O7 PTPERF: Project Plan

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Project Plan

1 Goals and Setting

1.1 Background

The video game industry is one of the largest entertainment industries in the market today. With a focus on creating unique experiences as well as pushing the performance and graphics fidelity forward; the video game industry have encountered a plethora of technological challenges. The technology powering these games must be flexible enough to allow for creative gameplay situations, while still able to meet the stringent performance requirements of modern games. This balance issue of flexibility vs performance have lead to some interesting patterns within the industry.

1.1.1 Entity Component Systems

Entity Component Systems(ECS) originally appeared towards the end of the 1990's, however the popularity of this approach has only grown. [1] Entity component systems exists in various forms with different flavors, however they all seem to share the same backbone, the focus on domain specific, decoupled and isolated behavior building blocks. These building blocks can then be combined in almost endless fashions to create complex behavior. The goal of an entity component system is to reduce complexity and decoupling within games. This in turn leads to greater flexibility, higher code reuse, and shorter iteration cycles. An entity is often defined as something that exists in the game world. How the entity functions is described through the component it contains, i.e. there is a larger focus on aggregation rather than inheritance. [2, components] As mentioned earlier there are several forms of entity component systems. Some implementations keep a more traditional OOP implementation, [2, components] while others are more akin to relational databases, where entities are simply identified through a unique ID. [3]

1.1.2 NOX Engine

The NOX Engine is an open source game engine originally developed by former students at Gjøvik University College. The engine is still in use today by the company Suttung Digital. After several discussions with Suttung Digital regarding the aim of this project, it was decided that we would develop a new entity component system for their engine.

1.2 Goals

This project will have a deep focus on entity component systems, both in a practical sense and theoretical sense. The goals of the project is therefore:

- Give insight into different entity component systems. This is done through published articles, as well as our own development and testing.
- Implement a functioning entity component system that can work within the NOX Engine. The new ECS should have the same functionality as the old one, as well as improved performance.
- Give insight into performance differences in a relevant test case. This case will be done with both the original NOX Entity system and our proposed systems.

1.3 Setting

The following section looks at some of the factors that influence our project.

1.3.1 Legal Setting

The NOX Engine is open source under an MIT license. This license is something we have to take into account when developing the new ECS.

1.3.2 Scientific Setting

There does not seem to be a great deal of academic articles published in relation to this topic, however what we actually have found seem to be of high quality. This means that we will also have to look into non-academic literature. Luckily there seems to exists more sources within the non-academic literature, written by industry professionals.

1.3.3 Time

The bachelor thesis has a hard delivery date in the middle of May. This means we have to structure our project around this deadline.

2 Scope

2.1 Subject Area

The bachelor will revolve around the idea of the entity component system, which is a design pattern commonly used in game engines, Unity and Unreal to name a few. The pattern tries to make it possible to create entities, which is a composition of components, where each component has its each unique separate feature. Different types of combinations of components will result in entities with different functionality. It is this feature of entity component system which gives the larger game engines the possibility to cover such a huge range of games.

2.2 Delimitation

We will only provide the same functionality the old system offered, as doing anything in addition to this would put us on an even tighter time schedule than we already are.

2.3 Project Description

We are creating a new entity component system module called NOX ECS 2 for the NOX Engine. It is going to have a focus on being threaded, having good performance, being maintainable, and achieving the same flexibility as the old entity component system.

2.3.1 NOX ECS 2

We will develop an entity component system, which will contain all the old functionality of the NOX Engines system, but with an added benefit of performance and maintainability. If the development of this module goes smoothly, it will hopefully be adopted into the NOX Engine, and subsequently improve the overall quality of the engine.

3 Plan for implementation

3.1 Important Project Characteristics

Our bachelor project has several characteristics which affect how we select our development model:

- Only two people doing the development, meaning that the development model needs to have an appropriate scale.
- Need to be agile, still many aspects that are unknown about this project.
- A need for an iterative process, as we have multiple modules that needs to be developed.
- We would like to incorporate multiple practices to ensure a sufficient amount of artifacts are produced to help in writing the thesis.
- Want to have the whole process well documented, in order to still have a good grip of how the entire process went at the end of the bachelor.

3.2 Arguments for Development Model

For the development of our bachelor project, we decided to go for scrum, together with certain practices borrowed from XP and RUP that we feel are appropriate.

We want our development model to produce a sufficient amount of artifacts and documentation for writing the thesis after the development process is finished. In addition, our previous knowledge of scrum allows us to start utilizing the model much faster, and everyone is up to speed on what to do from the get go. Theres also the fact that we have access to JIRA, which provides us with all the scrum utility tools in one place, making the whole process much easier.

3.2.1 Why not eXtreme Programming?

The first major issue we had considering XP was the lack of artifacts and documentation produced by the process. We could have made it work by changing the model around to include more planning and documenting, but that would move the model away from what it is supposed to achieve, which is fluid development throughout the process with new requirements added, changed and removed the entire time. In addition we need a plan to show Suttung that they can approve, in order for us to know if we are on the right track.

3.2.2 Why not RUP?

Even though the whole inception, elaboration, construction and transition phases fits quite well with our project, we feel that this is on the opposite side of the spectrum compared to XP when it comes to amount of documentation and artifacts. The amount of overhead caused by RUP would be too much for a development team with only two members. Use-cases and business models are important in the RUP model, but both are not worth investing our time into. Use-cases is a bit over the top for us, and creating business model is not useful. If we wanted to make RUP fit our requirements, we would remove a lot of its features, making it into something resembling scrum, hence why not just choose scrum.

3.2.3 Why not Waterfall Model?

A bit on the fence about going agile or not, since our project does require a substantial amount of research and planing before we can start the development, and there is a hard deadline for the thesis making a rigid plan plausible to utilize. Uncertainties with the specific requirements both from not knowing what kind of entity component system we are gonna make, and how it should be structured to fit into the NOX Engine means that we cannot use the waterfall model. It would've required way too much time in the planning phase to completely understand everything needed to implement our system.

3.3 Applying the Model

We are going to use the standard scrum model with all of its various features, and also including some other features from some other development models as well.

These are the practices from XP and RUP that we use in our development model.

- Coding standard
  The coding standard is there to give a consistency throughout our code, making it easier for the team to read others code, and also come to an agreement on what is right and wrong ways to write certain bits of code.
- Collective code ownership
  Everyone should have as much insight in what happens in the entire project at all times. This is going to be solved with weekly code reviews, explaining newly implemented code to the rest of the team.
- Simple design
  In every aspect of the project, we will have the mindset of trying to create a new functionality as simple as possible.
- Project glossary
  In order to make the thesis easier to read through we want to include a project glossary to give an explanation/description on several abbreviations, terminologies, and other words which aren't necessarily that obvious.
- Software Architecture Description
  We want a proper laid out plan for the architecture of our entity component system. This is so that we can have a clear understanding of the problem before we move into developing the actual system.

4 Quality Assurance

4.1 Intention

The idea of this project is to end up delivering a functional product to Suttung digital, meaning the product will be used in a professional setting. As a result of this goal, special care has to be put into quality assurance.

Coding Convention
Coding conventions will as far as feasible follow the internal coding conventions of Suttung digital. Conventions that does not follow the original conventions of Suttung will be discussed with Suttung. No matter how the final coding conventions ends up looking, the focus will always be on writing readable, maintainable and well performing code. This will be enforced through routine code reviews and testing.

Documentation
Documentation will be a huge factor, as the documentation as well as examples is what Suttung will be reading to gain an understanding of the new ECS. All

interfaces will be documented, even self-explanatory ones, as what is and what is not self-explanatory can change from person to person. The exact format of the documentation will be cleared with Suttung.

Git Usage
All developed code will be stored on git. To avoid breaking builds for the other group member, all implementation of new features will happen on separate branches. Branches will be merged into the master branch when the new code has been tested, and reviewed by a fellow group member.

5 Risk Analysis

5.1 Identified Risks

Below follows the identified risks related to this project, as well as the consequences related to the individual risks.

Poor Performance
Performance is a pretty hard topic, especially when combined with systems as complicated as ECS's.
Probability: Medium
Impact: Medium
Consequence:
A poor performing system would mean that we would have to spend more time optimizing the ECS, which could get in the way of the other tasks. A suboptimal solution would probably not be something Suttung would be interested in using either.

Incompatible Implementation
The main goal of this project is to allow Suttung to easily integrate the new ECS into their system. However it might be that our system ends up fundamentally different than theirs, and that the integration is not an easy process.
Probability: Medium
Impact: High
Consequence:
An incompatible implementation would mean that the Suttung group would not be able to easily integrate the ECS into their systems without major changes. In this case Suttung might decide that the new ECS is not worth it, and stay with their current solution.

Hard to find Bugs
Writing larger complex systems is a difficult challenge, and finding bugs in those systems could be incredibly time consuming.
Probability: High
Impact: Depends

Consequence:
The consequence of a bug depends on what sort of bug, and how fatal it is. Non fatal bugs with low recurrence is obviously not wanted, but it might be acceptable. This cannot be said for fatal program terminating bugs that recur with a high frequency.

Unrepresentative Test Case
The plan is to write a representative test case with the NOX Engine that we can use to see the flexibility and usage of the engine. However Suttung might decide that this case is not representative enough for their normal usage patterns.
Probability: Low
Impact: Medium
Consequence:
In the case where the test case is not representative enough, we would probably have to rewrite the test case, which will then take up time that we don't really have available.

Lost Work
Lost work could take many different forms, it could be loss of source code or documents.
Probability: Medium
Impact: Depends
Consequences The consequence of loosing work would be to either redo it, or drop the features if possible. How bad this is for the project depends on how much work that needs to be redone, and if we have enough time to redo the work.

Internal Conflict
Internal conflict would in this case mean all discussions and disagreements that severely hamper the progress of the project.
Probability: Low
Impact: Depends
Consequences The consequences of an internal conflict could be quite severe, in that it would hurt our overall progress. Again the impact here depends on how severe the conflict is and at what time the conflict is over.

Problem Understanding the NOX Engine
The NOX Engine is a big and complex system, getting a proper overview of the engine might prove difficult.
Probability: Medium
Impact: High
Consequences The largest consequence of this is that if we don't have a proper understanding of the engine, then we won't be able to fully understand how we should optimally implement our new structures either. This will also result in a loss of time that we could have used on development.

Missing Group Members
Chances are quite large that some days one of the group member wont show up for work. If this is a result of illness or any other factors is not really that relevant.
Probability: High
Impact: Depends
Consequences The consequence of this situation will be a loss of time that could be spent on work, both for the person who is gone, as well as the member who shows up. How much this impacts the project depends on how long the member is gone, and how much the other member relies on their work.

Lack of Proper Measurement Tools
Measuring performance will require specific tools. Hopefully the tools we want to use will fit the problem at hand, as well as giving us the wanted precision.
Probability: Medium
Impact: High
Consequences If we can't find proper tools for the measurements we want, we will have to find less precise measurement methods, which might hurt our case when we present the performance results.

Wrongly Estimated Time
Wrongly estimating the time it will take to work on each "module" within the project is a real risk.
Probability: Medium
Impact: Medium
Consequences The consequence in time estimation would be that we would have to drop a planned module.

5.2 Mitigation Strategies

Bellow follows our strategies for mitigating the chances of the identified risks happening. And how we might deal with them if they would occur.

Poor Performance
Performance problems will be mitigated through recurring profiling. Benchmarks should ideally be run quite often, and these benchmarks should guide further optimizations if needed.

Incompatible Implementation
The implementation will first go through a design phase, before it is presented to Suttung. This proposed design will be built on the research that have been conducted into the Suttung engine, as well as a relevant test case. Hopefully this will be enough to mitigate the changes of our implementation being incompatible with the NOX Engine.

Hard to find Bugs
Reducing the risk of bugs is a difficult task, however some general guidelines helps when developing code. For example, we will have a focus on clear access patterns, and local scope when writing multi-threaded code. There might also be some libraries out there that allows us to build tests specifically aimed at multi-threaded code. Other mitigation strategies includes writing more tests for the different code sections.

Unrepresentative Test Case
The test case will be developed based on usage patterns observed in real life use of the NOX Engine. The plan is also to verify the case with Suttung.

Lost Work
All of the source code will be uploaded to on-line repositories, this will also apply to the thesis itself, as well as all other documents related to the project. The group members are encouraged to commit work to these repositories often, preferably after each discrete "unit of work".

Internal Conflict
Both members of the group have worked together previously on project, which has gone quite well. Because of this we have not added extra mitigation factors, outside of the group rules.

Problem Understanding the NOX Engine
The best way to mitigate this risk is to use more time with the engine. We will therefore write the test cases that we are going to use for comparisons in the NOX Engine first. Suttung will also give us access to one of their games which is built with the NOX Engine. This will give us some clearer examples to look at, and hopefully reduce the time used to understand the engine.

Missing Group Members
Missing group members is hard to mitigate, however we will through daily meetings keep the other member up to date on what we are working on. Hopefully this will lessen the impact if a group member does not show up one day. In addition group members are encouraged to work remotely when possible, if they for some reason cannot show up for work.

Lack of Proper Measurement Tools
There are not that many performance measurement tools directed at C++ out there. We have already found a few profilers with a high precision level. However if we are not able to get the data we need out of these profilers, we might have to go to less precise measurement methods, like measuring frame rate.

Wrongly Estimated Time
We have already mitigated the consequences of this risk a bit, by including two weeks of buffer time. Planned regular meetings will also help reducing this risk, as it allows us to keep track of how we use our time, and potentially scale back some features or tasks.

6 Project Organization

6.1 Roles and Responsibilities

The group consists of two members, Per-Morten Straume and Trond Lohne. Both members will be responsible for the implementation of the bachelor project, as well as the writing of the bachelor thesis.
Additionally the official project lead will be Per-Morten Straume. The project lead will have the additional task of keeping track of progress, that the development follows the plan, and that the plan is kept up to date. A signed version of the group rules can be seen in Appendix B.

7 Development Plan

7.1 Milestones

7.1.1 Milestone 1: Specification

Technical Specification Document
At the first milestone we will have a technical specification ready, stating what functionality our ECS will provide, and what sort of performance increases that they are interested in.
Performance Metrics Document
In addition to the technical specification document we will also have a document describing the metrics that will be used when measuring performance on the different modules.
Approved Test Case
In addition to the approved design, we will at this point also have created a relevant test case for our performance tests with the NOX Engine. This will also be approved by Suttung.

7.1.2 Milestone 2: Iteration 1

Implemented Proposed ECS
At this point in time the plan is to have our proposed entity component system functionally implemented. Optimization also falls under the category of implementation, as we will do performance measurements within the test case as well to guide our optimizations.
Measured Proposed ECS
The other part of this milestone is to have our ECS functioning properly within

the test case approved in the last milestone. As well as having gathered performance data.

7.1.3 Milestone 3: Iteration 2, or new ECS

Implemented Iteration 2
Based on feedback from previous milestones we will either continue to reiterate on the proposed ECS or come up with a new one using the same process but with a new approach to the problem.

7.1.4 Milestone 4: Integration

Integrated ECS into NOX Engine
At this point we will reach our final goal, which is to get the ECS integrated into the NOX Engine. We will have done potentially needed refactoring and documentation.
Gamejam with Suttung
The plan is to have a gamejam with Suttung as a way of testing what they think of the new ECS. It might also be interesting to do gamejam with other people without prior experience with the NOX Engine to compare feedback on the different systems.

7.2 Documentation

Writing the thesis report will be a continuous effort throughout the entire semester, however it takes over the main focus after the milestones has been reached. We have set off 18 days to write the thesis, including 2 days to review it. We also have some days as a buffer as we have not taken weekends into account in the diagram.

7.3 Development Schedule

As seen in the Gant diagram we will be running 11 sprints, tied up to our 4 milestones. How many sprints that is required per milestone is based on our estimations. We think that both planning and implement the ECS system will take the most time, which is why they get more sprint periods than the other modules. We have also added two weeks that can be used as buffers, if the buffers are not needed, they will be used as regular sprints to further improve the quality of our implementations. The Gant diagram can be seen in Appendix A.

References

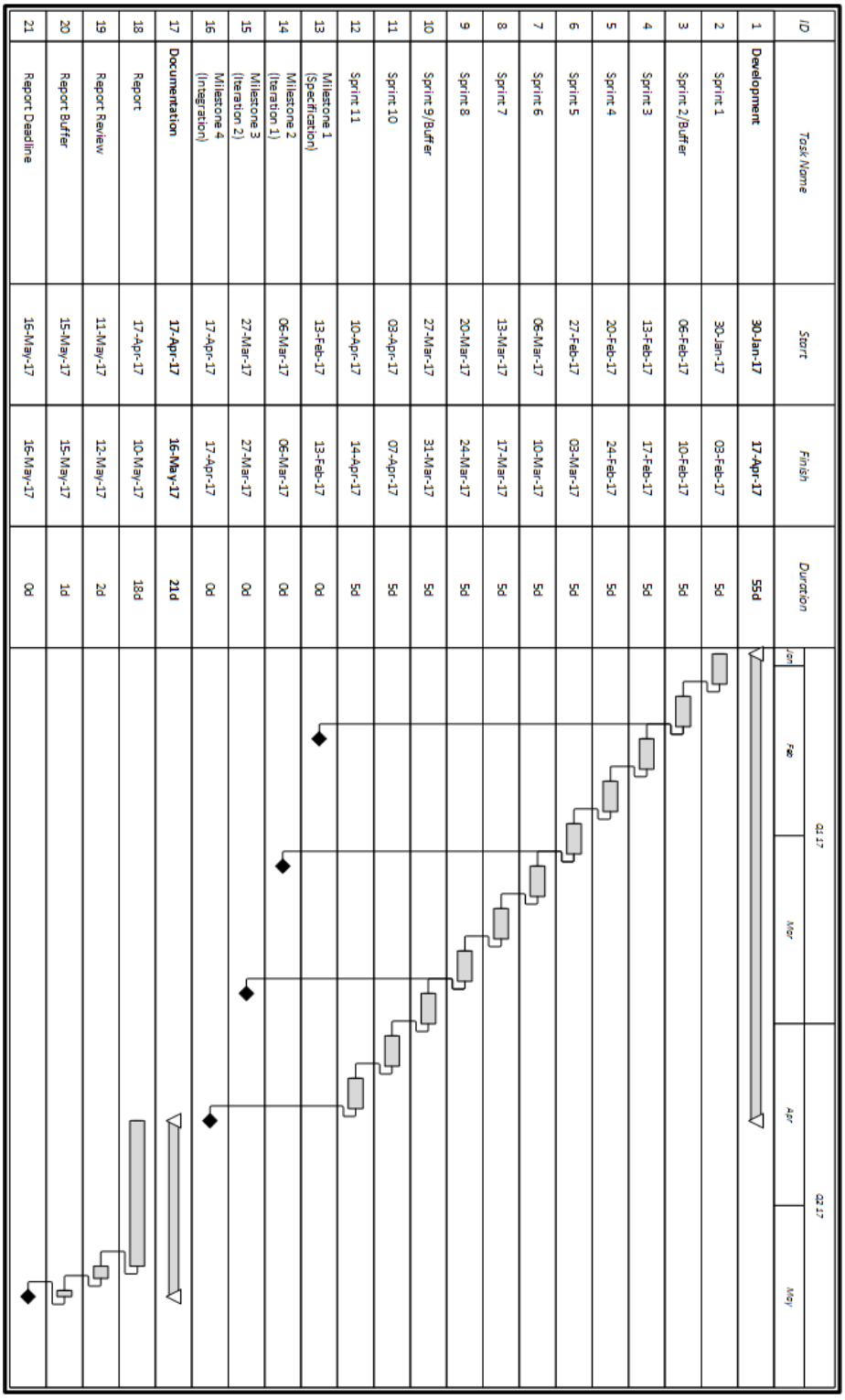
[1] https://en.wikipedia.org/wiki/Entity%E2%80%93component%E2%80%93system#History. retrieved: 24.01.2017.

[2] Robert Nystrom. *Game Programming Patterns*. Genever Benning, 2014.

[3] Entity systems are the future of mmog development part 2. http://t-machine.org/index.php/2007/11/11/entity-systems-are-the-future-of-mmog-development-part-2/. retrieved: 24.01.2017.

Appendices

Appendix A: Gant Diagram



ID	Task Name	Start	Finish	Duration
1	**Development**	**30-Jan-17**	**17-Apr-17**	**55d**
2	Sprint 1	30-Jan-17	03-Feb-17	5d
3	Sprint 2/Buffer	06-Feb-17	10-Feb-17	5d
4	Sprint 3	13-Feb-17	17-Feb-17	5d
5	Sprint 4	20-Feb-17	24-Feb-17	5d
6	Sprint 5	27-Feb-17	03-Mar-17	5d
7	Sprint 6	06-Mar-17	10-Mar-17	5d
8	Sprint 7	13-Mar-17	17-Mar-17	5d
9	Sprint 8	20-Mar-17	24-Mar-17	5d
10	Sprint 9/Buffer	27-Mar-17	31-Mar-17	5d
11	Sprint 10	03-Apr-17	07-Apr-17	5d
12	Sprint 11	10-Apr-17	14-Apr-17	5d
13	Milestone 1 (Specification)	13-Feb-17	13-Feb-17	0d
14	Milestone 2 (Iteration 1)	06-Mar-17	06-Mar-17	0d
15	Milestone 3 (Iteration 2)	27-Mar-17	27-Mar-17	0d
16	Milestone 4 (Integration)	17-Apr-17	17-Apr-17	0d
17	**Documentation**	**17-Apr-17**	**16-May-17**	**21d**
18	Report	17-Apr-17	10-May-17	18d
19	Report Review	11-May-17	12-May-17	2d
20	Report Buffer	15-May-17	15-May-17	1d
21	Report Deadline	16-May-17	16-May-17	0d

Appendix B: Group Rules

Group Rules

1. All time spent on the project will be tracked through toggl, with each entry given a proper headline indicating what sort of work that were done. When working on assigned issues/tasks the issue/task number is used to document in toggle, and also logged in Jira. The logged work in Jira is an approximation, for example a bunch of small but frequently interrupted sessions can be summed into a total.
2. A log will be written each work day, summing up progress and achievements for that day.
3. The expected amount of working hours per week is a minimum of 30 hours. Monday through Friday. If a group member has not contributed the required hours, he will work more to make up for it the week after.
4. Academic disagreements are handled internally within the group at first, possibly including a supervisor or third party if no agreement can be reached.
5. Each day is started with a meeting, reporting on what tasks that will be completed that day, progress from the day before, what issues we are currently having.
6. Meetings with the projects supervisor are scheduled to happen weekly or biweekly. All members of the group shall be present at said meetings.
7. Version control is done through git. Members are expected to commit and push often, documenting and securing their work. Commits shall happen at minimum once per working day.
8. Coding conventions shall be followed to the best of ones ability.
9. Project lead will be the public representative of the group, and can therefore sign documents etc. on behalf of the group.
10. Costs directly tied to the project will be split evenly among the group members.

Consequences

All violations of these rules will be logged. After three violations a written warning is given to the offending member, after the second warning a supervisor will be involved. A written warning will be signed by both the accusing and accused party, if any of the parties refuse to sign, a supervisor is contacted immediately. Deviation from these rules are allowed and wont have any consequences if it is cleared with the rest of the group first.

Contact Information

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Signatures

Trond Lohne — 27.01.2017

Trond Lohne — *Date*

Per-Morten Straume — 27.01.2017

Per-Morten Straume — *Date*