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Software Engineering and Design
Case Study 2 – Introduction

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Case Study 2: Personal Insulin Pump (PIP)

Medical systems

- More and more medical instruments now include embedded control software.
- These software systems are often critical systems as a patient's life (or at least their health) may depend on the correct and timely functioning of these systems.
- Because of possible health impacts, such devices need get official approval from national health authorities before market entrance.

Domain: Treating Diabetes

- People with diabetes cannot make their own or not enough insulin, a hormone that is normally secreted by the pancreas. Insulin is essential to metabolise sugar and hence generate energy
- Currently most diabetics inject insulin 2 or more times per day, with the dose injected based on readings of their blood sugar level
- However, this results in artificial blood sugar fluctuations as it does not reflect the on-demand insulin production of the pancreas

CS2: PIP - Concept of Operation

- A personal insulin pump (PIP) is an external device that mimics the function of the pancreas. It uses an embedded sensor to measure the blood sugar level at periodic intervals and then injects insulin to maintain a safe blood sugar level.
- Consecutive readings are compared and, if they indicate that the level of glucose is rising then insulin is injected to counteract this rise.
- The ideal situation is a consistent level of sugar that is within some ‘safe’ band (see next slide).

CS2: Personal Insulin Pump - Sugar Levels

- ***Unsafe***:
  - A very low level of sugar (arbitrarily, we will call this 3 units) is dangerous and can result in hypoglaecemia which can result in a diabetic coma and ultimately death.

- ***Safe***:
  - Between 4 units and about 7 units, the levels of sugar are 'safe' and are comparable to those in people without diabetes. This is the ideal band.

- ***Undesirable***:
  - Above 8 units of sugar is undesirable but high levels are not dangerous in the short-term. Continuous high-levels however can result in long-term side-effects.

CS2: Personal Insulin Pump - Insulin Injection

- Decision when to apply insulin does NOT depend on the absolute level of glucose that is measured in the sufferer's blood.
- Because insulin does not act instantaneously and the change in sugar level also depends on previous injections.
- Decision must be based on previous levels and rate of change of sugar level.

- PIP hardware schematic: