches (change of length)	hollow metal tube bent like a hook whose end is closed
Movement of the needle	Needle, Dial indicator	Not Given	Tube Stretches (change of length)	Needle movement (change in needle position)	connected to the tube

Example 3:

Strain Gauge pressure transducers work by deflecting a diaphragm between two chambers due to the pressure inputs. A Wheatstone bridge circuit is attached to the diaphragm. As the diaphragm stretches, the resistance of the Wheatstone bridge changes. The Wheatstone bridge converts the change in resistance into an output signal and amplifies the output.

Information Gaps in Example 3:

Phenomenon Identified	For the given Phenomenon
-----------------------	--------------------------

	Associated Part	Governing Physical Law	External Input	State Change Produced	Applicable Organ
Deflection of diaphragm	Diaphragm	Not Given	Pressure input	Stretches (change in length)	A diaphragm between two chambers
Conversion of resistance change into output signal	Wheatstone bridge	Not Given	Stretches change in length)	Change in resistance, Change in output signal	A Wheatstone bridge circuit is attached to the diaphragm