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Team : Prapti Setty
Patrick Jennings
Isaac Walker
David Phillips
JC Zhang
Daniel Cosgrove
Eoin Dowling

Signed and submitted by : _____
(on behalf of team 37)

CS3013 - Goup 37: Quantum Computing Management Report

1. The Project Planning Process
Discuss how effective the project planning and control process was in designing and managing the Project.

The aim of project planning is to guide a team as effectively as possible towards the end goal. Our stated goal in the project plan was *"learning about Quantum Computing, and testing [Microsoft's] recently released Quantum Computing Development Kit"* … *" The main objective is to decide whether the tool released adequately simulates how a quantum computer would work ."*
By the time we had written the project plan we had already decided to implement the **triangle finding quantum algorithm** (see below for the various other options we had cycled through).

The planning process was useful in forcing us to be precise about what we were and weren't doing (ie: the scope of our project). This was a particularly important task for our group because of the unusually open/vague nature of the client's requirement.
We made explicit what we would do:
- algorithm
- Code (possibly in C#) for the traditional implementation
- Report of our development & discoveries

and we made explicit what we would *not* do:
- Implementation of other algorithms (ie: on top of the agreed triangle finding problem)
- A sophisticated and well designed User Interface (we only require bare-bones: user need only be able to use the algorithm)
- Unifying General relativity and Quantum mechanics

Did this help the outcome of our project? Yes: we have delivered exactly the first three bullet points on time, and nothing more. The planning process helped focus our efforts and remove the temptation to wander into different territory.

We were not as effective in planning deadlines: while we have ultimately delivered the required stuff, the schedule we attempted to create for ourselves in the project plan was not followed. This was ultimately to be expected as we did not put a great deal of effort into the scheduling and thus were prone to poor estimation.

Overall we have followed our project plan effectively, if not to the letter. It helped define the structure of the team, distribute the workload and most importantly made clear what our objectives were.

2. Project goals and objectives & 3.Scope

2. Were the goals and objectives met? Did they change over the duration of the project and if so how were the changes handled and what impact did they have?
3. Were there any issues with Scope Creep? Were there any changes to the scope of the project and if so, how were the changes identified, handled, and what impact did they have?

-What were our initial goals?
Our initial goal (as stated above) was the requirement given by Microsoft:
"*learning about Quantum Computing, and testing [Microsoft's] recently released Quantum Computing Development Kit*".
Given this vague specification, the onus was on us to come up with an idea to implement, and thus we were in some sense responsible for defining our own goals (with the direction of our mentors and clients).

Initially the team came up with many ideas which seemed promising and interesting to us:
- Quantum cryptography was an intriguing possibility, security being a field that many are concerned will radically change once Quantum Computers become available.
- One team member came up with an idea that was popular with us all: to build a Quantum Circuit simulator. This would have a user interface to graphically design a quantum circuit. The resulting function of this structure would then be encoded into Q#, allowing the circuit function to be simulated.

While these initial ideas were interesting and helped us get to grips with the task, our clients ultimately recommended we scale back. The proposed ideas had two main problems:
1. There would be too much emphasis on UI and peripheral functionality, when the main objective was to use Q#.
2. The ideas seemed too difficult to implement in the given time.

-How did these goals change?
Taking this feedback into account, we switched our focus to finding a Quantum algorithm to implement in Q# (ie: one which computes using qubits rather than classical binary bits). This was much better aligned with the requirements of the project as almost all the resulting code would be Q#.

Searching for the right algorithm proved to take longer than expected (surprisingly Quantum mechanics research papers are difficult to wrap one's head around). Grover's search looked like an appealing search algorithm to implement, but we soon found that it was already implemented as a built-in Q# function.

We finally settled on the Triangle Finding Algorithm - the problem of determining whether a given graph contains at least one 3-cycle.

What impact did the change have? In a sense our goals didn't change because the client's only requirement was that we implement something using Q#. From our perspective however our goals to achieve this changed quite drastically, and the above process of researching to find the right task took up several weeks.

Did we meet our final and/or initial goals? Yes, we now have the Triangle Finding algorithm implemented and functional in Q#.

Scope
As mentioned above, our initial scope was too large and this was reduced before we started implementing anything.
-Review of impact

- In hindsight the Triangle finding problem was a better option. As a simpler problem with minimal extra requirements (no frills/UI) it did allow us to focus on the Q# development
- However time was wasted due to initial scope creep & not settling on algorithm implementation sooner

4. Project approach

Discuss the Scheduling, Milestones, and Gannt charting. How divergent was the actual project from the Project Approach?

Scheduling can be very tricky to get right, particularly with research-based projects like this where there are many unknowns and uncertainty. Still we tried our best to break the task down into milestones and give the most reasonable targets for meeting them.

The largest milestones in the project would be the following:
1. Decide what we'll implement.
2. Learn Q# and set up environment
3. Microsoft Presentation & Requirements Presentation
4. Have triangle finding algorithm working in Q# and classical
5. Analyse performance of implementation

We successfully reached all of these milestones within the timeline of the project.
But now let's look at how effective our planning was in helping us reach some of these.

Deciding what to implement and **Learning Q#** took much longer than expected. As detailed above several good ideas had to be scrapped. However if we were to do the project again it isn't clear how this process could be sped up, given the resources available to us. If we had had access to Q# resources and someone familiar with Quantum Computing these would have improved our speed, but these were not available for various reasons.
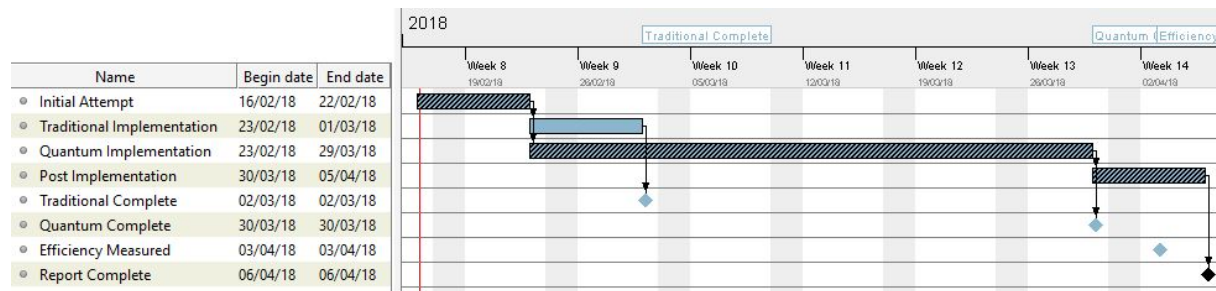
Implementing the Quantum Algorithm

As can be seen from the above Gannt chart, we allocated the vast majority of time to implementing the Quantum algorithm. This was an accurate prediction as it was only finished in the final week of term. However a better approach may have been to subdivide the Quantum implementation into its component tasks (as well as we could at that early stage) and attempt to predict the timeline for that.

So the actual project was very divergent from what we expected in some aspects, but quite accurate in other aspects.

5. Project organization

How did the project organisation work in practice?

Here's the hierarchy specified in the Project Plan :
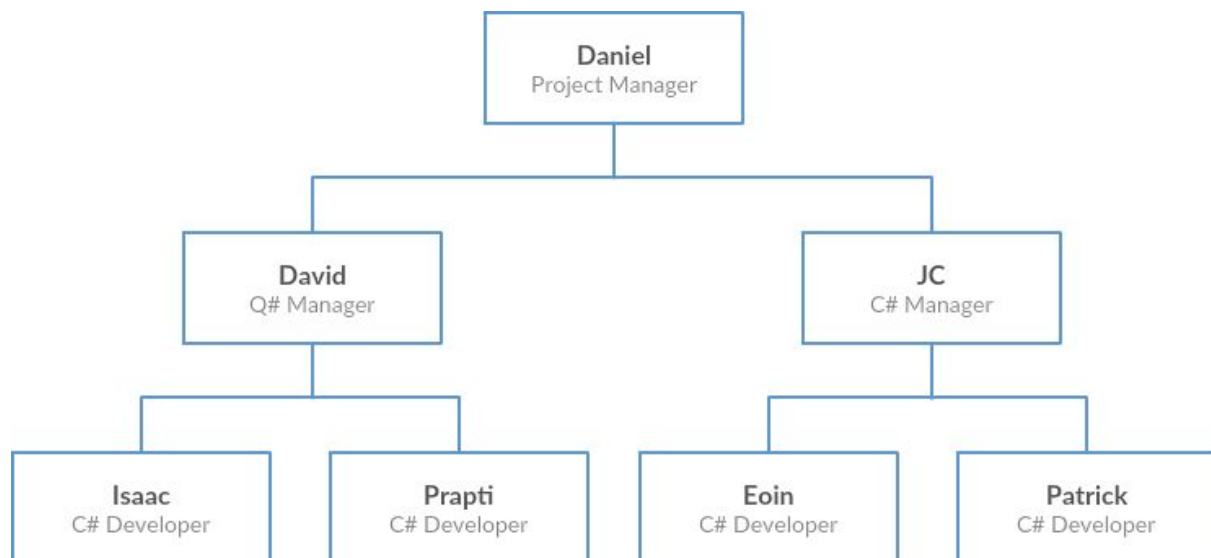
Towards the end of the project it proved more useful to break this hierarchy. Patrick moved to Q# development, Prapti moved to C#. The Q# side worked very efficiently in the last two weeks when we reorganised this way, making great progress and finishing the implementation.

6. Risk analysis

Did any of the identified Risks materialise and how were they dealt with? What new Risks arose and what impact did they have and how were they controlled?

Several members on the team got ill for extensive periods of time during the project. Fortunately not much slack had to be picked up by the others due to it and it didn't really affect our progress.

7. Project controls

Discuss the functioning of the Project Controls (Scope, Quality, Schedule) and how they worked in practice.

We'd like to think that we managed to stay within the scope of the project while completing everything within the scope. We went on weekly Teams calls with our clients who are also are mentors which helped us deliver the project in good quality as we constantly communicated with them. We followed the schedule with a decent amount of punctuality.

8. Communications

Discuss the Client meetings and the Project meetings and how they functioned in terms of the overall project.

Weekly Teams calls are a major part of how we communicated with our clients. Both of the parties would also occasionally share messages or documents over Teams usually when we discover useful resources that can help us complete the project.

Between the group we usually met twice every week to update on the progress each of us has made and to go over any problems that might have occured. They were a key part of how we were able to ensure that we weren't massively behind the schedule and to motivate each of us to continue working on the project.