

**NATIONAL UNIVERSITY OF SINGAPORE****IS1103 – Computing and Society**  
(Semester 1: AY2016/17)

Time Allowed : 2 Hours

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**INSTRUCTIONS TO STUDENTS**

1. This assessment paper contains **THREE** questions and comprises **ELEVEN** printed pages. Please write your answers within the boxes provided in this booklet only. Anything written outside these boxes will **NOT** be marked. Please write legibly.
2. Students are required to answer **ALL** questions.
3. This is an OPEN BOOK assessment. No electronically stored material or devices are permitted
4. Please write your Student Number below. Do not write your name.

**STUDENT NO:** \_\_\_\_\_

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This portion is for examiner's use only

Question	Marks	Remarks
Q1	/10	
Q2	/5	
Q3	/ 15	
Total		

1. The article below appeared in the Wall Street Journal in May 2010. Please read and answer the questions that follow. (10 marks)

Wentworth-Douglass Hospital, a small community hospital in this coastal New England town, used a college hockey game to showcase its new technological marvel: a \$1.4 million surgical robot named after Leonardo da Vinci. As the University of New Hampshire battled the University of Vermont last season before a crowd of 6,000, hospital representatives invited fans to try out the robot between breaks in the action.

The da Vinci has been billed as a breakthrough in the quest to make surgery less invasive. With its four remote-controlled arms and sophisticated camera, it enables surgeons to operate through small incisions with greater precision and visibility. At Wentworth-Douglass, however, the robot has been used in several surgeries where injuries occurred. One patient operated on days after the hockey game was so badly injured that she required four more procedures to repair the damage. In earlier robotic surgeries, two patients suffered lacerated bladders. There's no evidence to suggest the injuries at Wentworth-Douglass were caused by technical malfunctions. Surgeons who use the da Vinci regularly say the robot is technologically sound and an asset in the hands of well-trained doctors. But they caution that it requires considerable practice.

As a small regional hospital, Wentworth-Douglass has used the da Vinci about 300 times in four years. That's a fraction of the usage rate of some big medical centers and, some surgeons say, too little for the doctors at the hospital to master it. It's impossible to compare Wentworth-Douglass's rate of complications from robotic surgeries to that of other hospitals. Because of peer-review regulations designed to preserve doctors' anonymity, most hospitals don't disclose such information. Noreen Biehl, a spokeswoman for Wentworth, says the hospital's da Vinci complication rates are below the rates published in two recent gynecological studies. Wentworth-Douglass adopted the robot for the good of patients and still feels it was the right decision, she says.

The price of the machine ranges from \$1 million to \$2.25 million, depending on the model. In addition, hospitals pay another \$140,000 a year for the robot's maintenance and \$1,500 to \$2,000 per surgery for replacement parts. One study published in the Journal of Urology found that a hospital needs to do at least 520 surgeries a year with the robot to bring its costs in line with traditional surgery. That's seven times the number of robotic surgeries Wentworth-Douglass has been averaging.

"There's a medical arms race," says Paul Levy, chief executive of Beth Israel Deaconess Medical Center in Boston. "Technologies are being adopted and becoming widespread based on the marketing prowess of equipment makers and suppliers, not necessarily on the public good." Mr. Levy initially resisted buying a da Vinci in the absence of reliable data demonstrating it was better for patients. But he eventually relented when his urology team told him the hospital was losing business to competitors that had one.

Ben Gong, a spokesman for da Vinci maker Intuitive Surgical Inc., says the robot is worth the expense: "If something doesn't add value, it definitely should not be used. But I don't think the da Vinci is just adding costs." Last year, Intuitive Surgical reported profits of \$233 million on sales of \$1.05 billion. Its stock price has more than doubled over the past year to \$361 a share, giving the company a market value of \$14 billion.

The da Vinci was introduced in the U.S. in 2000. A massive machine operated from a console with joystick-like controls, the da Vinci is now employed for a variety of surgical procedures, from removing cancerous prostates to heart surgeries. By avoiding cutting open a patient's abdomen, it produces less blood loss, much smaller scars and a faster recovery, while giving surgeons a range of movement greater than the human hand.

In use at 853 hospitals across the U.S., the da Vinci has become a symbol of medical progress: One of the machines was featured on the cover of U.S. News & World Report's Best Hospitals issue last summer, while another appeared on the TV show Grey's Anatomy. It also became a symbol of health reform when President Barack Obama was photographed trying his hand at one during his visit to the Cleveland Clinic. However, some surgeons have questioned the way the robot has been marketed. Intuitive Surgical has marketed the da Vinci to hospitals as a way for them to increase their revenues and gain market share. A 14-minute video on the company's website features testimonials from surgeons and hospital administrators. A key message: The robot has been good for business. One cardiac surgeon in the video says at least 70 of his 250 annual cases are new patients who wouldn't have been referred to him if not for the robot.

Small hospitals have been receptive to the pitch. The 853 hospitals with da Vincis include 131 hospitals with 200 or fewer beds. Wentworth-Douglass began leasing its da Vinci in 2006. The 178-bed nonprofit facility competes for patients with six other hospitals located within a 30-mile radius in eastern New Hampshire and southern Maine. None of those hospitals had the robot, so Wentworth-Douglass saw an opportunity to gain a technological edge. Some of the hospital's surgeons opposed getting the robot because they felt Wentworth-Douglass didn't perform enough surgeries to overcome the machine's long learning curve, several current and former members of the medical staff say. Some surgeons with extensive robotic experience say it takes at least 200 surgeries to become proficient at the da Vinci and reduce the risks of surgical complications. That's difficult for surgeons at smaller hospitals to achieve. Jim Hu, a surgeon at Brigham and Women's Hospital in Boston who has done more than 1,000 surgeries with the robot, says it takes a urologist anywhere from 250 to 700 cases to master it. Dr. Hu considers the da Vinci a clear benefit for experienced surgeons, saying, "You can do a better job." But he cautions it can do more harm than good when used without adequate training.

Aleks Cukic, Intuitive Surgical's vice president of strategy, says the robot's learning curve "varies from procedure to procedure and from surgeon to surgeon." He adds: "There's no number" of surgeries required to master the device.

One of Wentworth-Douglass's surgeons, Paul Butler, expressed his opposition to buying the robot in a letter to the hospital's board of trustees. Another surgeon, Robert Lambert, says he told one of the trustees about the staff's opposition while the robot was being shown to the board. Both said the robot wasn't needed at a hospital the size of Wentworth-Douglass. Ms. Biehl says the hospital "took into account the opinions of all surgeon" before leasing the robot: "The majority were in favor."

Soon after leasing the machine in early 2006, Wentworth-Douglass began marketing it in advertisements on radio, television and in the local newspaper. The hospital also began pressuring its surgeons to use it, the current and former members of the medical staff say. Dr. Lambert, who left to become an assistant professor of surgery at Upstate Medical University in Syracuse, N.Y., says the pressure contributed to his departure. Ms. Biehl



denies any such pressure. Wentworth-Douglass says Dr. Lambert left mainly because he couldn't convince the hospital to start a bariatric surgery program.

Some current and former members of the medical staff say the training Wentworth-Douglass offered on the robot was insufficient. It included two days of operating on pig and human cadavers at a hospital in New Jersey. Upon their return, the trainees started operating on live patients. Surgeons from other specialties supervised the first few da Vinci surgeries of newly trained doctors. A urologist supervised some of the hospital's gynecologists in their first robot surgeries. Ms. Biehl confirms the training regimen but says the urologist, who was on the staff of another hospital, had considerable experience with the robot.

Intuitive Surgical says the New Jersey hospital, Hackensack University Medical Center, is one of 20 hospitals that train surgeons on the robot. When new hospital clients buy the robot, the package includes the two-day course for two surgeons at one of the training centers, which the company pays for. Intuitive Surgical's Mr. Cukic says it's up to hospitals to create guidelines for when their surgeons can do surgeries with the robot unsupervised. "That's not for us to say," he says. At Wentworth-Douglass, surgeons begin doing da Vinci surgeries unsupervised after four cases.

Dr. Hu of Brigham and Women's, who did a one-year fellowship and assisted on 400 robot surgeries before he began operating solo, says that's much too soon. "None of us would go and get surgery if we knew the guy had done it just a couple times before," he says.

Wentworth-Douglass's four urologists resisted using the robot without more training, people familiar with the matter say. Three of the four ended up leaving the hospital. Unlike the urologists, the hospital's gynecologists started using the robot. Several complications occurred. The bladders of two female patients were lacerated during routine gynecological surgeries performed with the robot, a person with direct knowledge of those cases says. One of the patients had to be sent to the Lahey Clinic in Burlington, Mass., for another surgery to repair the damage, the person says. The patients survived. A spokesman for the Lahey Clinic declined to comment. Ms. Biehl says bladder injuries "are a known risk of this type of surgery" whether or not a robot is used. She declined to discuss the cases or identify the patients, citing patient privacy laws. Mr. Cukic of Intuitive Surgical says it's hard to draw any conclusion from the cases without knowing Wentworth's overall rate of complications.

In June 2007, one of general surgeon David Coppola's first da Vinci patients was an elderly man with a stomach condition. Under the supervision of a proctor, Dr. Coppola operated on the man for several hours with the robot, people with knowledge of the case say. But Dr. Coppola eventually gave up on using the robot and switched to open surgery. The patient died after his esophagus was perforated.

It's unclear whether the esophagus was injured during the robotic part of the surgery or after Dr. Coppola opened the man's abdomen and reverted to traditional surgery. Dr. Coppola didn't return calls seeking comment. Ms. Biehl declined to discuss the case, citing patient privacy laws, but she says the hospital has had "no deaths of patients related to robotic surgery injuries." Mr. Cukic declined to comment about the case.

One of the surgeons featured in the hospital's robot advertisements was gynecologist Elizabeth Chase. In one newspaper ad in which she posed with a smiling patient, Dr. Chase was quoted as saying that the robot enabled her "to perform intricate surgery more safely." On March 2, 2009, Dr. Chase

Dr. Chase and Dr. Banaski didn't return calls seeking comment. Ms. Biehl calls Dr. Chase "an excellent surgeon" and says she is currently cleared to operate with the robot on her own. Ms. Biehl adds that no medical malpractice lawsuits have been filed against Wentworth-Douglass "related to robotic surgery."

- [illegible]

[illegible]

You have attended 2 days training in the use of the robot and learn that you are to perform a robot assisted surgery on a patient with 3<sup>rd</sup> stage stomach cancer. This is the recommended treatment option for such cases. The operation cannot be delayed and none of the other surgeons are available. Prior to meeting your patient, a journalist friend shows you the Wall Street Journal article given in question 1. So when your patient asks you about the safety and outcome of the procedure, you share with him the information you have just read.

[illegible]



3. Read the case and answer the following questions in the boxes provided. (15 marks)

Four years ago, Jane started her own consulting company. Today she has a team of 5 persons working under her. The consulting company specializes in information security, management information systems and networking solutions.

Currently she is designing a game information system to store and manage player information for a medium sized game company called Spectre. In the past three years, Spectre has successfully launched several games on the mobile platform. One of their games had over 1 million downloads and two of their games had over 500,000 downloads. Spectre is set to launch a new game, Fantasy City, 3 months down the road and they hope to enter the augmented reality game market. The sequel to Fantasy city is already being planned. (An augmented reality (AR) game is one that uses the real world environment or objects and augmenting them with computers or mobile devices. Pokemon Go and Zombies, Run! are examples of AR games.)

Jane has been working with Spectre's CEO (Benson) and the head of the computing unit (Colin). As the number of active players increased past 500,000, Colin convinced Benson that they need re-haul their computing system in the light of the expanding player base. Spectre hired Jane as an external consultant. After careful analysis, Jane suggested that Spectre build a new game information system rather than re-hauling its existing computing system. With the majority of the functionalities of the game information system discussed, it is now time to make decisions about the kind and degree of security to build into the system. AR games require the players' actual GPS coordinates in addition to other sensitive information like mobile device identifiers, and players' credit card information.

Jane described several options to Benson and Colin. Benson preferred the less secure system as the buying a new game information system was not in his original budget. Spectre had invested a considerable amount of money into developing the AR game engine for a series of AR games and thus money would be tight. Going for the more secure system would mean that the sequel to Fantasy City would have to be delayed. Jane strongly felt that Spectre's current computer system security is inadequate. Employees might be able to figure out ways to get access to player data, not to mention the possibilities of online access from hackers. She explained the risks, urged Benson to reconsider and Colin agreed. However, Benson as CEO chose the game information systems design with current (i.e. less) level of security.



- a. Use the ACM code of ethics (write the number) to analyze Jane's concerns and Benson's decision. Explain your answers. (5 marks)

Jane:

Benson:

b. What should Jane do? List her options and evaluate each of them. Which action would you advise Jane to pick and why? Explain your answer. (6 marks)

[illegible]

Spectre went ahead to develop the less secure game information system. Fantasy City turned out to be a great success and so did its sequel. However, eighteen months later, Spectre's server was attacked and 300,000 players' names, game nicknames, GPS locations and other information were posted in a hacker game forum. Fortunately, the players' credit card information was not posted nor and Spectre was able to confirm that there were no changes in player data (i.e. none of the players lost any game items nor were there any changes in their private information.)

- c. Were there data security, system security and/or network security breaches? If you feel that there is insufficient data to assess whether a breach has occurred, what are the additional information you will need in order to decide. (4 marks)

Data security breach (Yes/no/insufficient data) Explain.

Systems security breach (Yes/no/insufficient data) Explain.

Network security breach (Yes/no/insufficient data) Explain.

End of paper