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D4.1

Serious Games Design

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Executive Summary

This deliverable outlines the design blueprint of the SYMPHONY serious game and forms the scope of the rest of WP4, mainly; Task 4.2 – Game interfaces and Task 4.3 – Game implementation.

This report begins with researching current financial technologies and policy games which are available on the market, then put through a design analyse – where a set of common user experiences problems emerge. A variables description document was created between the modelling and technology partners in order to explain to the game designers the role of each variable in the ABM (Agent Based Model).

Once the research had been completed and the game designers had a good understanding of how the ABM operates, a design methodology for the Game User Interface (GUI) was created in order to reduce the complexity of engaging with the ABM. The methodology insured that only “decision critical” variables would be shown to the player, reducing the effects of information overload, therefore reducing complexity of interaction with the ABM.

Initial sketches and concepts where drawn up to get a good understanding of the look & feel of the SYMPHONY serious game, this also allowed the game designers to add and remove components to improve the user experience. Two designs where created in order to appeal to Policy Makers and Citizens, a serious version and a more game like entertainment version.

The game design explains the types of game modes which can be setup, how players will progress, types of goals they will complete and the variety of game mechanics which will build a unique game-play experience around the ABM’s data. The Technical section focuses on how the game will be built, detailing use cases for each screen as well as identifying the functional and none functional requirements for the game.

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List of Abbreviations

ABM = Agent-based model
Ai = Artificial Intelligence
CPI = Consumer Price Index
GDP = Gross Domestic Product
GUI = Game User Interface
PCV = Player Controlled Variable
Sim = Simulation
VAT = Value-Added Tax
WP = Work Package

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1 Introduction

Monetary policy modelling and analysis is a complex and difficult process. Policy makers not only are required to have a vast knowledge of the economic system but also the ability to understand many economic factors and combinations of variables which make up the macro economy. The ability to grasp a full understanding of the macro-economy on a multi-country level is not an easy task, even for the most seasoned policy maker.

Economy modelling tools are rife with complexity in terms of usability and users' ability to understand what is being presented on screen. These tools require specialized skills and expert-level knowledge which can often only be gained through expertise and experience in the field. Current technologies for monetary policy modelling such as Minsky[1], require the user to have a deep understanding in economic mathematical models and the ability to decode complex equations.

Policy games create a safe environment where people who have a key role in confronting major problems can put their knowledge and skills to the test. They provide the opportunity for a realistic experiential learning experience to mobilize core competencies and test skills which may be called upon in the future.

In this document we propose to build a game which will not only act as a tool for policy makers and key stakeholders but also a platform for which citizens can engage in monetary policy without being required to have a full in-depth understanding of how the economy works.

1.1 The Objective

A Game User Interface that will provide the utility of a monetary policy tool but the experience of a game enabling Policy Makers and Citizens to engage with SYMPHONY's macro-economic engine in a meaningful way.

1.2 ~~Monetary~~ Policy Game Introduction

The SYMPHONY game hereinafter referred to as "the game" will provide a fully immersive experience into SYMHPONY's macro-economic engine through a Game User Interface (GUI). Providing a space for policy makers and key stakeholders to explore and experiment with monetary policy ideas and for citizens who are interested in monetary policy, macro-economics and the financial sector in general - can join in order to provide a more realistic financial world simulation.

By providing a GUI we aim to reduce the complexity of interaction with the simulation engine (WP3) to set of simple and intuitive meta-game experiences which aim to guide the players through the experience by allowing them to play and experiment while being educated about the different components of the macro-economic environment.

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To achieve this, we devised a set of core overall design concepts which have been chosen to ensure that the player will get the most out of a game session.

- **Exploration**: The game will encourage players to discover and explore policy solutions and problems through guiding their creative thinking and decision making, by using a set of game mechanics and interface patterns; recurring solutions that solve common design problems.
- **Behaviour**: Providing specific game mechanics and interface patterns to stimulate certain cognitive processes which will help guide the user to make; more informed decisions, encourage exploration, risk taking and experimentation in the game.
- **Feedback**: The player must have clear feedback on all actions taken, so that they adapt and adjust accordingly in order to improve performance. This can be achieved either through a system-player or player-player interaction.

By using these concepts we aim to overcome one of the biggest and most challenging problems when designing an interface which involves financial data and analysis; simplifying the user experience. Current financial technologies are complex in nature and are not remembered for their user friendliness, by using a game based approach the game will not only excel beyond the state of the art of current financial technologies but provide a playful interface for policy modelling and a unique opportunity for Citizens to take part in a new approach to monetary policy engagement.

1.2.1 Data Driven Gameplay

The game is driven by the data generated by the simulation engine's Agent Based Model (ABM). A connector provides a translation link between the ABM and Game. When a player provides their input it is sent back to the ABM via the connector (WP5) in order for the next step to be calculated. The meta-games which incorporate goals and encourage exploration however sit within the game and do not impact the simulation.

The ABM contains hundreds of variables, most of which should be hidden from the players whilst in game. Our approach is to only display decision critical values and to incorporate only those variables which can be manipulated by the player, thereby considerably reducing the complexity of interacting with the ABM from the player's perspective.

Although the ABM drives the economic simulation it does not provide a playful experience, this is provided by a set of game mechanics (see section 4.3.4) with the game. These mechanics define the rules and processes which together form the game-play. The game mechanics react and report on the data provided by the ABM and feedback from the players, essentially bridging the gap between the two;

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Goals - Goals are a sequence of actions which give the player structure and motivation to progress forward exploring different areas and options in the game. In the game there are two types of goal structures;

(i) Predefined goals which are primary for citizens are pre-sets defined by the game designer, arranged in a rigid hierarchy, which can only be adaptable by players' choices

(ii) Player defined goals which are for policy makers, allowing them to set their own goals they wish to achieve. i.e. reduce unemployment rate by 4% over two years.

Victory conditions of a goal are dependent on specific variable values in the ABM, for the example above the variable in the ABM would be *unemployment_rate* from the Eurostat agent.

Score – A measured quantity of achievement associated with a player or team, often score is a key indicator of how well the player has progressed in the game. In the game there will be scores for each of the different player roles. i.e. the Government player may have *unemployment_rate* and *GDP* (Gross Domestic Product) where as a Firm may have profit as a score.

~~**Risk-Reward**~~**Managing Risk** – Risk can be defined as the potential to lose game progress or assets. i.e. time, experience and score could all be lost through the element of risk. Risk managed well can lead to r~~R~~eward, which is the positive result of overcoming risk which could include the gain of new assets, experience and score. Striking a fine balance between the two creates the Risk-Reward mechanic; the chance for receiving a reward in the game which is linked to some risk which will induce a penalty if the player fails to acquire the reward. Many of the decisions made while playing the game will have some low and some high economic risk associated with them. i.e. trading in the capital markets has substantial risk and reward, stock traders can put a lot of their capital on the line in order to gain big rewards, sometimes they win and sometimes they lose.

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2 The Game Requirements

2.1 Player Profiles

Below are the types of audiences we aim to build the game for:

Policy Makers/Stakeholders – people who work for Government bodies and financial institutions with their main aim to use the SYMPHONY game as a tool to experiment and test out monetary policy ideas.

Citizens – people who are interested in macro-economic and monetary policy. Citizens can not only play the game but also use it as a learning platform to discover more about the different factors of the macroeconomic world - Targeting mainly financially minded individuals such as; first time investors and economics students.

Researchers – people who wish to study not just the data and simulation outcomes of the game but also to study the social interaction of players and their ability to make financial decisions, exploring their cause and effects.

2.2 Player Roles

The ABM contains multiple agent types, which all interact and affect each other; however in the game the human player can only take control of a selection of these agents. The selected agents are key economic players, having a human player take control will help provide more realistic results to the Policy Maker when a game session is running. These agents are referred to as “Player Roles”.

Household Firm Bank Central Bank Government

Figure 1: Visual representation of the player roles.

Each Player Role has their own unique abilities, for example; Household players are the only role that can play the stocks/bonds market, Government players can affect tax, central bankers’ interest rates, banks’ lending agreements and firms to produce goods for consumption.

Decisions made by Government and Central Bank players (policy area) can have dramatic effects on other player roles; Households, Firms and Banks. Vice-versa if Households and

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Firms aren't able to financially sustain themselves they can cause Banks to go under causing a crisis, leading to recession, depression or even a whole country defaulting on its debt repayments. Each player is closely interrelated, creating a network where every decision taken by each of the player roles can have serious consequences for others in the in-game economy. A fine balance must be struck between playing it safe and taking risk in order to survive. More detail on player roles can be found in **APPENDIX I** of this document.

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3 The Game User Interface (GUI) Design

Overwhelming interface design is a serious issue for sophisticated financial and economic modelling technologies. The ever increasing competitive nature of the financial sector drives a “he who holds the most information, has the upper advantage” culture, interfaces increase in complexity to contain as much information as possible - sacrificing the user experience. Bloomberg’s terminal [2], an industry leading financial database is still stuck in the Microsoft Dos[3] era, where the learning curve is steep for which a lot of decision critical information is hidden in layers upon layers of Teletext[4] style pages and menu systems, requiring days to weeks to learn the basics and years to master.

Complexity reduces utility, dramatically increasing the learning curve, reducing productivity and generally causing player workflow problems such as feeling intimidated and being overloaded by choice (overchoice)[5]; having more choice appears to be positive, however the problem is making the optimal choice, when presented with too many choices the human brain becomes indecisive, unhappy and even refrains from a making a choice altogether.

Well-designed games however have an innate ability to reduce complex learning curves by using a process called Chunking; the process of breaking down complex tasks into smaller, easily digestible ones. For example a household player may be given the task to trade in the stock market; however they may not know anything about the market. The game can break up the stock market experience into smaller chunks, teaching the basics first then gradually introducing new interface elements and techniques as the player progresses. Allowing the player to learn at a pace that suits them. A good interface design combined with an intuitive game-play structure will be able to break down any task, no matter how complex, thereby reducing the overwhelming nature that is a primary problem user experience with current financial technologies.

The SYMPHONY GUI will not only aim to provide a well-rounded user experience but also to help guide the player to make positive decisions, i.e. providing decision critical information when and where the player requires it. *There will be two GUI design themes, a serious theme which will appeal to policy makers and stakeholders and a playful theme which will appeal more to citizens.*

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3.1 Methodology

A methodology was needed to ensure we covered the components of the simulation engine; we created a simple cyclic process that relied heavily on research and iteration in order to evolve the GUI design. The design process required a high attention to detail when looking at how each of the components work together, also in-depth design study in macro-economics, modern money mechanics and current financial dashboards and technologies was also required to enable the design to sit comfortably in a financial setting and still look appealing to the eye.

Below is a diagram of the methodology concept we have incorporated into the design of the game.

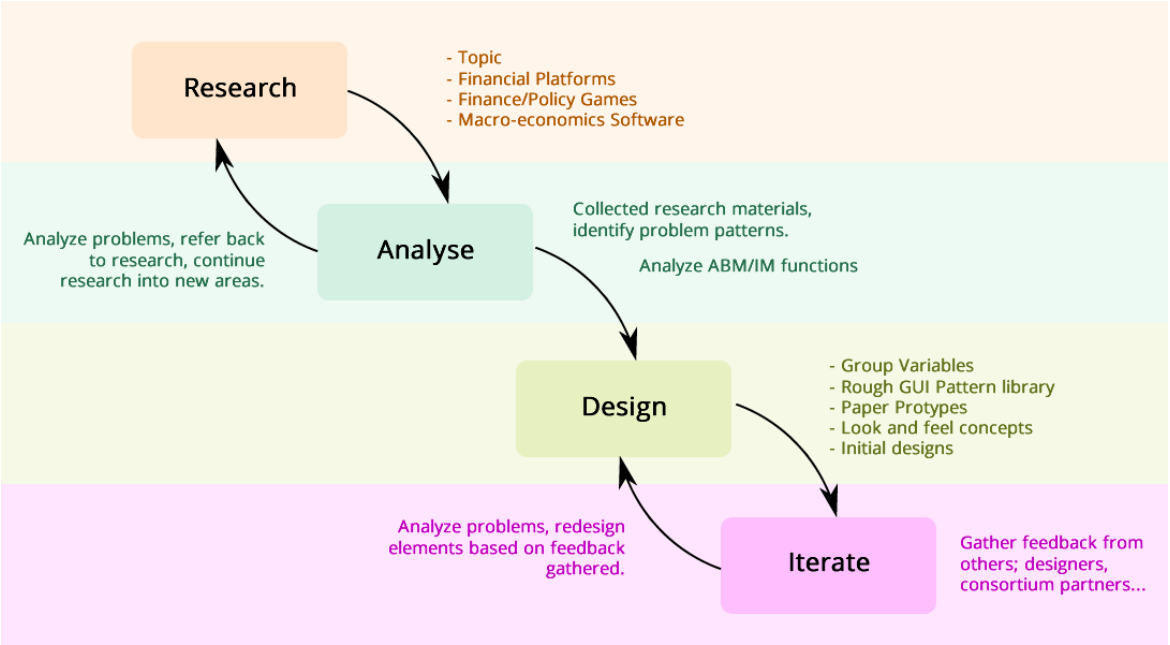

Figure 2: Design methodology created for the GUI design.

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3.1.1 Research

Research for the GUI design process started off by looking into the financial sector, in particular monetary policy and macro-economics, including help from the project partners to explain how the economic system works. From the initial discussions with the project partners and research sessions the game design team was able to gain a good insight into how the simulation engine operates in relation to the real world economy. Once a basic understanding of the ABM was established, detailed research into financial technologies could proceed. We aimed to look at policy modelling applications, policy/economic video games and financial tools. We split up the visual research into three sections; policy modeling, policy and economic games, financial tools/dashboard designs (in particular data heavy interface designs).

We used a variety of services such as Pinterest[6]; a visual discovery tool that lets you find ideas by others and share your own and Dropbox[7]; a cloud service which allows you to upload and share files among your team on mobile and desktop devices. This provided us the ability to collate research material and share items of interest among the design team and project partners. **Figure 3** shows one of the interest boards created around data dashboard designs.

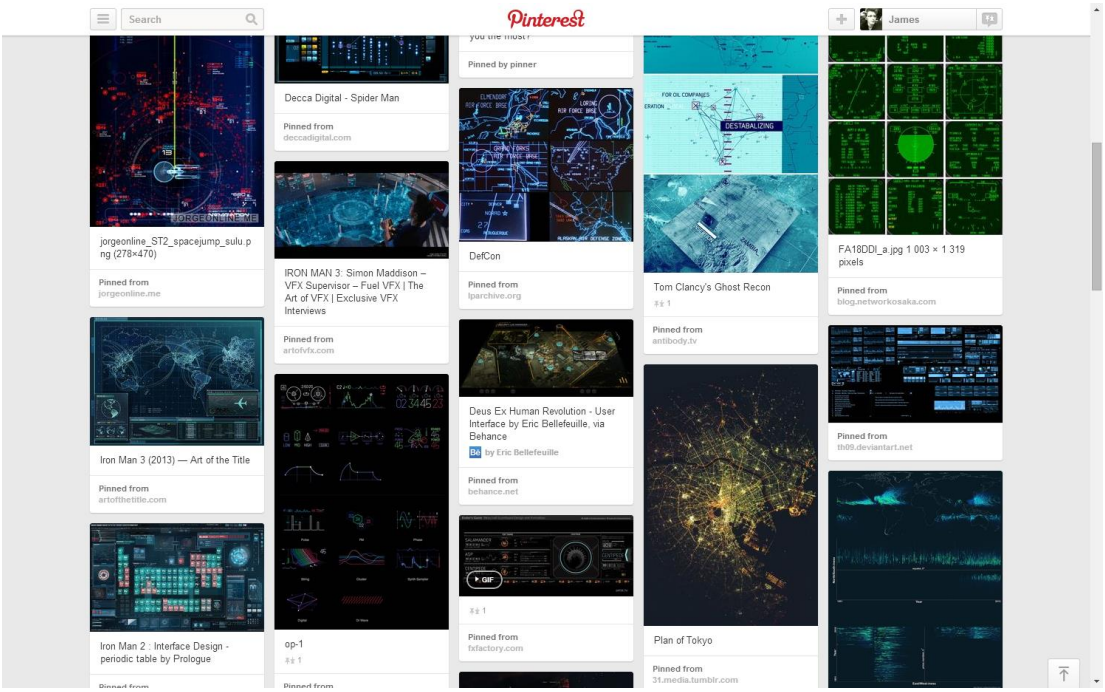

Figure 3: Board showing collated images of the research done.

The design team also immersed themselves into the world of financial tools and Big Data by creating physical mood walls for each of the sections, below (see **Figure 4**) you can see one of the research walls which was dedicated to showing financial tools, just from the picture we can see the wealth of information some interfaces display to users.

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Figure 4: Designer Research Wall

3.1.2 Analysis

During the research hundreds of images and videos where collected from;

- Industry Leading Platforms; Bloomberg Terminal, Eikon[8], Morgan Stanely Matrix[9], BARX[10] and Infront[11]
- Current Game Technologies; Capitalisms 2[12], Democracy 3[13], Geopolitical Simulator 3[14], Spent [15], SimCity[16]
- Financial Dashboards; Bank Trends[17], Google Finance[18] and StockTweets[19]

The collection comprised of; images, tutorial documentation, YouTube[20] videos of people using the software and also some free trials were taken to help our designers gain firsthand experience of how these technologies operate. During the research phase problems where noted and soon became apparent that these problems are consistent throughout software which deals with financial data (real world/sim). Although the games we did review where very well designed and kept the information to a bare minimum they lacked granularity, which the financial software tools provided.

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In the table below we have listed a set of problems which were consistent throughout the research, these problems we found to be primary causes to major problems in the user experience.

Problem	Solution
1. Users are required to know a considerable amount of how the financial sector works.	Games are great for introducing each element as the player progresses; interactive tutorials help guide the player through difficult game-play journeys.
2. Vast knowledge of the different diagramming techniques and visualizations is required to make sense of what is going on.	Reduce the variety of diagrams; introduce a default type, which can be reused across the experience. Some variety may be needed to convey certain types of information, however the player should only learn once and not every time a new screen or piece of information is presented to them.
3. Too much irrelevant information on screen presented to the user.	Only present context related information that can guide the player to make a decision and not act as noise.
4. 10-20 clicks culture where sifting through pages of information seems to be the social norm.	Try to aim to give the user the decision critical information within 3 clicks or less.
5. Database approach, information is presented but no clear indicators of what to do with it.	Provide a journey which introduces information as and when it's needed as well as educate the user so they are able to make decisions.
6. Access to these tools for Citizens is too costly for a student or someone who shares interest in monetary policy.	One of SYMPHONY's main objectives is to engage Citizens, where anyone interested in finance will be able to sign up and play.
7. Decisions are comprised of hours of research into financial data such as; reports, balance sheets, firm data, country data, which takes up a lot of time and effort.	Although time is needed in order to decide if to increase variables such as tax or interest rates, there should be contextual information presented on the screen where that decision needs to take place or at least a visually indicated journey of where to go to get the information to make the decision.
8. Interfaces are usually static and don't fit the needs and requirements of all the users who use them.	By using a "Bento-Box" approach to screen layout, pieces of information can be comprised into widgets. Players can customise what widgets to show on each panel to fit their

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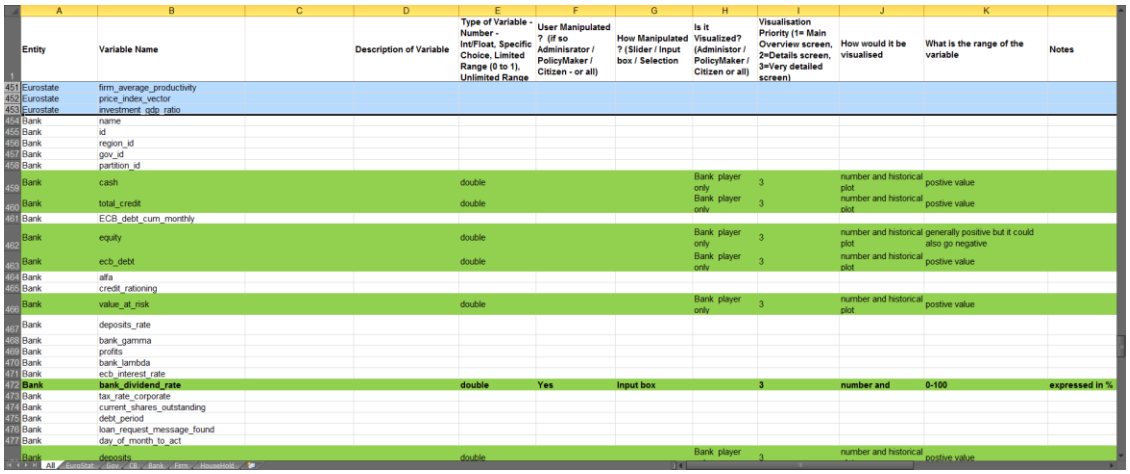
	needs/requirements, thereby providing a solution for them to personalize their experience.
9. Tutorials consist of huge instruction books and libraries of videos.	By using a game a "Do it yourself" approach can be adopted, games allow for interactive tutorials, the player can learn by doing with the games guidance.

Table 1: Problems identified with current financial technologies.

3.1.3 Supporting Materials

During the research and analysis an internal document "SYMPHONY Variables Description" was jointly created between the modelling and technology partners, to help document and detail what each of the variables in the ABM does. The document is used as a reference guide for the game designers to ensure they support all the required variables of the ABM.

The document also detailed which variables are of priority to the player and which ones should be hidden away from view. This was the first step to simplifying the player's interaction with the ABM. The document also formed the foundation of the GUI design and was constantly referred back to for reference in design and functionality.



	A	B	C	D	E	F	G	H	I	J	K	
1	Entity	Variable Name		Description of Variable	Type of Variable - Number - Int/Float, Specific Choice, Limited Range (0 to 1), Unlimited Range	User Manipulated ? (if so Adminisrator / PolicyMaker / Citizen - or all)	How Manipulated ? (Slider / Input box / Selection	Is it Visualized? (Administor / PolicyMaker / Citizen or all)	Visualisation Priority (1= Main Overview screen, 2=Details screen, 3=Very detailed screen)	How would it be visualised	What is the range of the variable	Notes
451	Eurostate	firm_average_productivity										
452	Eurostate	price_index_vector										
453	Eurostate	investment_gdp_ratio										
454	Bank	name										
455	Bank	id										
456	Bank	region_id										
457	Bank	gov_id										
458	Bank	partition_id										
459	Bank	cash			double			Bank player only	3	number and historical plot	postive value	
460	Bank	total_credit			double			Bank player only	3	number and historical plot	postive value	
461	Bank	ECB_debt_cum_monthly										
462	Bank	equity			double			Bank player only	3	number and historical plot	generally positive but it could also go negative	
463	Bank	ecb_debt			double			Bank player only	3	number and historical plot	postive value	
464	Bank	alfa										
465	Bank	credit_rationing										
466	Bank	value_at_risk			double			Bank player only	3	number and historical plot	postive value	
467	Bank	deposits_rate										
468	Bank	bank_gamma										
469	Bank	profits										
470	Bank	bank_lambda										
471	Bank	ecb_interest_rate										
472	**Bank**	**bank_dividend_rate**			**double**	**Yes**	**Input box**		**3**	**number and**	**0-100**	**expressed in %**
473	Bank	tax_rate_corporate										
474	Bank	current_shares_outstanding										
475	Bank	debt_period										
476	Bank	loan_request_message_found										
477	Bank	day_of_month_to_act										
478	Bank	deposits			double			Bank player	3	number and historical	postive value	

Figure 5: SYMPHONY Variables Description Excel Spreadsheet

This was the first visual mockup of the GUI in its rawest form. The functionality visual mockup for the bank player role is shown in **Figure 6**, which categorises the variables into four important groups that helped organise each of the ABM's variables:

- Can Manipulate – Variables, which a particular player role is able to change.
- Private Data Displayed – Variables that only a particular player role can see, no other player roles can see this data. I.e. A banks balance sheet is not public. However it

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was removed later on in the design process as it made more sense to provide this data to other agent roles. I.e. Households (market traders) who would trade financial securities.

- Public Data Display – Data that all player roles could see.
- Decisions Made – Decisions, which the player role could do within the game.

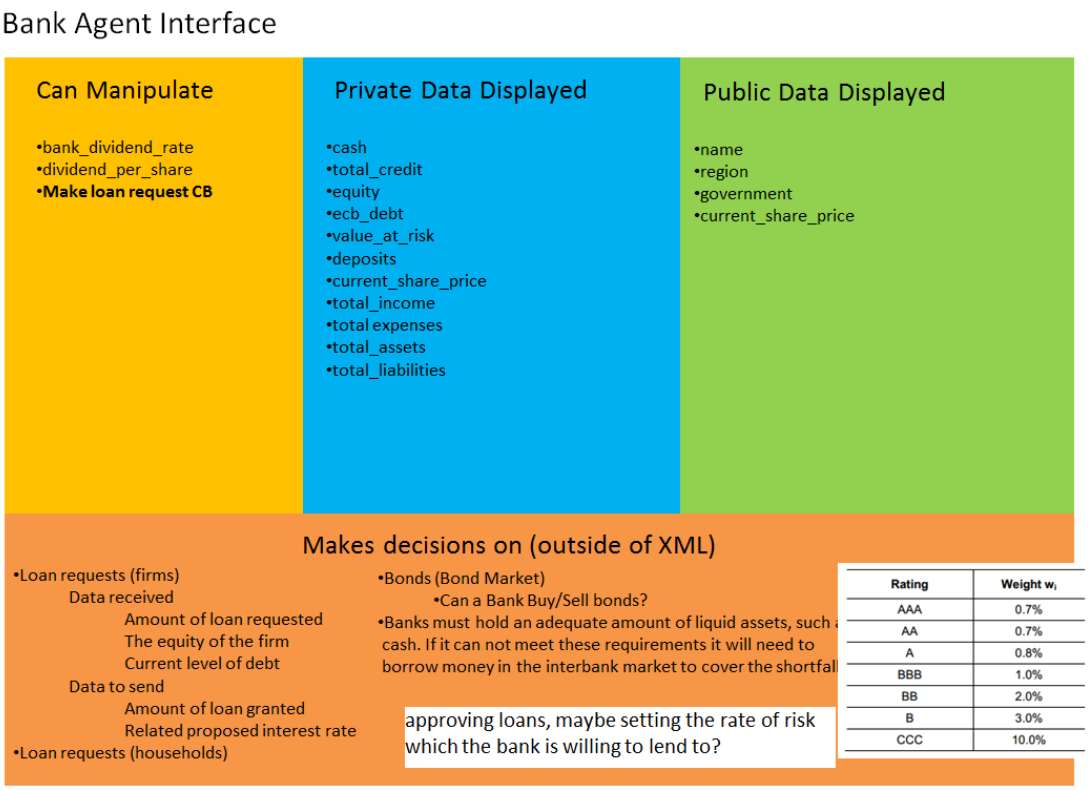

Figure 6: Example of the Bank agent interface, in functionality terms.

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3.2 Design

The visual functionality mockups (shown in **Figure 6**) provided a good foundation to begin the design process:

1. Identify groupings within the list of variables per an agent.
2. Convert variables to interface patterns.
3. Paper prototype of each layout for each player role.
4. Provide a sitemap of the GUI.
5. Look and feel design, sketches and concept mockups
6. Initial designs for policy maker and citizen GUI versions.

3.2.1 Identify groupings within the list of variables per an agent

A list of variables was created per a player role and then each variable was categorised according to their function. The Government player role for example (shown in **Figure 7**) had a lot of variables to do with tax, so the group was named “tax”, which then was split into the four types of tax. The player role can manipulate; labour, capital, corporate and VAT tax.

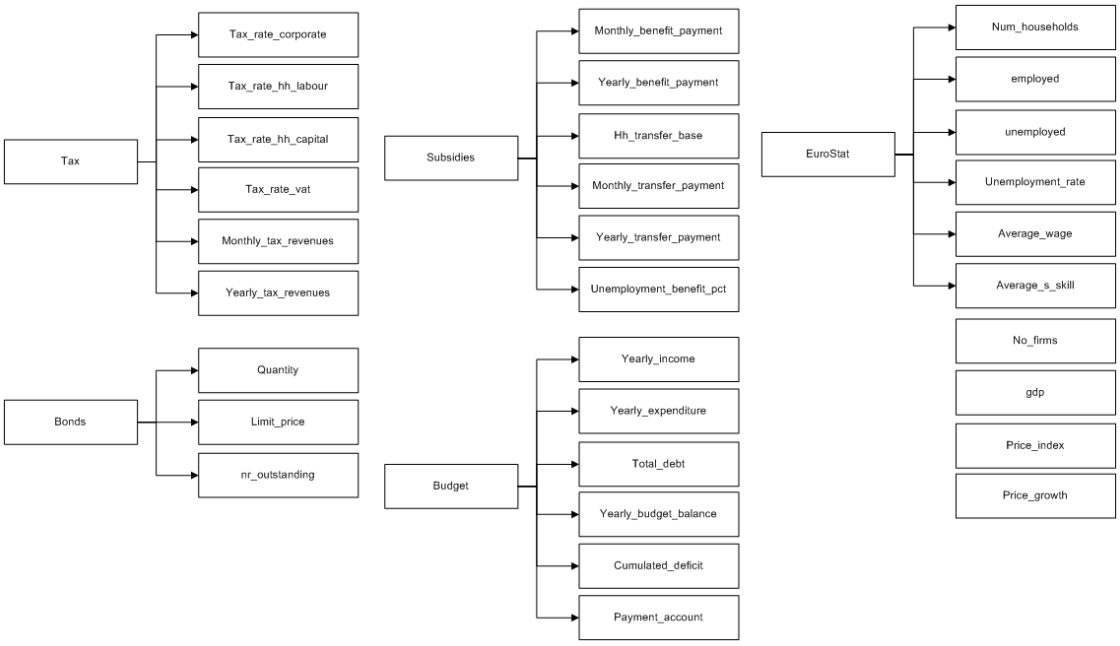

Figure 7: Government player role diagram showing the groupings of variables.

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3.2.2 Convert variables to interface patterns.

Next each of the variables was converted to a GUI pattern which was generic enough to be reused across all the player roles, excluding the player role only variables which where specific to a particular player role. We analysed each variable and coded them by; string or integer, then worked out if there were any cross overs with other player roles. If a crossover was identified we marked it as a pattern, if there was no cross over then it was marked as a specific function. i.e. the Bank player will have a variable which states the risk rating for firms and households the player is willing to lend at, this variable is unique to the bank player only and cannot be reused across other roles. The pattern library we created is shown in **Figure 8** below.

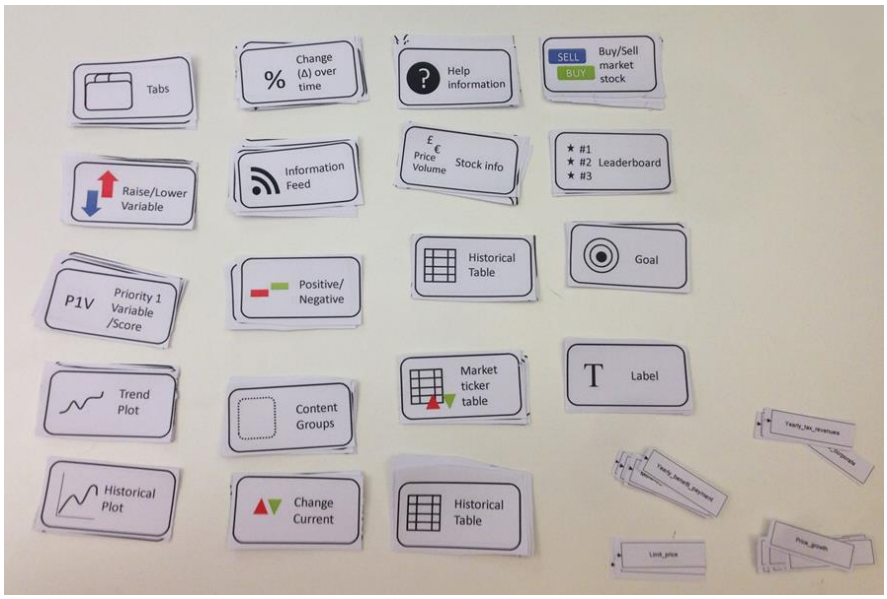

Figure 8: The paper prototype of the GUI pattern library

3.2.3 Paper prototype of each layout for each player role

We chose to create a paper prototype to remove the constraints computerised mock-ups have, this enabled the design team to be more creative in the design sessions as opposed to them individually sitting at their desks using their own computer and not interacting as a team.

The paper prototypes main aim was to test to ensure the groupings that where created per each player role worked and felt right, as well as introducing visual elements to the design process. After a lot of debate and critical analysis of each group and pattern, we finalised the paper versions and recorded the results. Below are two examples of the paper prototypes created for the Government and Bank player roles.

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Figure 9: Government player role panel mockup

Figure 10: Bank player role panel mockup

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3.2.4 Provide a site map of the GUI

A sitemap provides the overview of the structure of a website; we use a sitemap for the game in order to see from a high level all the screens which are required for the game. Messages and popups are displayed as “messages” in the main section of the sitemap.

In **Figure 11** the diagram uses the process blocks to represent individual screens in the game-play experience. The site map helps visualise the overall game world and acts as a layout for what graphical design elements are needed.

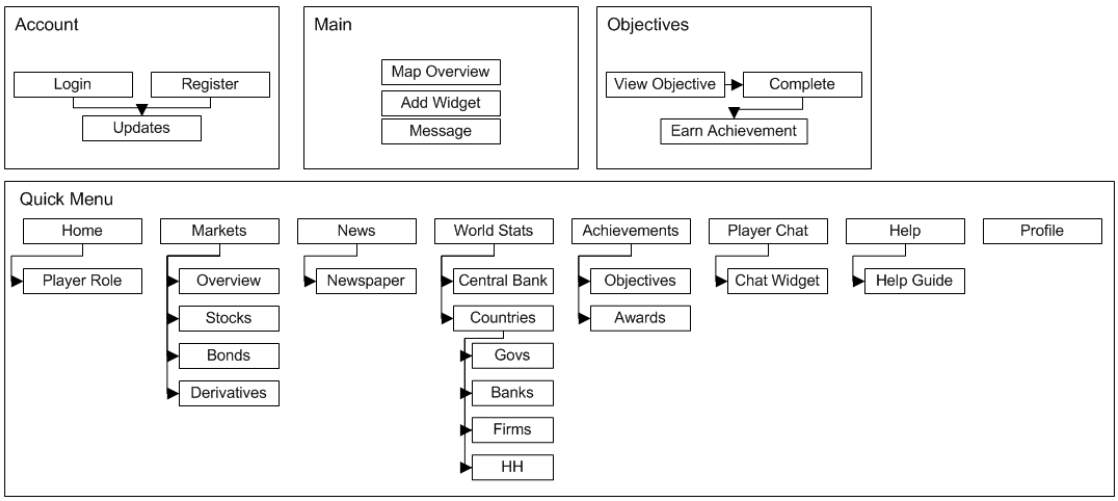

Figure 11: GUI Sitemap diagram

3.2.5 Look and feel design, sketches and concept mockups

Once we had a rough idea of the layout for each of the player roles and how the game world structure may look like, we were then able to progress on to the look and feel mockups and conceptual designs. It was apparent from early stage concepts that the game would have a science fiction style interface, made popular by movies (see below) such as Iron Man (**left**)[21], StarTrek Into Darkness[22] (**middle**), and of course the most notable Minority Report [23] (**right**).

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Sketches

We experimented with different types of interfaces and visualization methods, below you can see eight sketches comprising of different interface themes and visualization methods.

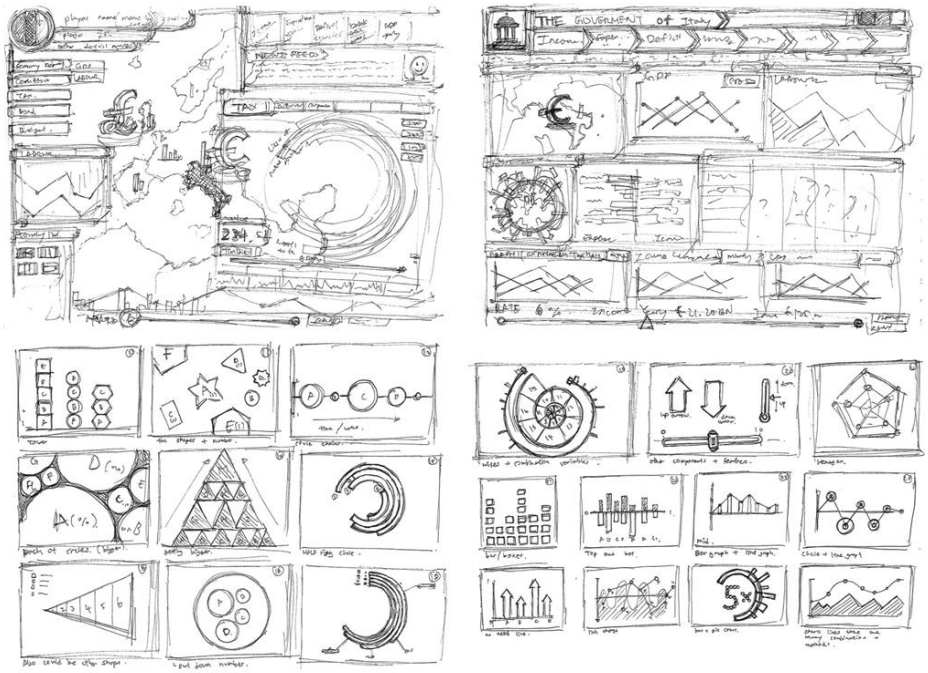

Figure 12: Sketches showing different interface styles and visualization techniques

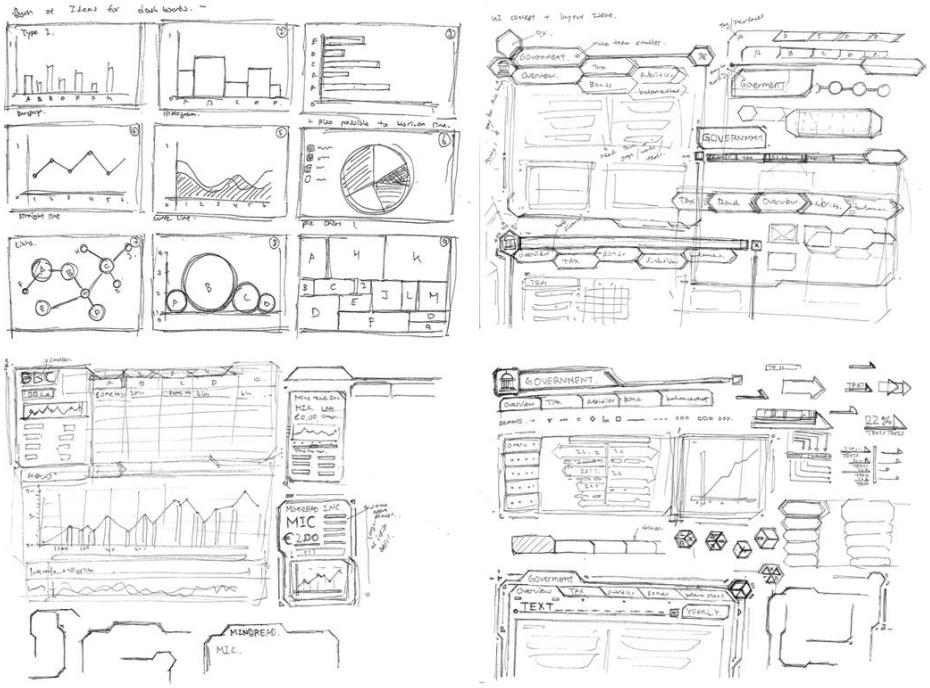

Figure 13: Sketches exploring different visualization techniques and interface layouts.

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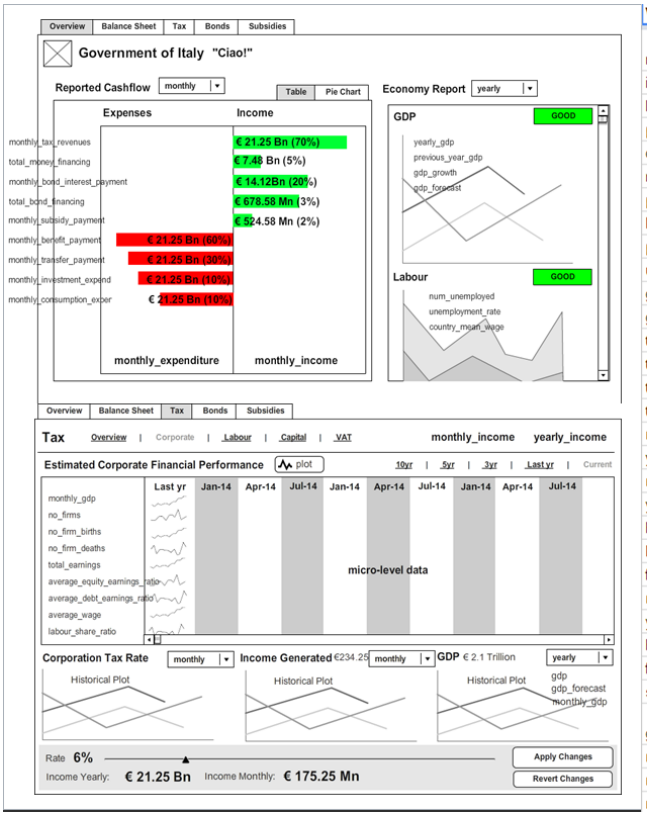
Wireframes

After the initial sketches where made we moved into creating a set of rough wireframe mock-ups in order to visualize the amount of data on the screen to the player. We were able to quickly remove and simplify elements however the wireframe did not resemble the design and only acted as a layout indicator to how much information needed to be displayed to the player.



Variable	Interface Area
name	
id	
list_of_regions	
payment_account	
day_of_month_to_act	
region_id	
partition_id	
bond	Bond
pending_order	Bond
unemployment_benefit_pct	Subsidies
gdp_fraction_consumption	
gdp_fraction_investment	
tax_rate_corporate	Tax
tax_rate_hh_labour	Tax
tax_rate_hh_capital	Tax
tax_rate_vat	Tax
monthly_tax_revenues	Tax + Cashflow
yearly_tax_revenues	Tax + Cashflow
monthly_benefit_payment	Subsidies + Cashflow
yearly_benefit_payment	Subsidies + Cashflow
hh_transfer_payment	
hh_transfer_base	
firm_transfer_payment	
monthly_transfer_payment	
yearly_transfer_payment	
hh_subsidy_pct	Subsidies
firm_subsidy_pct	Subsidies
subsidy_flag	Subsidies
gov_interest_rate	
monthly_bond_interest_payment	Bond + Cashflow-Income
monthly_subsidy_payment	Subsidies
monthly_consumption_expenditure	Cashflow - Expenses

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Concepts

Once we were happy with the wireframes we began the concepts, these would represent the graphical feeling of the game. Here the GUI was transformed from simple wire frame components into an image that looked like a screenshot of the game. Two concepts where created to show off the possibility of a different look and feel around the same theme.

Concept A

Figure 14: Concept A, World View, graphical treatment.

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Figure 15: Concept A, Market View, graphical treatment.

Concept B

Figure 16: Concept B, World View, graphical treatment.

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Figure 17: Concept B, Market View, graphical treatment.

The plenary meeting in London provided the perfect opportunity to gather feedback from all the consortium partners as well as the most important task; to choose the concept they preferred.

Feedback summary:

Both concepts are nice; however concept B lends itself to be more plausible. The interface should be adaptable as all the variables of the ABM and new elements are still unknowns so this should be a factor in the design. Concept B was chosen by all partners.

What was apparent that the chosen concept had a static interface, meaning if new items needed to be added it would need to go through a redesign, which wasn't an economically viable option. We set out new objectives for the initial design:

- The GUI should be fully responsive and customizable, to allow the player to customize their experience.
- Game goals should be more visible to the player.
- Certain variables, which the player can manipulate, should provide instant feedback to the player. I.e. when increasing the Corporate Tax rate an estimation value should be calculated to see how much Income would be generated if the player decided to increase the rate by a specific amount.

The result; an adaptable interface, which could be customised for the specific player roles as well as providing the player the ability to customise their experience, this principle was adopted from what financial tools do best. What became apparent quickly was simplifying the interface by organising it into tabs or windows

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What was apparent was simplifying by removing/hiding information into tabs or other screens didn't provide the player any advantage in trying to avoid the effects of overchoice. It merely created a new problem where vital information was hidden from the player when making a critical decision, i.e. if the Government player was to raise Corporate Tax they may want to see the current income generated or macro indicators such as the Consumer price index (CPI) or Gross Domestic Product (GDP). Chunking information into digestible widgets allowed for an in-game character to explain each widget, introducing them one by one until the player knew exactly all the key widgets they needed to make a decision such as raising Corporate Tax.

Below is a selection of the styles and themes we explored when designing the GUI interface for the game.

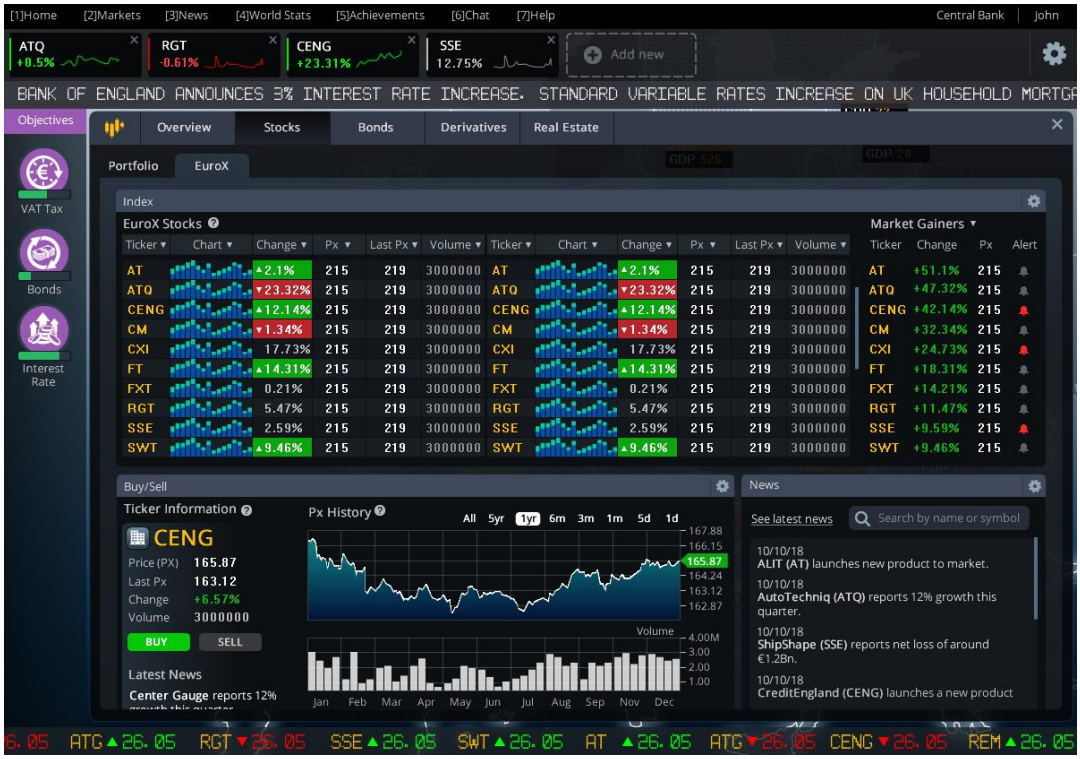

Figure 18: Example look and feel version 1

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Figure 19: Example look and feel version 2

Figure 20: Example look and feel version 3

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Figure 21: Example look and feel version 4

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3.3 Policy Maker GUI

The policy maker GUI theme provides a more serious view of the game, although all the game elements are still visible. What is important about this version of the GUI is it appeals to the serious user; most of the research on financial tools and software was used to construct the look and feel for the policy maker GUI.

Please not the GUI design is not final, and does not represent the full end product.

Figure 22: Policy Maker GUI, Home view.

Annotation

1. **Quick menu bar** – Here the player is able to navigate across the different environments within the game, providing the player with easy access to; their home screen, markets, news, achievements, help and account/profile information.
2. **Ticker** – The ticker will display different information depending on the player role;
   - Household – Displays stock market index.
   - Firm – Displays stock market index.
   - Bank – Displays stock market index.
   - Central Bank – Displays country GDP index
   - Government – Displays country GDP index.
3. **Side panel** – The player can access each individual agent from this panel as well as view the latest economic news and rankings between players, agents on different economic indicators, i.e. rank countries by GDP.

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4. **Goals** – The goals panel is visible on screen at all times; this allows the player to keep track of their progress while playing the game. The goals panel also allows the player to click on an individual goal to see more information or they can playback using the auditory feedback function to hear their progress.
5. **Simulation day/time** – This element keeps track of the date within the game. This is important as certain player roles can only make decisions on a weekly or monthly basis.
6. **Victory Points** – The Victory Points the player accumulates while playing is displayed here. Victory Points are awarded when the player shows good performance or when goals are completed. At the end of the game victory points are a mechanism for social comparison so players can see how they did compared to others.
7. **Agent Overview –** The agent overview displays the economic indicators and instruments of the player's agent as well as other agents within the game. The panel works on a tab basis, every time the player wishes to access a new agent a new tab is created and the information related to that agent is displayed.
8. **Chat Panel** – The chat panel allows players to chat with each other in-game, discuss strategies and policy ideas with player roles of the same kind or globally everyone.

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3.4 Citizen GUI

For a citizen to engage with the game, the Policy maker's GUI would not appeal to them, as it comes across more as a tool than a game. The citizen version emphasizes a more playful experience, where visual communication is similar to popular music titles such as Rock Band [24] or music editing software such as EJay [25]. The main aim for the Citizen GUI is to provide a visual style that is appealing to the player, using bright colours and game like visuals to entice them to engage and discover what the game is about.

Please not the GUI design is not final, and does not represent the full end product.

Figure 23: Citizen GUI, Home View.

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3.5 GUI Pattern Design

The vast amount of data and types of data the player needs to understand in the game can be overwhelming at first; we have opted for a widget-based approach that helps chunk data down into easy digestible pieces. The most important factor is to design and build a GUI that can accommodate and adapt to changes to the ABM and the ability to provide extra components for the game without requiring a re-design. What is required is a set of generic templates or patterns that can be utilized across the game design once and apply multiple times. For this approach we look to the field of architecture for inspiration.

The main mindset of an architect is to focus on the use of space and experiences people should have, i.e. when crossing a bridge or navigating a skyscraper. In the 1970's Alexander, et al [26] introduced the concept of design patterns in the book *A Pattern Language: Towns, Buildings, Construction*. Based on this experience of design within his field, these patterns described design challenges of all different kinds, where an architect could encounter anytime from designing a city to arranging future in a room.

The book describes patterns which connect to each other in such a way that choices made by using the pattern naturally move attention to other patterns. The focus was to create a method of codifying design knowledge in separate but interrelated parts; the practical use of patterns is summarized by the extract below:

"Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice."

There are also design patterns for software engineering by Gamma et al[27], and interaction design by Borchers[28]. In this next section we describe the GUI patterns we have constructed for the game. These patterns have been specifically designed to ensure they are reusable across all sections of the game, this approach will allow for a "design once, deploy many" mindset. We shouldn't need to show a custom visualisation/graph for each variable. If a variable can be displayed as a historical plot then it will have a pattern associated with it; the same pattern is used on all variables that can be displayed as historical plots.

Please note: All images from this point will display the Citizen GUI version for visual style and effect, the Policy Maker version will mimic the exact details however will be represented in a more serious colour scheme.

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3.5.1 Vertical Stacking

A primary problem faced when designing the GUI, was the information architecture and the utilization of real estate on the screen, avoiding information heavy sections of the interface, which looked intimidating, ultimately causing overchoice.

From our research in **section 3.1.1** we found that financial software falls short when it comes down to user experience. The main objective for these types of tools it to display as much information as possible in detail in hopes the user knows exactly what's going on at all times about everything single value on the screen.

We decided to look elsewhere to see if any other industry's deal with the same amount of complex data and visualization methods, we discovered similarities in the music industry, in particularly music composition software. Similar amount of data is displayed in visual form such as sound wave graphs and information heavy blocks, however the interface tells the story and organizes decision critical information all on one layer which makes using them a lot simpler than a trading terminal for example. Industry leading software such as Apple's Logic Pro [29] and Steinberg's Cubase [30] are prime examples of user experience design solving real estate and information architecture problems.

Although these interfaces can get complicated, they do for a reason. By the time the interface becomes complex the user is at the level where the type of complexity level is needed in order to satisfy their utility requirements. The software presented many different variables, knobs and buttons to manipulate, however the interface was simple to understand due to the fact that each instrument was on a horizontal track stacked vertically, this made it simple to understand not just the individual instrument but the composition of the whole song.

We began to notice similarities between the way music instruments are presented in software and how economic indicators/monetary instruments could be presented. We applied the same design pattern to the GUI and found that stacking the indicators made it much easier to compare between each other, compared to our first approach where we tried to compare indicators side by side that seemed to take up a lot of real estate and was difficult to convey to the player.

In the **Figure 24** below you can see how the interface has been specifically designed to provide the player with as much visual feedback as possible as well as providing a clean design that allows the player to compare economic indicators quickly.

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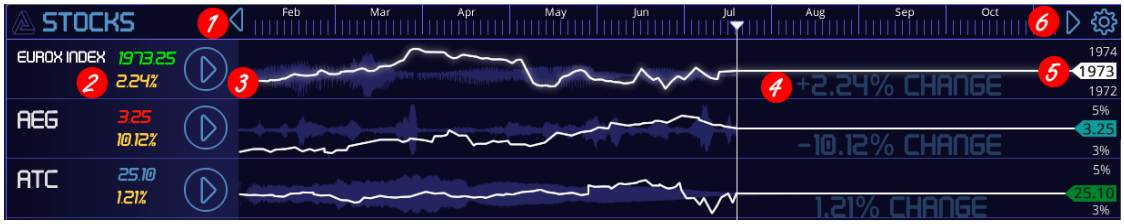

Figure 24: Example showing how indicators can be stacked.

Annotation

1. Timeline is consistent along the top; each indicator is plotted as a historical plot so the timeline is always at the top of the panel.
2. Colour coding is a type of visual feedback, Green meaning good and red meaning bad. In the context of the game Green means there has been a positive change since the last value, red being a negative change, blue meaning no change in value. Yellow indicates to the player that this value is changeable; in the stock market it represents change in the agent overview it means the player can manipulate the variable.
3. A player can see the graph being plotted or if they choose to they have the ability to hear how the economic indicator is doing using the auditory feedback function, represented as the "play icon".
4. Change is an important factor when looking at an indicator; we have placed the value twice to guide the player's eye to help them make better more informed decisions whilst avoiding straining the player's eyes too much. The player can compare change amount, current amount and progress on the right and change amount, scale and current amount on the right.
5. Each indicator has a scale, which is unique to it. The scale shows the lowest, highest, middle and current value the indicator has reached. This interface pattern is common among financial software and proves efficient and effective for the user experience in the game.
6. The player has the ability to scroll back and forth through time using the timeline functions as well as change the time scale using the settings (gear icon).

3.5.2 Progressive Disclosure

Progressive Disclosure reduces cognitive overhead to help maintain the focus of the user's attention by minimalizing visual and information noise. This is mainly achieved through moving less frequently used elements behind a secondary of interaction, most commonly through additional popups or screens through a mouse roll-over, mouse click or keyboard shortcut. Jakob Nielsen [31] defines progressive disclosure as:

"Progressive disclosure defers advanced or rarely used features to a secondary screen, making applications easier to learn and less error-prone."

In order to achieve this we need to prioritise static, dynamic and interactive variables that surround each of the economic indicators/monetary instruments. I.e. a stock variable has a

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lot of values associated with it: price, last price, change, volume, firm details and latest related news to the stock. Table 2 below shows an example of how we prioritized the information into two screen levels.

Variable	Screen Level	Why
Stock Symbol	1	This is the name of the stock and should be visible to the player at all times when viewing stock data.
Current Price	1	The current price of the stock is a very important piece of information that should be displayed with the Stock Symbol at all times.
Last Price	2	Last price isn't as important as the current price, "Change" can provide much more valuable information that the last price.
Change	1	Is the value between the last price and current price as a percentile, this provides valuable information about the stock's performance.
Volume	2	Shows the volume of stock released by the Firm, doesn't help the player make a decision.
Firm details	2	Shows details about the firm that the stock is representing.
Related News	2	News can inform the player of the stock performance and company activities, however it isn't viable to show news feed for each stock on the interface.

Table 2: Progressive Disclosure, prioritizing decision critical information

Figure 25 shows the results of using the progressive disclosure process on the GUI designs. (1) Shows the first design showing all information related to the stock. Visually similar to how real world financial technologies present stock data. (2) Second design, hides the Volume historical graph and latest news stream. (3) Third design, simplified to show only the decision critical pieces of information. The player can choose to see more detailed overview of the stock by clicking on it.

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Figure 25: Iterations of the design using progressive disclosure.

3.5.3 Tabs and Accordions

Tabbed navigation brings a real world element to the GUI, and when done right works very well in an experience. “Tabs” come from the use of tabs in filling cabinets, a real world object most people have some experience with – and a concept that requires no instruction. The game uses tabbed navigation in order to organization how the player views individual agent data. Each tab in the Agent Main panel represents a single agent in the game. There are three main design advantages to using tabs these are:

- Tabs provide context. They offer the ability to give visual indication of a user's location within a body of information.
- Tabs build on a real world metaphor. The selected state is reinforced with the file folder tab metaphor of a folder physically in front of the others in the set.
- Tabs provide navigation. They provide the ability to navigate the site.

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Tabs can be stacked within the game (**Figure 26**) to allow for many agents to be accessed quickly and easily. By providing a stacked tabbed navigation will allow primary player roles such as central bank keep an eye on many agents all at the same time, i.e. all government agents/players, markets and latest news.

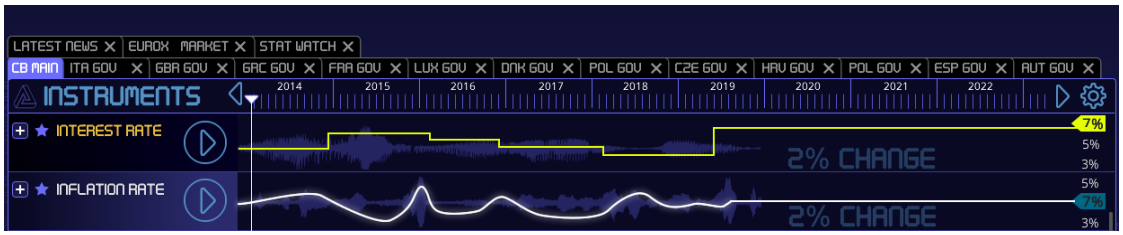

Figure 26: In-game stacked tabbed navigation.

A stacked tabbed navigation will prevent problems such as readability for each of the tabs, this happens when programs such as Google chrome has too many tabs open. **Figure 27** shows this problem clearly where the text has no space to be displayed so blank tabs are shown instead – the user has no idea what each tab will direct them to.

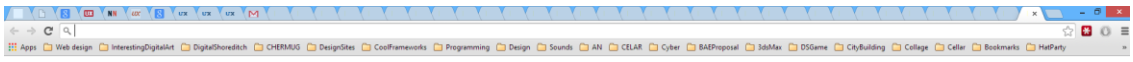

Figure 27: Google chrome, tabbed navigation.

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4 Game Design

Figure 28: The Symphony Game logo.

SYMPHONY Economic DJ is a multiplayer online game, where players take part in an macroeconomic simulation as key economic players, where they have the ability to role play as a; Government, Central Bank, Bank, Firm and Household with the ability to take charge of financial decisions to help steer the virtual economy to a brighter future. The game will provide a unique experience to engaging with monetary policy through the use of auditory feedback. Players will not only be able to see their progress but also hear it, giving them the ability to listen to stock prices jump up and down as well as understand why certain monetary policies have greater impact than others.

Game sessions are finite and will come to an end once the set time is up, i.e. 40 years in-game time has passed. Game sessions can be run within a few hours for policy maker and stakeholder workshops to a whole month for the citizens. Player's progress by completing goals within the game, that earns them victory points and bonuses for good performance. Penalties are given the player fails to reach the goal, either by going bankrupt or destabilizing the economy in such a way that it's rendered impossible to recover from.

The game relies on four primary features:

- **Goals** – Players work towards a set of goals within the game; these goals can either be set by the player or by the designer. A policy maker may want to set their own goals compared to a citizen who may want to just play along with what the game designer has created for them.

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- **Victory Points** – Victory points are the measurement of a player's progression within the game. Victory points are awarded to players for good performance and completing goals. Victory Points are a key performance indicator that can rank players between each other.

- **Auditory Feedback** – Each economic indicator, i.e. GDP can be plotted on a historical graph**.** The game is able to take the data from the graph and convert it into audio, which will allow the player to playback the graph. This provides an extra tool to engage players by using their auditory sense. Players can listen to the stock market as well as hear how well they are doing and may also identify certain patterns that where missed when observing the data visually.

- **Multiplayer-Synchronized Appointment Dynamics** – Each player roles requires a different allotted time in order to successfully play their in-game role. For example a Central Bank player may only make decisions once a month (in-game time) where as a Household player can make decisions on a daily basis. If the Household player where to make decisions the same frequency as the Central bank it would take a whole month to buy a stock, they would miss one month of the stock market which isn't fair, causing them to lose money or worse go bankrupt and be eliminated from the game.

4.1 Game Types

4.1.1 Workshop Game

A workshop game version will run for a consecutive amount of hours, depending on how long the workshop facilitator sets the game to run and how many players there will be participating. The game can be set to run in two time modes depending on the facilitator's preference for time allocation, for example:

- Longer in-game time limit, longer the decision period (real world time).
    - I.e. A workshop may last for 5 hours that would allow for 50 years, 1 hour per every 10 years.
- Longer in-game time limit, shorter the decision period (real world time).
    - I.e. A workshop also may last for 5 hours however requirements are for it to run 100 years, reducing the time to make decisions.

Each participant will have the ability to choose a player role they wish to play, if a player role is not fulfilled the artificial intelligence (ai) will take on the role.

Player roles which rely on each other may need to wait for the other player to make a decision before they can continue, i.e. a Firm will need to wait for a bank player's decision

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on their loan request. Player roles are also allocated different time slots to which they can make their decisions. For example a Central Bank player can only submit their decisions once a month, if they miss the first week of the month and submit their decisions the second week; they have two more weeks to wait until they can make their next set of decisions. A Firm or Household may make a decision every day and will have a shorter decision period time. Using this method allows players to synchronize with each other much more easily otherwise if a Firm waited the same amount as a central bank to make a decision they would require six months in order to make a production run viable.

Government and Central Bank players can make their decisions every month, Firm and Household players can make their decisions on a daily basis and Banks are in-between as they rely on Firms and Households to request loans in order for them to make decisions.

In-game goals will be down to group discussion and will reflect on the main objectives of the workshop. The aim for the players is to achieve these goals while playing the game. The game comes to the end for a player when they go bankrupt, leading to them exiting the game and being shown their final score and progress. Bankruptcy is only applicable to households and firms or when the time limit for the game is reached, i.e. 40 years.

The game comes to the end for the player when they go bankrupt, applicable only to households and firms or when the time limit for the game is reached, i.e. 40 years.

Players are then able to compare in-game score as well as well as see everyone's decisions and progress on a timeline, created during the game.

4.1.2 Public Monthly Game

The public game will run on a monthly basis, resetting at the end of the month. The public game will allow players to drop in at any time during the game running and does not require them to join at the beginning of the game in order to participate. A player who jumps in half way through a game session will assume control of an Ai agent that has been running in the game until the point where the player joins.

The multiplayer-synchronized appointment dynamic will still be applicable to the public game to ensure synchronization of the different player roles. Decisions may have an expiration time to avoid players waiting on each other causing gameplay to come to a halt if one player decides not to engage. For example the Firms loan request will expire after 10 in-game days if the bank player does not respond.

In-game goals will be set by the players however the game will help provide an indication of specific goal challenges others have set to help guide their choice. The game will end for the player if they go bankrupt or when a month (real world time) comes to an end. A new game is then setup by the administrator ready for the next month.

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4.2 Player Roles

The ABM contains multiple agent types which all interact and cause consequences for each other; however in the game the human player can only take control of a selection of these agents. These agents are key economic players, through which allowing a human player to take control will provide more realistic results to the Policy maker when the game is running. We refer to these agents as 'Player Roles'.

Each player role requires the player to work towards achieving a set of goals; for Household players goals may consist maximising their financial gain through investing in stocks and bonds in the markets, Firms to produce successful products, Banks to make profit on financing Firms and Households, Central Banks to keep the economy stable through raising/lowering interest rates and Government to ensure the correct polices are enacted in order to benefit growth of the economy as whole. Decisions made by Government and Central Bank players can have dramatic effects on other player roles; Households, Firms and Banks. Vice-versa if Households and Firms aren't able to financially sustain themselves they can cause Banks to go under causing recession, depression and even a country defaulting on its own loans. Each player role is closely interlinked, creating a network where every decision taken by each of the player roles can have serious consequences for the others. A balancing act must be struck between playing it safe and taking risk in order to survive.

In **APPENDIX I** we have constructed a fact sheet for each of the playable roles; the reader can find a brief description of the player role, what it can control and what other player roles have a positive/ negative effect on it.

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4.3 Gameplay and Mechanics

4.3.1 Gameplay

In this section we use a type of diagram called a Machination, a game economic diagram. Machinations [32] is a framework and interactive, dynamic, graphical representation tool that helps describe games as dynamic systems and focuses mainly on closed feedback loops within them.

The key shown in Table 3 below will help interpret the diagrams:

Node	Name	Description	Example (Coal plant energy production)
	Source	Creates resources	Mine coal
	Resource Connector	Controls the flow of resources	Coal travels to power plant
	Resource Pool	Stores resources	Coal gathers in a container
	Converter	Converts resources into other types of resources	Coal is converted into electricity.
	State Modifier	Changes the state of a node	Electricity is released to the Grid
	Sink	Removes resources	Electricity is consumed in the home.

Table 3: Key and example of Machination diagram nodes.

Please note: The game mechanic model diagrams in this section are for high level visual explanation purpose only and may not represent the implementation for the final game.

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4.3.2 Game Progression

The ABM will compute a simulation step every day (in-game time). How long an in-game day will take to compute in real world time will depend on the amount of players/agents in the game and the technical specifications of the ABM's computational servers. Player's turns are staggered depending on their player role to help keep all player roles synchronized together. **Figure 29** shows a high level overview of how game progression works for the player roles.

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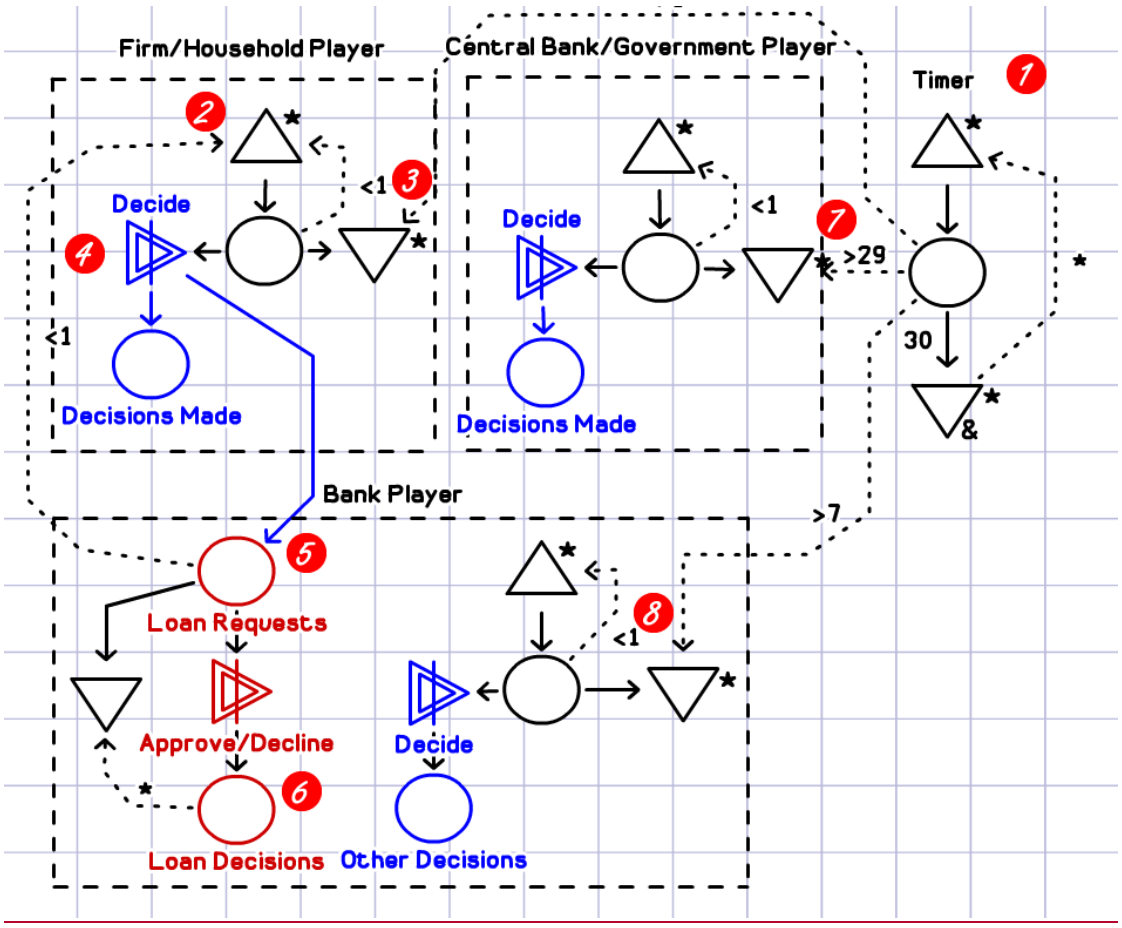

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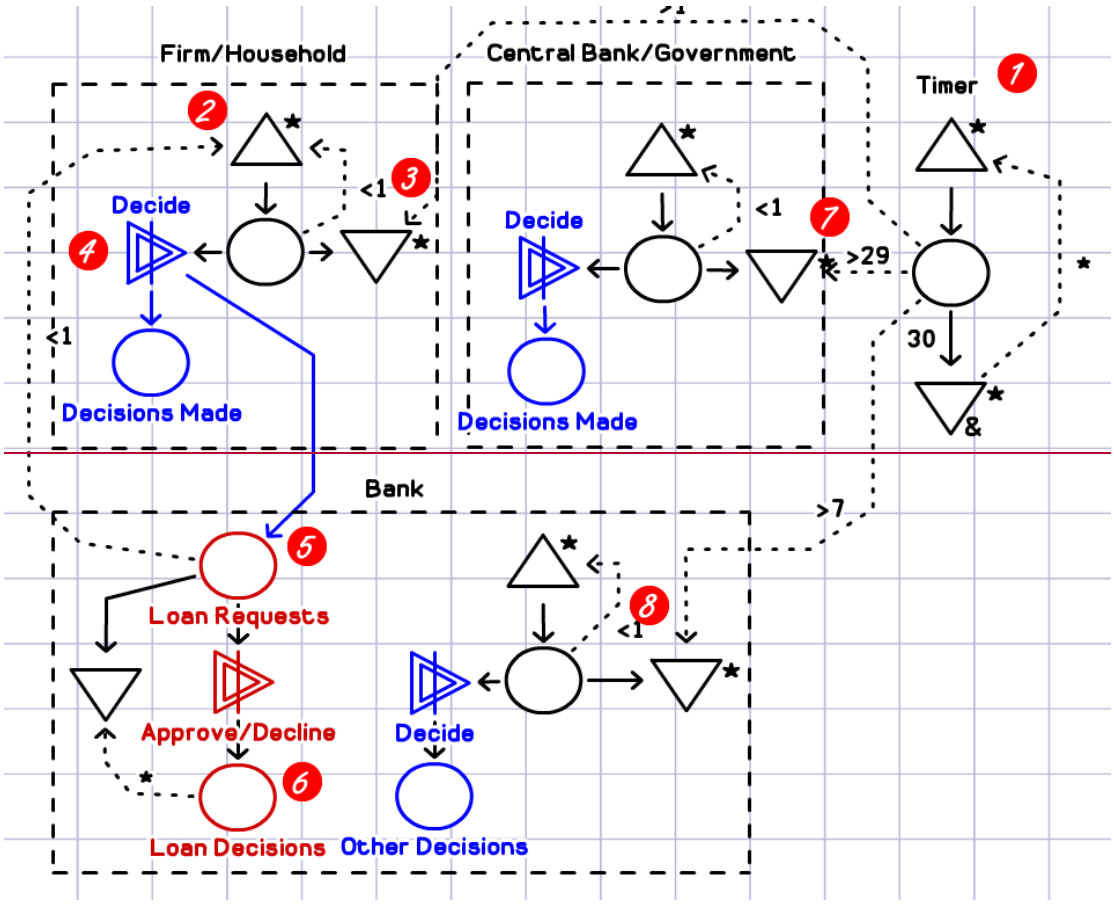

Figure 29: High level view of how progression and time allocation work.

Annotation

1. The timer represents the ABM ticking over each day. Each resource created by the timer represents one in-game simulated day. After a month or in the diagram above 30 days, the timer resets.
2. A Firm/Household gets 1 decision resource each day, a decision resource allows the firm/household to make all their decisions within the day before the time is up and the next day starts.
3. Once the day is up the decision resource is destroyed and a new one created. This is to represent a new day starting.
4. During the day the player can decide to do something related to their role. A special decision is to request a loan that is then sent as a request to the Bank player.
5. The Bank player receives the loan request, causing the Firm/Household decision resource source to stop; this simulates the Firm/Household player waiting for the Bank player's decision.
6. Once the Bank player has made their decision the loan request is destroyed and the Firm/Household player can continue making decisions. This model does not go into fine detail to display what happens when a loan is approved or denied and the effects it has on the Firm/Household player.

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7. The Central Bank and Government players are able to make their decisions once every 30days. Once they have made their decisions they will need to wait 30 in-game days until they can make their next set of decisions.
8. The Bank player will be able to make decisions every 7 days excluding loan requests, which can be responded to on a daily basis depending when they come in.

Multiplayer-Synchronized Appointment Dynamic

Due to the nature of how the ABM operates each player role requires a different amount of in-game time to make a decision, thus we propose to use a staggered time slot mechanism for the player roles, this will allow us to synchronize the five different game-play experiences together, keeping the game fair for all players participating.

For example a Central Bank player may only make a decision on a monthly basis (in-game time), where as a Firm would be able to make decisions on a weekly basis. Otherwise if the Firm made decisions within the same time as the Central Bank, it would take a minimum of six months for the Firm to start product production. A Bank however is a special exception; this player role can make decisions on a monthly basis such as increasing shareholder dividends. However if a Household or Firm player requests a loan, this decision can be done on a daily basis. This is to avoid time being lost for Household and Firm players, avoiding them waiting around for the Banks next decision period to come around. The table below shows the appointed time to make a set of decisions for each of the player roles.

Player Role	In-game appointed time
Household	Daily basis
Firm	Weekly
Bank	Monthly, excluding loan requests
Central Bank	Monthly
Government	Monthly

Table 4: Player roles, staggered appointed time for decisions

Once a set of decisions has been made, the game will display an appointed time for when the player can return to make their next set of decisions for the week/month. The game does not display an appointed time to player roles which make decisions on a daily basis as the ABM steps through in each day, otherwise the player would experience multiple window pop ups every time the ABM steps through. The appointment dynamic window seen in **Figure 30** will show day/time ticker will be present on the interface in full view for the player.

The window shows exactly what time they can return to the game in order to make their next set of decisions. A small narrative is provided around the wait time to make it seem meaningful rather than just the countdown ticker.

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Figure 30: A mockup of a Firm player's appointed time window

Interactive Tutorials

Each player role will require the player to learn the basics of how their particular role should operate in the virtual economy as well as the game's GUI layout. Most current serious games use overlays; a series of overlaid text or images on top the GUI which act like a slide show or introduction videos which explain how to play the game. However overlays are static and provide labels to interface elements, see **Figure 31**. What is really required is an overlay system which provides the player the game-play experience and not just static information.

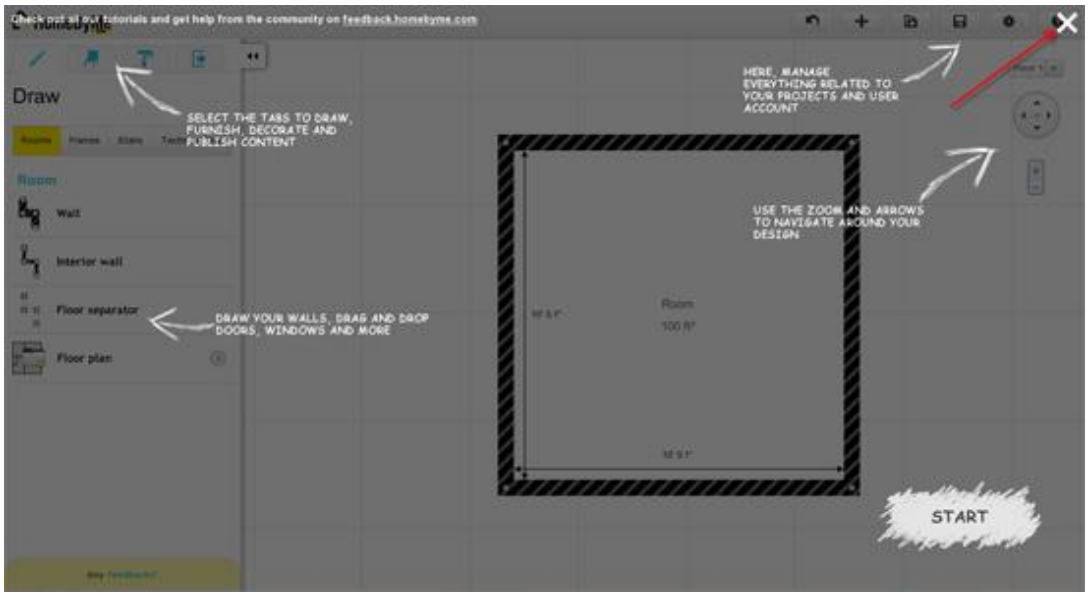

Figure 31: Overlay showing introduction text to the application interface.

We looked at how modern entertainment games which have complex/data rich interfaces handled their "beginner player" experience. None of the entertainment games we could find

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used an introduction video as a tutorial on how to play the game, this was mainly due to the fact that remembering what happened 2 minutes ago in a video which is trying to provide as much information as possible within a certain time limit becomes very difficult, which the player has probably forgotten most of the important information at the beginning. However many games which are interface/data rich did use interactive tutorials. The most prominent was Civilization V[33] by Sid Meier, where the interface is complex with many menus and windows the player needs to navigate however the beginner's tutorial was integrated into the game-play – you didn't actually feel like you're playing a tutorial.

Players learn by doing, this is referred to as Experiential Learning [34] Aristotle once said, "For the things we have to learn before we can do them, we learn by doing them"[35]. For an interface that requires the player to invest time in order to use it efficiently an interactive tutorial is essential for the game.

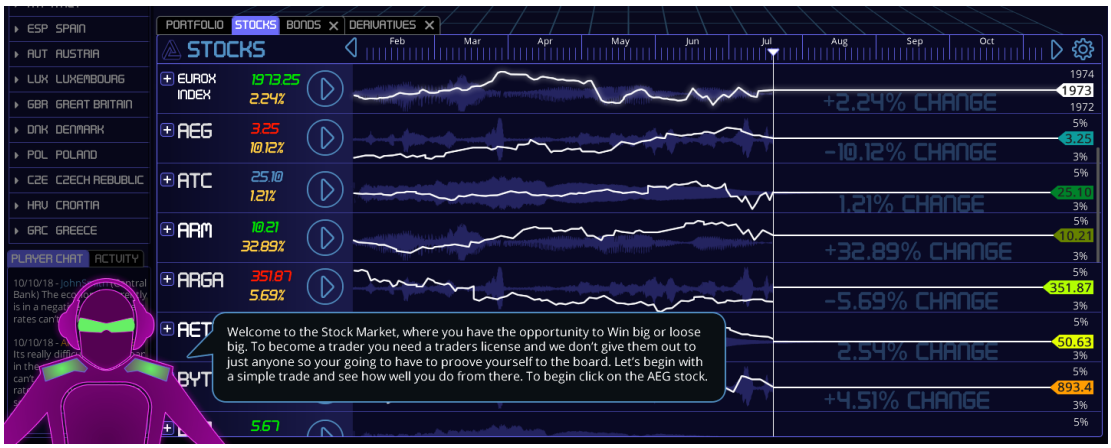

Figure 32: Household tutorial; welcome to the Stock market.

it's fine watching a video however after the video has finished and the player is put into the game world they have pretty much forgotten most of the how to play information explained 2-3 minutes ago in the video, causing them to suffer emotional discourse and frustration – ultimately leaving the game.

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4.3.3 Player Goals

Goals can facilitate task performance because they motivate people to exert effort, encourage people to persist, guide people's attitudes, and direct their behaviour to focus on the outcome. In other words, setting goals as a motivational technique helps to provide standards for systematic self-evaluation, which serve as a cue to regulate action by strengthening the linkage between effort (or motivation) and performance [37].

Each player role requires the player to work towards achieving a set of goals; for Household player, goals may consist of maximizing their financial gain through investing in stocks and bonds in the markets, Firms to produce successful products, Banks to make profit on financing Firms and Households, Central Banks to keep the economy stable through raising/lowering interest rates and Government to ensure the correct polices are enacted in order to affect how the economy is run. Decisions made by Government and Central Bank players can have dramatic effects on other player roles; Households, Firms and Banks. Vice-versa if Households and Firms aren't able to financially sustain themselves they can cause Banks to go under causing recession, depression and even a country defaulting on its own loans. Each player role is closely interrelated, creating a network where every decision taken by each of the player roles can have serious consequences for the others. A balancing act must be struck between playing it safe and taking risk in order to survive. Goals provide a sense of meaning and structure to the game experience for the player.

Although goals have one or two victory conditions they require many decisions to be made in order to complete them. A goal such as increase GDP by 5% within 10 years (for Government player) may require many decisions of tweaking tax rates and subsidy rates in order to provide a stable environment for Firms/Households to flourish in order to increase GDP for the country.

Figure 33 shows how goals are represented to the player while playing the game. Below for example the "Reduce Debt" goal has a target of 7%, to view more information on the goal the player can click on it to get a detailed view of the goal and hints on how to achieve it. The stars represent when a reward is given to the player, as the player's Debt reduces under the target amount of the goal they are awarded victory points. Lower the stars go the more victory points awarded. However some goals may require the player to keep on the target line or go above in order to score victory points.

Figure 33: GUI - Showing in-game (Citizen GUI) Goals panel.

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Goal Structure types

The game provides six different goal structure types; each type provides a different challenge to the player. In the table below we have provided the structure of the goal and an example to show how the structure could be used within the game.

Structure	Example
Increase XIndicator, YAmount by ZTime	Increase GDP 10% by 2020
Decrease XIndicator, YAmount by ZTime	Decrease Unemployment 5% by 2010
Increase XIndicator, YAmount every ZTime	Increase Profit 4% every 3 years
Decrease XIndicator, YAmount every ZTime	Decrease Debt 5% every 5 years
Keep Xindicator, YAmount for ZTime	Keep Inflation at 3% for 3 years.
Keep WIndicator XDirection, YAmount for ZTime	Keep Inflation Below 3% for 3 years

Table 5: Goal structure types and examples.

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Figure 34 shows a high level overview of how the goal structure works within the game. The Player Controlled Variable (PCV) is maniuplated by the player which in turn effects one or more economic indicators. The system listens out for when the economic indicator amount reaches the goal's target amount, once reached, victory points are awareded to the player.

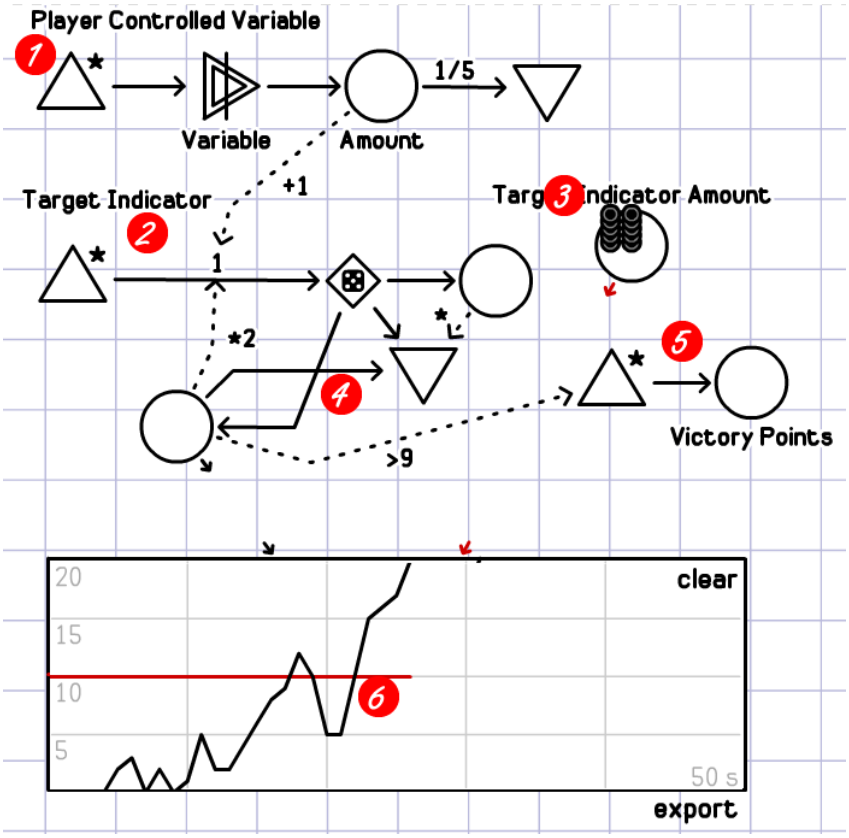

Figure 34: How Goals work in relation to a PCV and economic indicator.

Annotation

1. Represents a player-controlled variable, for example for the Central Bank player the controllable variable could be the interest rate. By controlling the variable the player impacts the economic indicator, for example Inflation.
2. Player decisions impact the target indicator either directly or indirectly depending on their relationship within the ABM.
3. The goal condition in this model is for the target indicator to reach 10 points in order for the player to receive a victory point. They can achieve this by using their control variable.
4. This is a random engine, it allows the model to simulate at a high level the unknown effects of the whole economy, which may cause the indicator to drop or shoot up within any period of time.
5. When the indicator reaches 10 points a victory point is awarded and keeps being rewarded until 50 steps in the simulation have passed, in essence this would be the time out function for the goal.

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6. On looking at the player's progress we can see the economic indicator shown in black and the target shown in red, the indicator reaches the target line in step 18 then drops then reaches it again in step 26. In this simulation run the player receives two victory points, excluding the bonus victory points which are not part of this model.

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4.3.4 Game Mechanics

Game Mechanics are the rules, processes, and data at the heart of the game. They define how game play progresses, what happens when, and what conditions determine victory or defeat. The interaction of various game mechanics in the game determines the complexity and level of player interaction in the game. In this next section we detail the game mechanics which will form the core game-play for the game.

Achievements

Achievements are virtual recognition for completing a difficult task, not to be confused with Victory Points that are awarded for completing goals within the game. Achievements also provide a sense of "bragging rights" between players, to show what they have accomplished in the game compared to others. They often provide a medium in which players can display their social status within the game.

There are two types of achievement: **Measurement** and **Completion**. Measurement achievements are given to players for completing a task to a certain degree, i.e. in the game a trader who earns 500 profit from one trade is awarded the "Trader – Bronze", however if they earn 1,000 profit from one trade they are award the next level up "Trader- Silver". The achievement is "Trader" however the level awarded is dependent on the measurement of the player's performance. Measurement achievements are multi-level unlike completion achievements that are singular.

Completion achievements don't provide a measurement of player performance instead they are offered as an award for completing a certain task. Completion achievements can be split down into two more sub categories:

- **Performance contingent achievements** – require skills in order to gain the achievement, i.e. Earn 100,000 profit on one trade; will require a good understanding of the market and a bit of luck in order to gain the achievements.
- **Non-performance contingent achievements** – don't require any skills, just for the player to turn up. In the context of the game, there are no non-performance achievements.

In **Table 6** below we list the achievements for each of the player roles, some are unique to the player role and some are generic – meaning all players have the chance to earn the achievement.

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Role	Achievement	Type	Description
All	Honor: Complete all - Bronze Level	Completion	Complete all achievements at Bronze Level
All	Honor: Complete all - Silver	Completion	Complete all achievements at Silver Level
All	Honor: Complete all - Gold Level	Completion	Complete all achievements at Gold Level
All	Honor: Complete all - Platinum Level	Completion	Complete all achievements at Platinum Level
All	Honor: I am a survivor	Completion	Survive a Recession
Household	Trader License	Measurement	Successfully complete the tutorial for Market Trading
Household	Trader - Bronze	Measurement	Earn 500 profit from one trade
Household	Trader – Silver	Measurement	Silver: Earn 1,000 profit from one trade
Household	Trader – Gold	Measurement	Gold: Earn 5,000 profit from one trade
Household	Trader – Platinum	Measurement	Platinum: Earn 10,000 profit from one trade
Household	Portfolio – Bronze	Measurement	Gain 50,000 portfolio value
Household	Portfolio - Silver	Measurement	Gain 100,000 portfolio value
Household	Portfolio – Gold	Measurement	Gain 500,000 portfolio value
Household	Portfolio - Platinum	Measurement	Gain 1,000,000 portfolio value
Household	Mortgage – Bronze	Measurement	Pay off mortgage within 30 years
Household	Mortgage – Silver	Measurement	Pay off mortgage within 20 years
Household	Mortgage – Gold	Measurement	Pay off mortgage within 10 years
Household	Mortgage - Platinum	Measurement	Pay off mortgage within 5 years
Household	Honor: 1 trade wonder	Completion	Earn the most profit (compared to all other households) from one trade

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Household	Honor: Gold Standard	Completion	Highest value portfolio (compared to all other households)
Household	Honor: Risk Taker	Completion	Trade all cash in on one trade and make a profit
Household	Honor: Get Rich Quick	Completion	Earn 1million within 1year
Firm	Get Promotion	Completion	Complete CEO Firm training tutorial
Firm	Growth – Bronze	Measurement	Hire 10 more employees
Firm	Growth – Silver	Measurement	Hire 50 more employees
Firm	Growth – Gold	Measurement	Hire 150 more employees
Firm	Growth – Platinum	Measurement	Hire 800 more employees
Firm	Production - Bronze	Measurement	Produce 100,000 units
Firm	Production – Silver	Measurement	Produce 500,000 units
Firm	Production – Gold	Measurement	Produce 1,000,000 units
Firm	Production - Platinum	Measurement	Produce 5,000,000 units
Firm	Profit - Bronze	Measurement	Make 500,000 profit
Firm	Profit – Silver	Measurement	Make 1,000,000 profit
Firm	Profit – Gold	Measurement	Make 5,000,000 profit
Firm	Profit – Platinum	Measurement	Make 20,000,000 profit
Firm	Honor: Bootstrap	Completion	Survive the whole game without taking a loan.
Firm	Honor: Conglomerate	Completion	Make the most profit (compared to all other firms)
Firm	Honor: Undercut	Completion	Sell product at the lowest price (compared to all other firms)
Firm	Honor: Luxury Goods	Completion	Sell product at highest price (compared to all other firms)
Bank	Become a Banker	Completion	Complete CEO Bank training tutorial
Bank	Profit - Bronze	Measurement	Increase profits by 10% within 10 years
Bank	Profit – Silver	Measurement	Increase profits by 20% within 20 years
Bank	Profit – Gold	Measurement	Increase profits by 50% within 25 years
Bank	Profit – Platinum	Measurement	Increase profits by 50% within 10 years
Bank	Bonuses - Bronze	Measurement	Award 100,000 dividends for shareholders
Bank	Bonuses – Silver	Measurement	Award 500,000 dividends for shareholders

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Bank	Bonuses – Gold	Measurement	Award 1,000,000 dividends for shareholders
Bank	Bonuses - Platinum	Measurement	Award 5,000,000 dividends for shareholders
Bank	Lending – Bronze	Measurement	Lend a loan with 5% interest
Bank	Lending – Silver	Measurement	Lend 10 loans with 10% interest
Bank	Lending – Gold	Measurement	Lend 50 loans with 5% interest
Bank	Lending - Platinum	Measurement	Lend 100 loans with 20% interest
Bank	Honor: Risky Business -	Completion	Take on a CCC rated risk firm and survive the loan period
Bank	Honor: Loan Shark	Completion	Provide an accepted loan at the highest set interest rate
Bank	Honor: Loan Angel	Completion	Provide an accepted loan the lowest set interest rate
Central Bank	Elected Governor	Completion	Successfully complete Central Bank Governor tutorial
Central Bank	GDP - Bronze	Measurement	Increase GDP by 20% end of game
Central Bank	GDP – Silver	Measurement	Increase GDP by 30% end of game
Central Bank	GDP – Gold	Measurement	Increase GDP by 50% end of game
Central Bank	GDP - Platinum	Measurement	Increase GDP by 70% end of game
Government	Income – Bronze	Measurement	Increase income by 5% with 3years
Government	Income – Silver	Measurement	Increase income by 10% with 3years
Government	Income – Gold	Measurement	Increase income by 25% with 3years
Government	Income – Platinum	Measurement	Increase income by 50% with 3years
Government	GDP - Bronze	Measurement	Increase GDP by 20% end of game
Government	GDP – Silver	Measurement	Increase GDP by 30% end of game
Government	GDP – Gold	Measurement	Increase GDP by 50% end of game
Government	GDP - Platinum	Measurement	Increase GDP by 70% end of game
Government	Honor: Reach top GDP ranking	Completion	Compared to all other Government Players/Agents.
Government	Honor: In your	Completion	Pay off countries debt before end of

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	debt		game.

Table 6: Examples of Achievements that will appear in the game.

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Auditory Feedback

Auditory feedback and Visual feedback make up the Symphony game-play experience, not only can players see what's going on but also hear specific indicators and their activity. Utilizing sound to denote progress of an indicator is unique within the current financial technologies market. Specific audio signatures can be heard to represent if the indicator is in a positive state or negative state. Below is an example of an indicator's graph plot

Using auditory feedback with financial data is what makes the game unique compared to current technologies on the market. The game takes the experience of engaging monetary policy to another level by providing an auditory experience. Players are not only able to see their progress in-game but hear how well they are doing. The set of goals players set or choose to complete in the game are referred to as a Symphony. The player's Symphony will let the player know how well overall they are doing within the game.

Figure 35: Showing high and low pitch based on indicator data.

Annotation

1. Represents a PCV, for example for the Central Bank player the controllable variable could be the interest rate. By controlling the variable the player impacts the economic indicator, for example Inflation.
2. Player decisions impact the target indicator either directly or indirectly depending on their relationship within the ABM.
3. The goal condition in this model is for the target indicator to reach 10 points in order for the player to receive a victory point. They can achieve this by using their control variable.

Investments

Investments require players to commit resources, such as money for a certain amount of time in order to gain rewards later. Investments invoke risk-reward. Risk can be defined as the potential to loose game progress or resources, i.e. time, experience and score. Reward is the positive result of overcoming risk that could include the gain of new resources, time and score. A fine balance must be struck between the two maintain a risk-reward environment; the change for receiving a reward in the game which is linked to some risk which will induce a penalty if the player fails to acquire the reward. Many of the decisions made while playing the game will have some low and some economic risk associated with them, i.e. trading in the stock markets has substantial risk and reward, stock traders can lose or gain a lot of capital by taking leaps of faith, sometimes they win and sometimes they lose.

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Below is an example of how an investment mechanic with risk-reward creates uncertainty and how taking risk could reap rewards or loses.

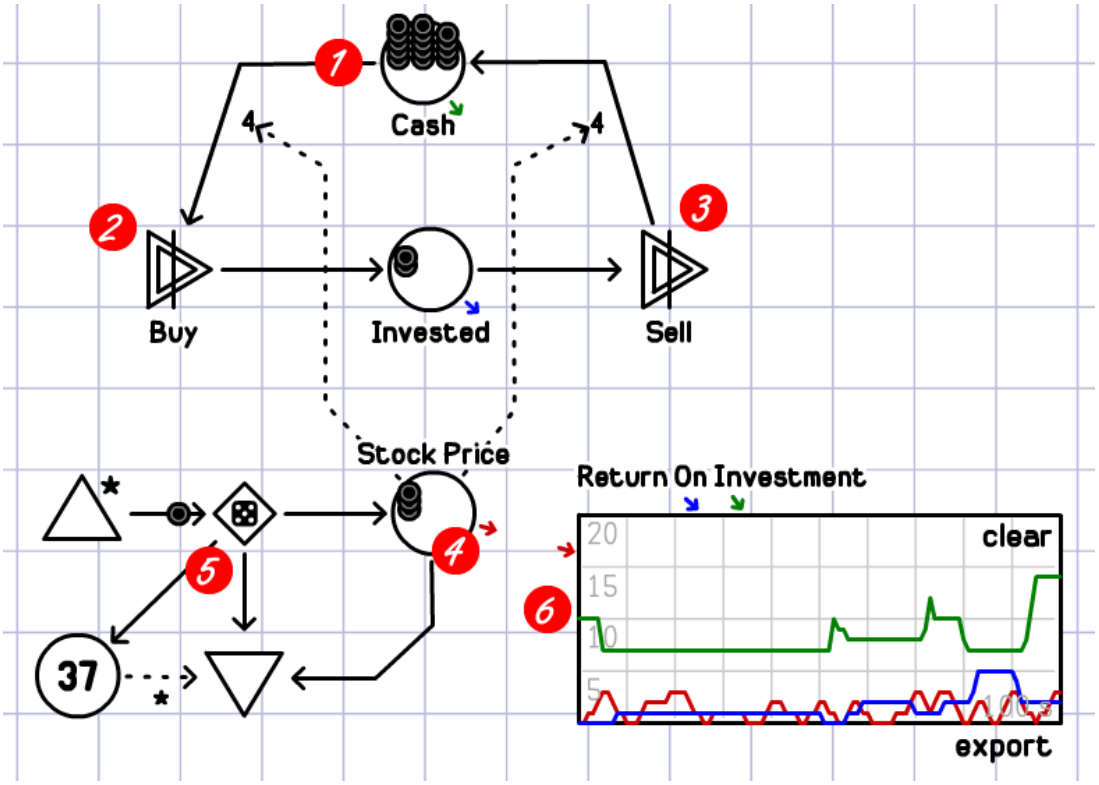

Figure 36: Simple example of investment, risk-reward.

Annotation

1. A Cash pool, which shows the available cash the player, has available to spend.
2. The Buy converter converts the cash into an investment resource, the Stock Price pool dictates the amount of cash required for it to be converted into an investment resource.
3. The Sell converter, converts an investment resource back into cash which is returned to the Cash pool, the amount of cash one investment resource is converted into is dictated by the Stock Price pool.
4. The Stock Price pool is simulating the stock price.
5. Random engine which simulates the randomness of the market and economy affecting the stock price positively and negatively.
6. Amount of Cash (green), Stock Price (red) and Invested Amount (blue). Looking at this graph the player was able to make a daring investment near the end of the simulation, which projected their cash by 4. Their investment paid off with a 40% return on investment.

Figure 37 below shows an advanced version of the investment risk reward. The model aids the player in their investment decision by calculating Invested Potential Worth, Potential Profit and Actual Profit.

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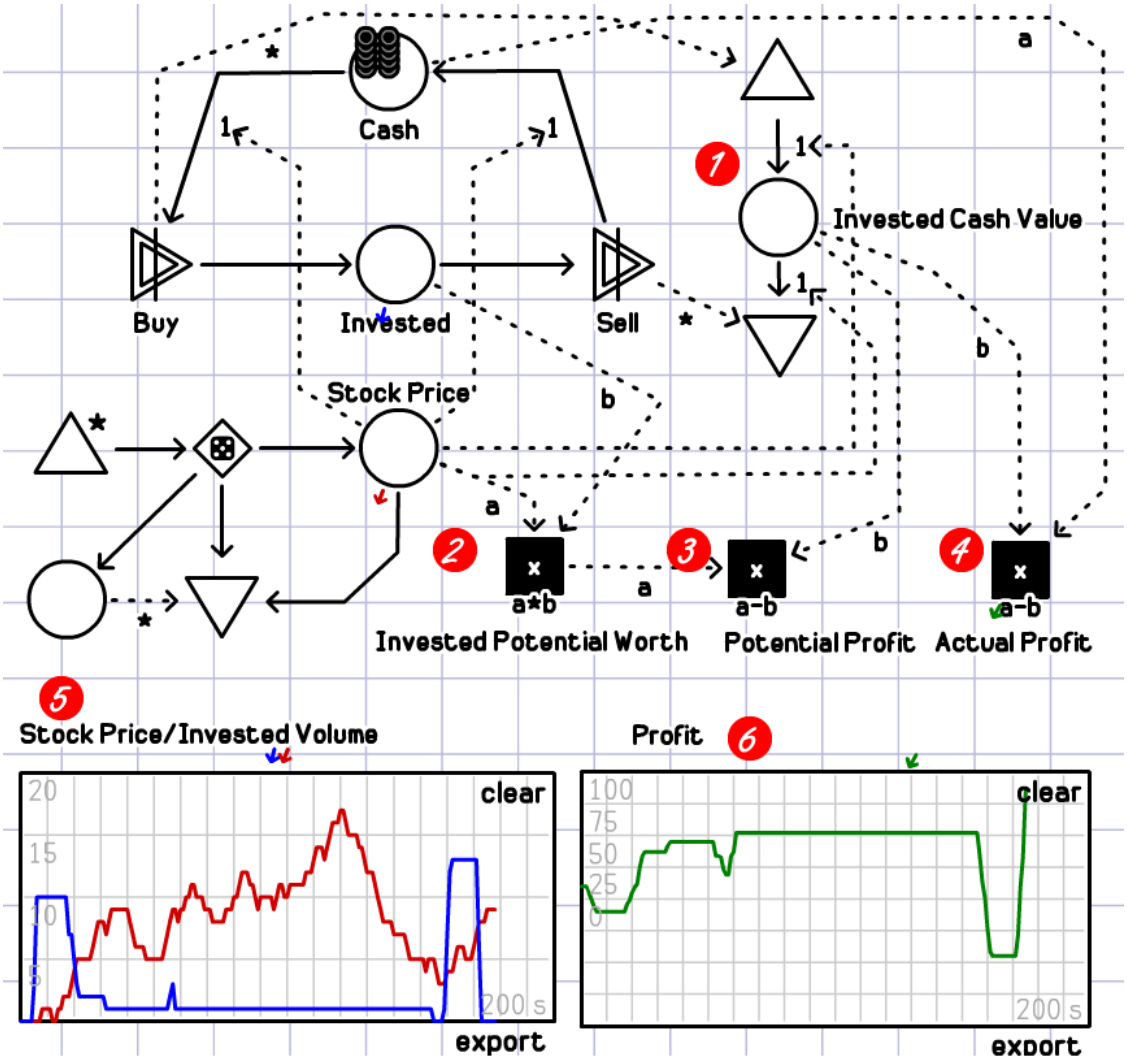

Figure 37: Advanced example of investment, risk-reward.

Annotation

1. Invested Cash Value pool shows the amount paid for at the time of buying a stock.
2. Invested Potential Worth shows how much the investment resources potentially are worth; Investment Amount x Stock Price calculates this.
3. Potential Profit is the potential profit made from the current investment resources the player owns.
4. Actual Profit shows the actual cash profit made so far.
5. Graph which shows Stock Price and Invested Volume amount, we can see that the player has chosen to buy low then sell high near the end, however waited too long to invest while the stock price was soaring high.
6. Plots the profit made by the player from their investment strategy during the game.

From the example above we can see by just adding a few extra calculations to the model the player is able to make a more informed investment decision. The game will provide

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information like this around player controlled variables and other decisions to help guide the player to make better decisions rather than making them second-guess what will happen. However some decisions may be difficult to calculate and may only show forecasted values on major macroeconomic indicators such as interest rate and the consequences of increasing it.

Victory Points

Player progression is measured by the quantity of Victory Points they have accumulated over time while playing. Victory Points are awarded to players when conditions in the goals are met either during or when the goal condition is reached or times out. Victory points awarded during a goal are referred to as Bonus Victory Points, these provide the player positive feedback for doing a good job before the goal condition is met. **Figure 38** shows how a goal "Reduce Unemployment Rate 7% by 2050" appears to the player, (1) the stars represents when Bonus Victory Points are awarded to the player. (2) Every time the unemployment variable drops below the 7% target mark the player is awarded Bonus Victory Points, (3) however if the variable begins to rise while still under the target mark bonus victory points are not awarded. Once the goal condition has been met, i.e. 2050 is reached then victory points for completing the goal are awarded. Even if the player misses this condition they still have a lot of chance beforehand to earn Victory Points.

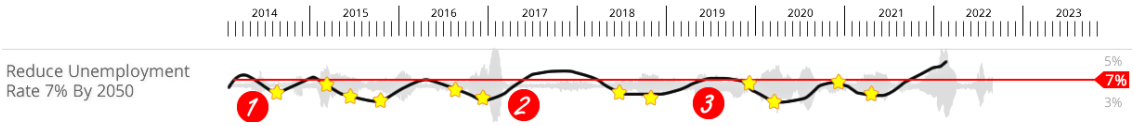

Figure 38: Goal structure and visual representation of Bonus Victory Points.

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4.4 Trend Reporting and Analysis

Social comparison is a fundamental psychological mechanism for influencing people's behaviours and experience. People constantly engage in social comparisons whenever they are confronted with information about how others are, what others can and cannot do, or what others have achieved and have failed to achieve, they relate this information to themselves.

Social feedback in the game provides the ability for players to see how they have done compared to others who have played. The Trends screen displays performance scores based on comparison metrics such as country, age range and gender. Location

Below is a list of the metrics which the game will collect upon signup as well as the comparative metrics such as player score which will be used to generate the report at the end of the game. They will also have the opportunity to tweet out their score to their twitter network which will provide some indirect marketing for the game:

- **Victory points** – Shows the amount of victory points earned by the player compared to others. A global ranking mechanism could be used to show how well the player did compare to everyone else who has taken on the same role. Important to note that a global rank across all player roles would not a viable option.
- **Goal completion rate** – Shows the rate of goal completion per a game session. A full 100% goal completion rate could be ranked, i.e. you are Star Banker for getting 100%. Player can see how well they did compare to all other players playing the same role.
- **Location** – Displaying which country/state they are from compared to everyone else playing the game, this is not a player specific metric.
- **Age Range** – Displaying the age range vs. all other age ranges of how well the player has progressed. For example the player can see if the under 30's are better than the over 50s at playing the game.
- **Gender** –Displays which gender is currently outperforming the other. This is one of the most common social comparison metrics.

Please note: data collected by the game should be ongoing in order to generate a diverse report which represents a more overall picture of the social comparisons between players.

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5 Technical Architecture

5.1 System Requirements

5.1.1 Client

As an online game we will be building the game using Canvas this will require a modern browser in a reasonably powerful computer in order to run the game. The mobile interface will require an up-to-date OS version on a normal sized phone or tablet. We will not support running the desktop interface on tablets.

In Table 7 is a specification of the current browsers and versions requirements in order to run the game.

Browser	Version
Internet Explorer (Microsoft)	10 or higher
Chrome (Google)	36 or higher
Safari (Apple)	6.1 or higher
Firefox (Mozilla)	30 or higher
Internet Explorer Mobile (Microsoft)	10 or higher
IOS Safari (Apple)	6.1 or higher
Chrome Mobile (Google)	36 or higher
Android Browser (Google)	Not Supported

Table 7: Client browser requirements.

5.1.2 Server

The server will require a small scalable cluster of virtual servers with at least 512MB of RAM each and an up-to-date version of Ubunutu. The servers will need close proximity for speedy data transfer.

5.2 Functionality Requirements

The research leading to these results has received funding from the European Community's Seventh Framework Programme [FP7/2007-2013] under grant agreement no. 611875

5.2.1 Use Cases

In this section we outline the main screens and use cases for each one. These main screens are primary to the game-play experience.

5.2.2 Common Components

These components are either on screen at all times or are fundamental to the game-play experience.

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Navigation Bar

The Navigation bar allows the user to navigate through the main screens of the game; Home, Markets, News, Achievements and Help. It also displays the Date/Time for the simulation as well as the player score. The Navigation bar is constantly on screen and is never hidden away from view.

Figure 39: Common Components - Navigation Bar

ID	Use Case	Functionality
1	Click “Home” button	Opens the main agent overview tab in the Main Agent component.
2	Click “Markets” button	Opens a dropdown, user can select the specific type of market they want to access. Clicking on the link opens up the tab for the market in the Main Agent component.
3	Click “News” button	Opens the news tab in the Main Agent component.
4	Click “Achievements” button	Opens the achievements tab in the Main Agent component.
5	Click “Help” button	Opens the help tab in the Main Agent component.

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Ticker Bar

The ticker bar displays current firm stock data or country GDP rates. Colour coding is used to indicate if a variable has increase (green) or decreased (red) hasn't changed (blue) since the last simulation step. This ticker bar feeds information from right to left.

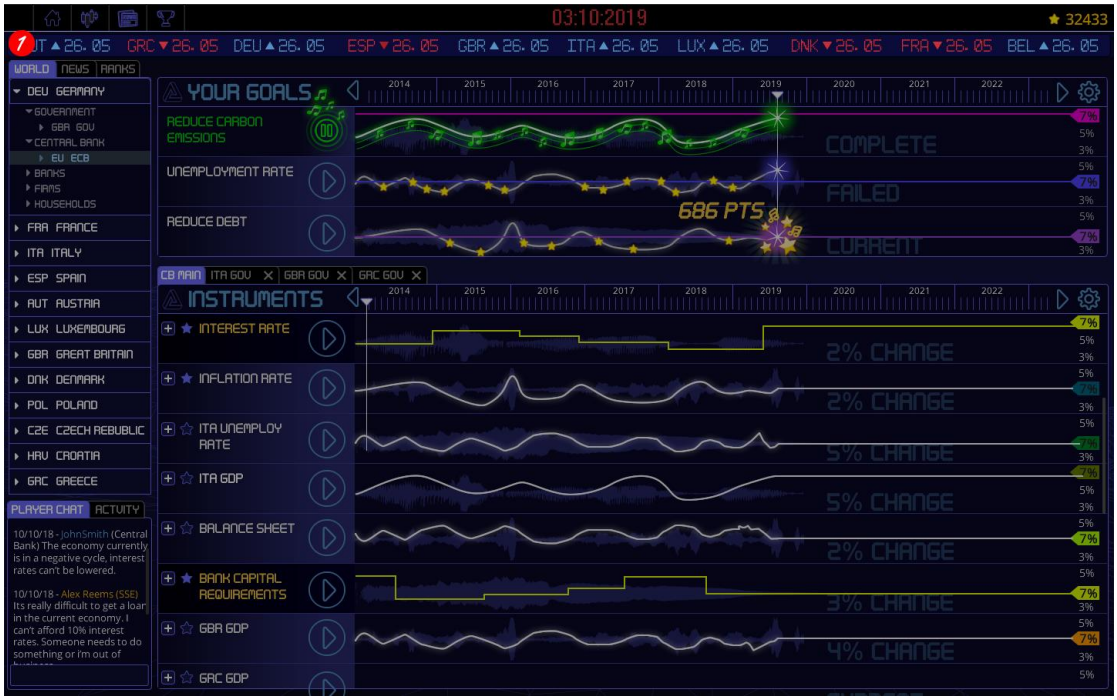

Figure 40: Common Components - Ticker Bar

ID	Use Case	Functionality
1	User is Central Bank/Government	Display ticker which shows government symbols and GDP rate.
2	User is Firm/Household/Bank	Display ticker which shows firm symbols and stock price.
3	Clicks "Symbol" text	Opens the agent overview tab for the specific agent who is related to the symbol in the Main Agent component, i.e. A Firm or a Government.

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Side Panel

The side panel is a secondary navigation component. The player is able to navigate through agents in the game by using the World tab, keep updated with the latest news with the News tab and keep track of other player/agent progress using the Ranks tab.

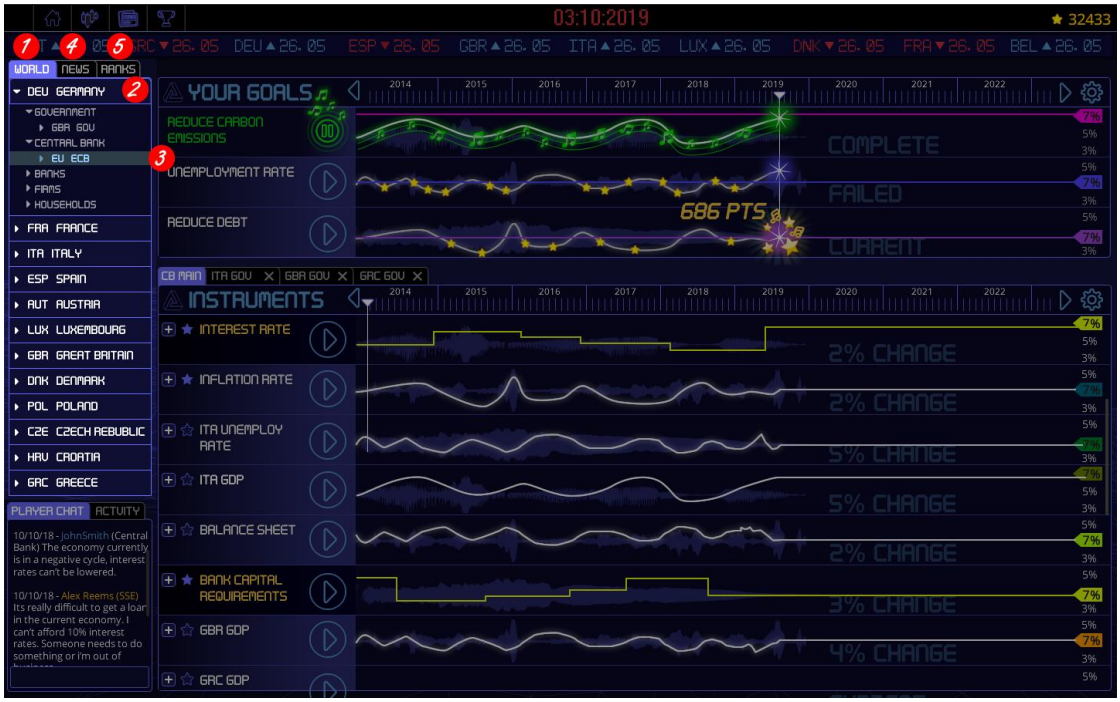

Figure 41: Common Components - Side Panel

ID	Use Case	Functionality
1	Clicks “World” tab	Displays the World tab to display all Government agents in the game.
2	Clicks “Country” button	Expands into a tree view to reveal all the agents related to the specific government.
3	Clicks “Agent” link	Opens specific agent overview in the Main Agent component.
5	Clicks “News” tab	Displays latest news feed generated from the game news feed component.
5	Clicks “Ranks” tab	Displays player ranking (leaderboard). Ranked by count of victory points from highest to lowest.

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Player Chat/Activity

In order to communicate together players can use the inbuilt chat component which allows players to type messages to each other. The component also allows the player to view their activity history to keep track on all the changes they have made during game-play.

Figure 42: Common Components - Player Chat/Activity

ID	Use Case	Functionality
1	Clicks “Player Chat” tab	Displays the player chat room.
2	Input text in input field and pressed send/enter on the keyboard	Sends the text to the chat area for other players to see.
3	Clicks “Activity” tab	Displays player activity log, i.e. [date] interest rate set to 3.4%

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Goals

The goals component helps the player keep track of their goals while in-game. Each goal is plotted to show if the player has reached their target or not. The goals component can be adjusted to fit the player's height requirements.

Figure 43: Common Components - Goals

ID	Use Case	Functionality
1	Clicks "Play" button on Goal	Plays the goal midi from start to current point in time.
2	Clicks "Goal" section	Opens Single Goal overview window.
3	Click and drags "Play head" element	Navigates through the goal midi, where the player can press "Play" button to start the midi file.
4	Click and drags Goals Component edge to adjust the height of the component.	Adjust the height of the component based on where the user lets go of the mouse button.

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Agent Main

When viewing an agent the player is displayed the Agent Main screen, here the player is able to view each variable which is within an agent. All agents are viewed in this way. If the player is in control of the agent then the Home screen is their Agent Main screen.

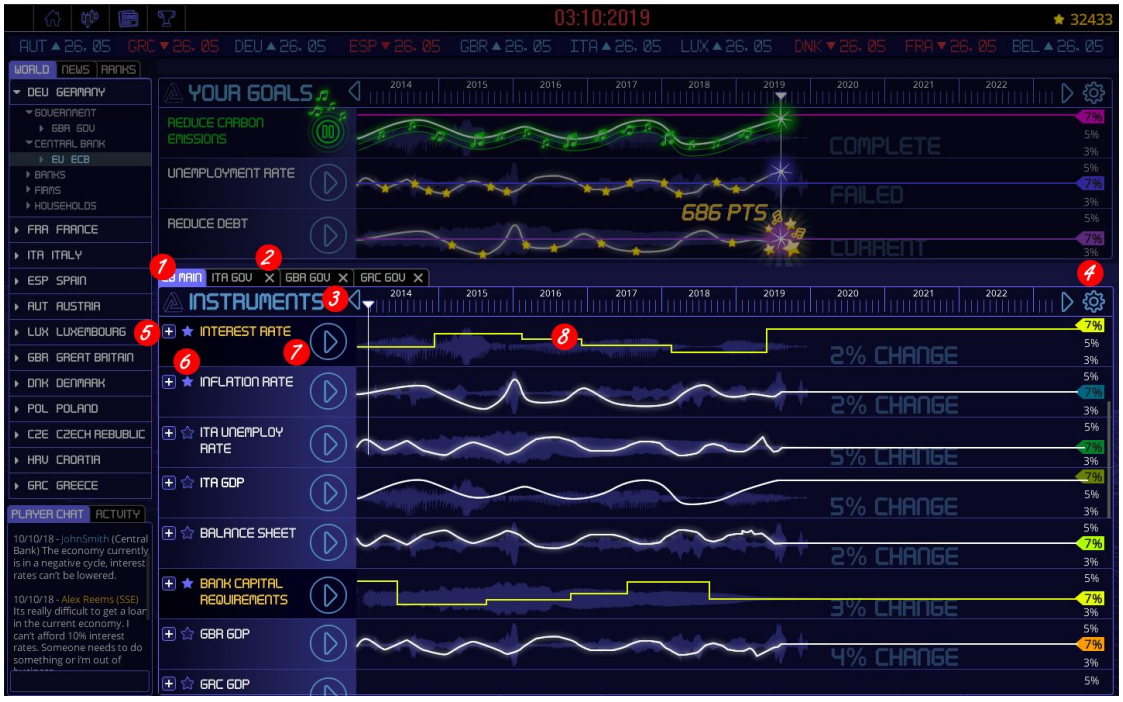

Figure 44: Common Components - Agent Main

ID	Use Case	Functionality
1	Clicks tab within tab bar along the top	Displays information relevant to the tag, i.e. Agent Overview information.
2	Clicks “Close” button on tab	Closes the tab and removes it from the tab bar.
3	Clicks arrows along timeline	Manipulates the timescale for the graph, forward and backward.
4	Clicks “Settings” button	Opens Settings window
5	Clicks “+” button	Expands the indicator to show more detailed information. *See Expanded Indicator View.*
6	Clicks “Star” button	Saves the indicator as a favourite.
7	Clicks “Play” button	Plays the indicator midi from start to current point in time.
8	Hover mouse over graph	Shows the amount based off the indicator plot.

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Expanded Indicator View

When the player expands the view of an indicator on the Agent Main screen they are presented with more detail about the indicator, this includes;

- Policy Effects – Shows the positive and negative effects of the policy. For example the Government player raises Income Tax which could have negative effect on production for Firms.
- Set Rate – If the indicator can be manipulated the player is able to set a new rate each turn.
- Current Rate – Shows the current indicator rate. If changes have been made, then the player decides to revert. The amount will revert back to the current rate.
- Estimated Calculation – Provides a small indication of what will happen if the indicator rate is increased/decreased, i.e. Raising Tax will increase Income.
- Apply/Revert Changes – Applies new rate changes or revert to the current rate.

Figure 45: Common Components - Expanded Indicator View

ID	Use Case	Functionality
1	Clicks "-" button	Contracts all detailed information.
2	Clicks left/right arrow buttons	Scrolls left/right. Shows policy effects details or compare to leaderboard.
3	Clicks on input field or Clicks on up/down arrows	Allows user to enter in numeric value into the input field or use arrows to increase or decrease

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		the default value (current rate).
4	Clicks “Apply Changes” button	Once this has been clicked it will not be active until the players next turn, unless see next use case (5).
5	Clicks “Revert Changes” button	Reverts the changed variable to a previous state, thus enabling the apply changes button again.
6	Clicks “Help” button	Displays help window.

Markets

General Market Layout

This screen is setup to be a template; if new markets are activated within the ABM then every market can share the same layout. The General Market Overview displays the financial markets in the ABM. Here the player can engage with the market and buy/sell financial securities in the game.

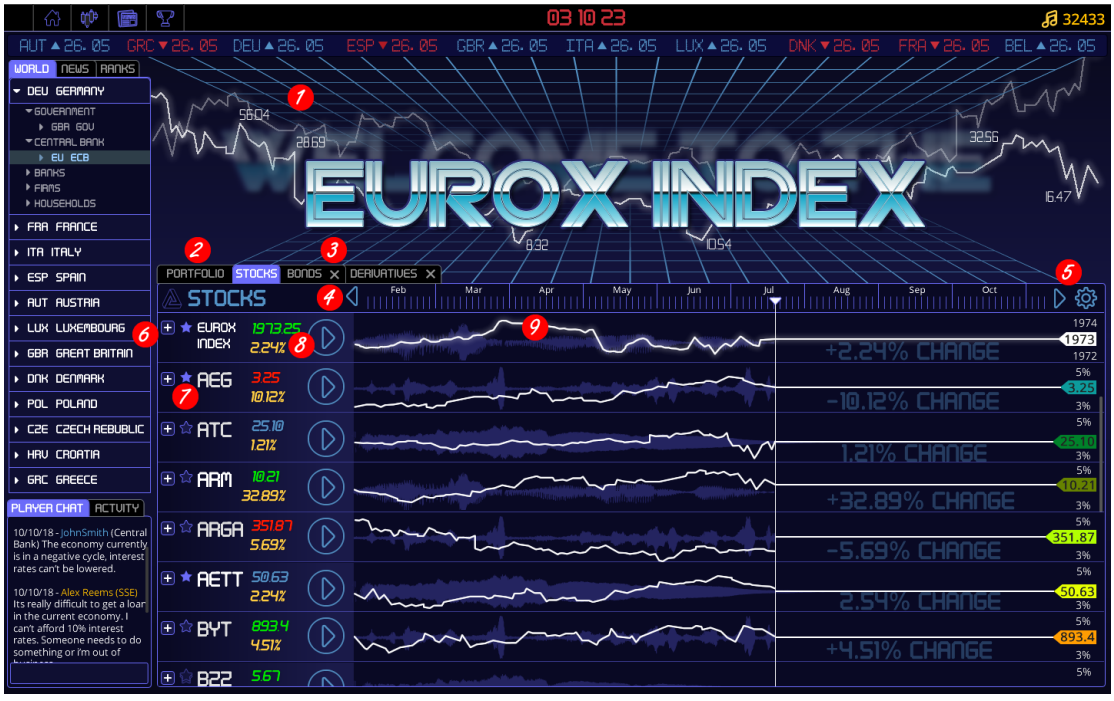

Figure 46: Markets - General Market Layout

ID	Use Case	Functionality
1	User enters page	Intro screen is displayed
2	Clicks tab within tab bar along the top	Displays information relevant to the tag, i.e. Stock Market index
3	Clicks “Close” button on tab	Closes the tab and removes it from the tab bar.
4	Clicks arrows along timeline	Manipulates the timescale for the graph, forward and backward.
5	Clicks “Settings” button	Opens Settings window

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6	Clicks “+” button	Expands the indicator to show more detailed information. *See Expanded Securities View.*
7	Clicks “Star” button	Saves the security as a favorite.
8	Clicks “Play” button	Plays the indicator midi from start to current point in time.
9	Hover mouse over graph	Shows the amount based off the indicator plot.

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Expanded Securities View

More detailed information is displayed to the player when they expand a security by using the “plus” button on the GUI. A detailed overview of the security will allow the player to make a buy/sell decision. Colour coding is used to indicate if a stock has increased (green) or decreased (red), hasn’t changed (blue) since the last simulation step.

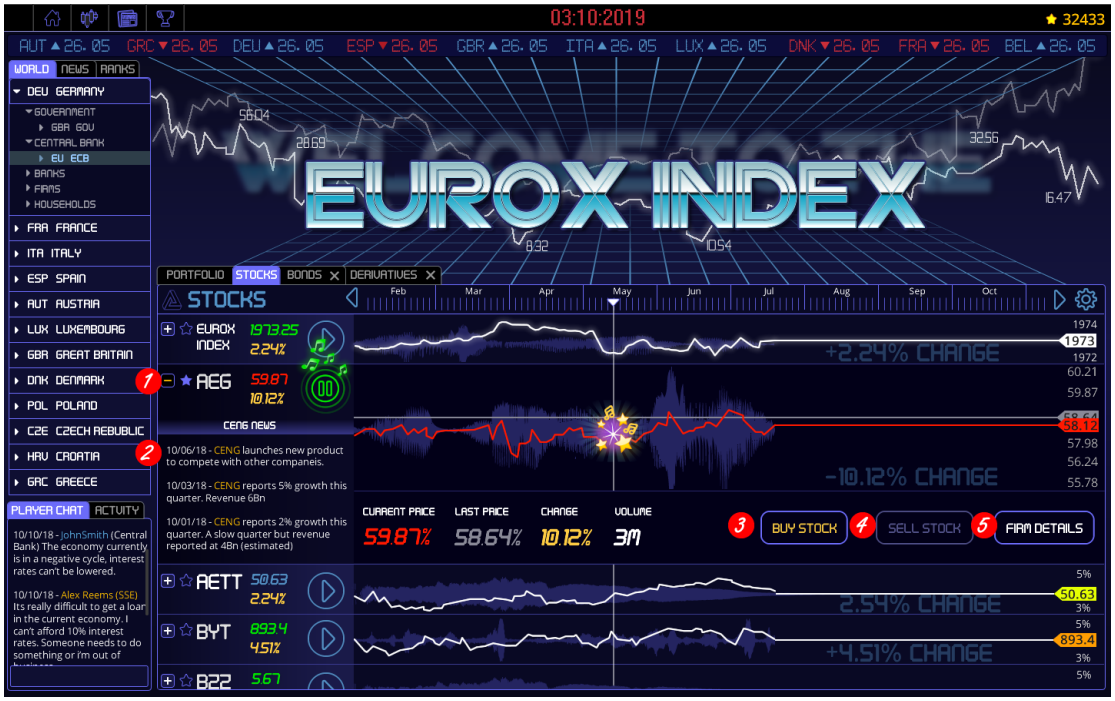

Figure 47: Markets - Expanded Securities View

ID	Use Case	Functionality
1	Clicks “-” button	Contracts all detailed information.
2	Clicks link in news feed	Taken to the relevant agent
3	Clicks “Buy Stock” button	Opens the Market Buy Order.
4	Clicks “Sell Stock” button	Only available when user has bought stock. If true then open the Market Sell Order.
5	Clicks “Firm Details” button	Opens a new tab showing the relevant firm details related to the security.

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News

News Terminal View

The player can use the news terminal to keep updated with the latest news generated from each of the agents this can be useful for all agents, for example a Household player may be watching the news to provide them some financial information for making an investment decision on the Stock Market.

Figure 48: News - News Terminal

ID	Use Case	Functionality
1	Clicks “Category” button	Displays news relevant to the category.
2	Clicks sort options	Can sort news by Date or Category in ascending or descending order.
3	Clicks link in news feed	Opens a new tab and displays the relevant agent information.
4	Inputs text into the search box	Performs search on news feed.

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5.2.3 Window components

Window components are displayed when a certain action or button is triggered from the main components.

Goals

Goals Overview

The Goal Overview window displays all the goals the player has to complete within the game. The player can also access single goals from here by clicking the “Show Me” button.

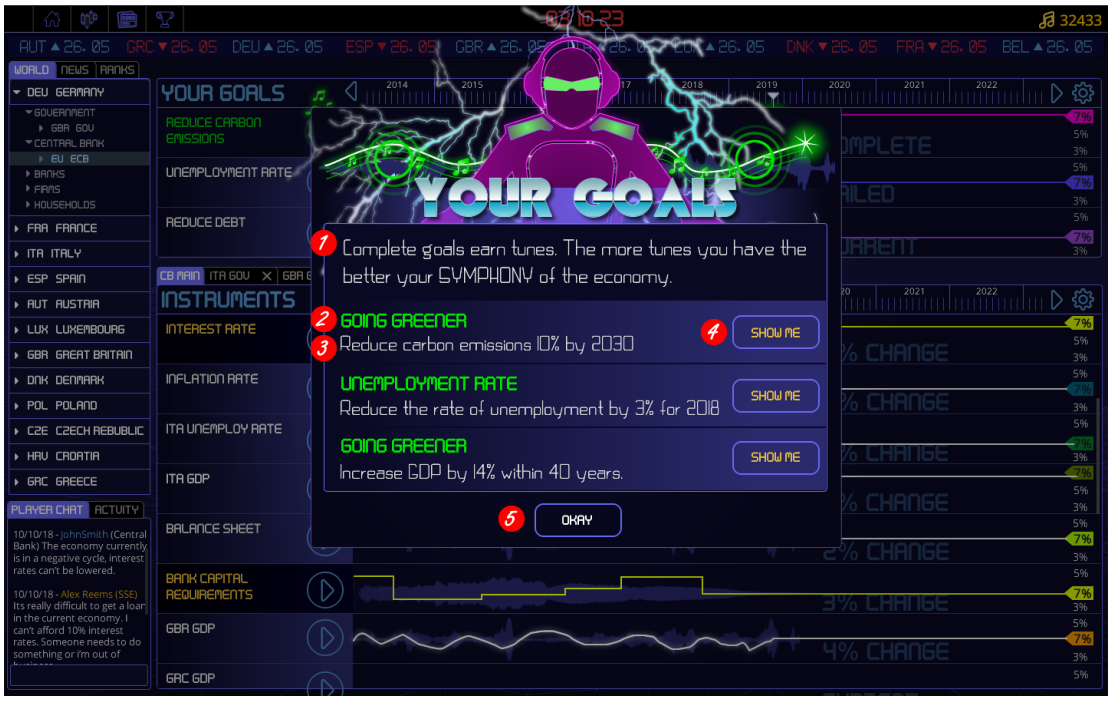

Figure 49: Goals - Goals Overview Window

ID	Use Case	Functionality
1	Window displayed	Displays description about completing goals
2	Clicks “Goal Name” text	Closes window, opens Single Goal window.
3	Window displayed	Displays short single goal description.
4	Clicks “Show Me” button	Closes window, opens Single Goal window.
5	Clicks “Okay” button	Closes window

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Single Goal

The Single Goal Window displays detailed information related to a single goal, here the player can see the time limit, their progress so far as well as hints/tips on how to complete the goal condition.

Figure 50: Goals - Single Goal Overview Window.

ID	Use Case	Functionality
1	Window displayed	If goal condition has a time limit, this component is shown counting down.
2	Window displayed	Shows current goal progress.
3	Window displayed	Shows goal description text
4	Window displayed	
5	Clicks “Show Me” button	Closes window, opens new tab with relevant agent.
6	Clicks “Okay” button	Closes window

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Goal Complete

When a player completes a goal this screen is displayed. Here the player can see how well they did as well as re-play the goal audio signature.

Figure 51: Goals - Goal Complete Window

ID	Use Case	Functionality
1	Window displayed	Displays completion text.
2	Clicks “Play” button	Plays the indicator midi from start to current point in time.
3	Clicks arrows along timeline	Manipulates the timescale for the graph, forward and backward.
4	Hover mouse over graph	Shows the amount based off the indicator plot.
5	Clicks “Okay” button	Closes window.

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Goal Failed

Figure 52: Goal - Goal Failed window

ID	Use Case	Functionality
1	Window displayed	Displays failure text.
2	Clicks arrows along timeline	Manipulates the timescale for the graph, forward and backward.
2	Hover mouse over graph	Shows the amount based off the indicator plot.
3	Clicks “Okay” button	Closes window.

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Achievements

Achievements Window

The player can view all the achievements they can complete. Each achievement has specific conditions in order for the player to be awarded a; bronze, silver, gold or platinum version of the achievement.

Figure 53: Achievements - Achievements Window.

ID	Use Case	Functionality
1	Window displayed	Shows achievement with description and current state.
2	Window displayed	Shows the state of the achievement; not complete, bronze, silver, gold and platinum.
3	Clicks “Okay” button	Closes window.

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Achievement Gained

Figure 54: Achievements - Achievement Unlocked window

ID	Use Case	Functionality
1	Window displayed	Displays achievement earned text.
2	Clicks “Okay” button	Closes window.

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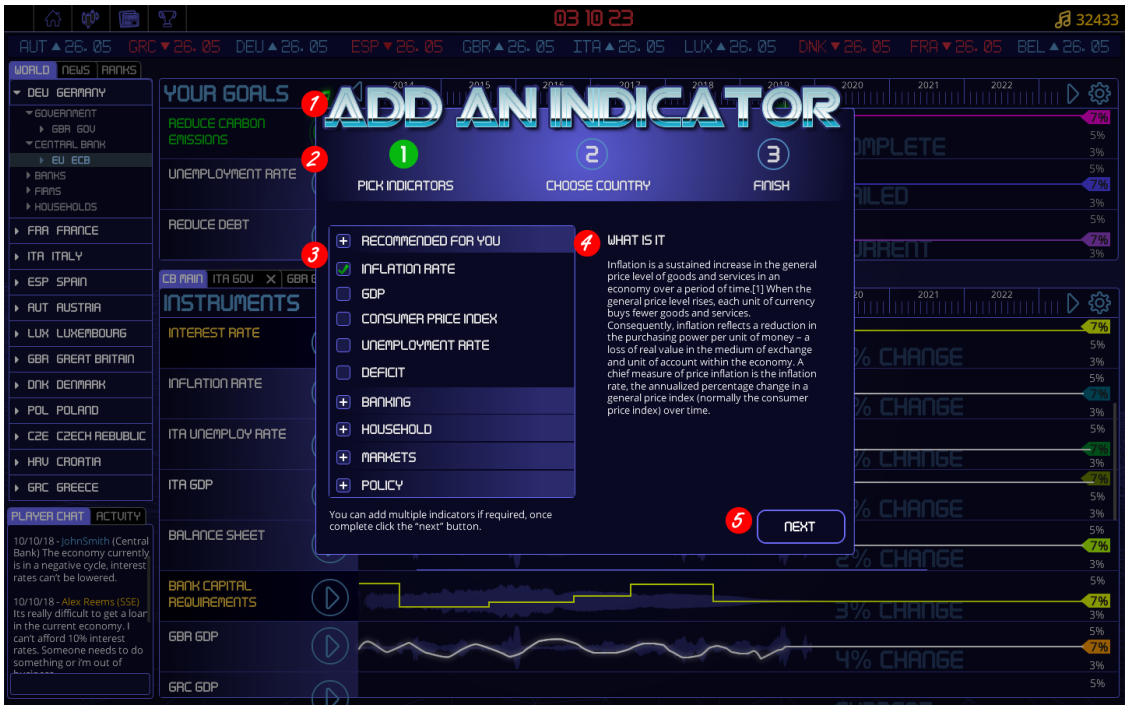
5.2.4 Customizable components

These are components that allow the player to customize the game to fit their play style. This includes adding new indicators, changing player settings and organizing favourite indicators.

Customization Options



ID	Use Case	Functionality
1	Window displayed	Add indicator window – step 1 of 3
2	Window displayed	Shows first step out of three.
3	Clicks category	Shows sub categories – Accordion
4	On mouse hover of category/sub category	Shows help/descriptive information about each of the indicators.
5	Clicks “Okay” button	Proceeds to next step.

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Favourite Indicators

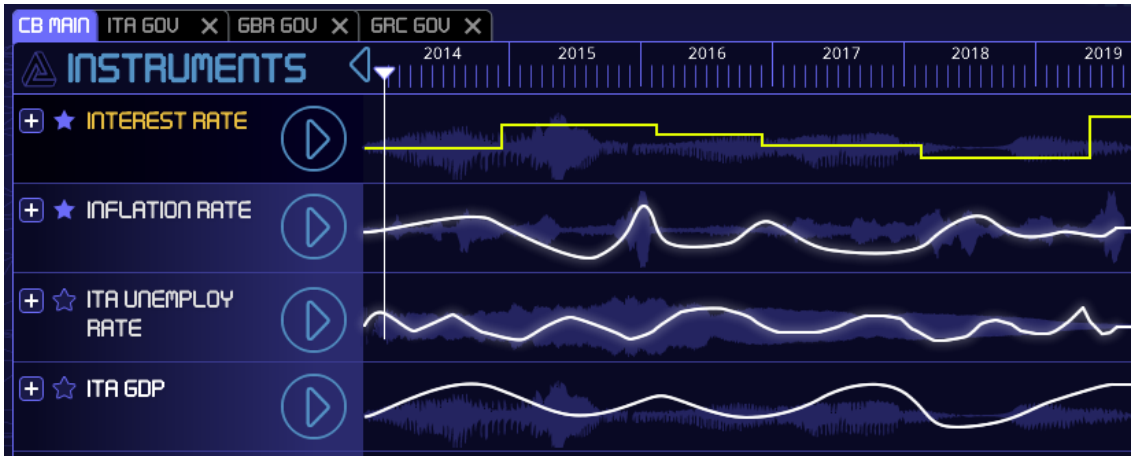

Figure 55: Customization – Favourite Indicators

ID	Use Case	Functionality
1	Clicks empty star icon	Adds the specific indicator to the player's favourites list. An indicator which is a favourite will be displayed in every agent overview screen, regardless to if it is related to the agent or not.
2	Clicks full star icon	Removes the specific indicator from the player's favourites list.

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5.3 Non Functionality Requirements

5.3.1 Scalability

The game is a web application should be able to scale from 5 players to 100 players without any problems. For example, when we are scaling upwards, the user should not “feel” any performance hit or any glitches in the site while this is happening

5.3.2 High Availability

For the game it is important it is to operate without significant downtime or any unexpected game terminations, as the general public do not understand downtime and will happily choose another product if ours is slow or down.

Twitter[38] and YouTube both managed to achieve at least 99 % uptime in 2013. Twitter’s 99th percentile for core requests peaked at 400ms.

5.3.3 Efficiency

The game needs to ensure that the application operation is as efficient as can be to reduce running costs and stretch a budget for server costs.

5.3.4 Usability

Because we are aiming for the game to be easy for everyone to use, we need to focus on the UX and UI of the system.

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6 Conclusion

This document describes the serious game design and technical specification of the SYMPHONY: Economic DJ game. The serious game developed in WP4 for the SYMPHONY platform. It details the objectives of the game, covering the two versions for a Citizen and Policy Maker as well as player roles, game goals, game mechanics, technical architecture and use cases. The next deliverable is D4.2 where an early version of the SYMPHONY game will be developed is due in M18 followed by the final version by M30.

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APPENDIX I: Player Roles Character Fact Sheet

In the following we present a fact sheet for each of the playable roles; the reader can find a brief description of the player role, what it can control and what other player roles have a positive/ negative effect on it. Note that it is not a full technical description of the agents and should be taken into consideration when reading; it is more to shown the each role from the player's point of view.

<table>
<tr><td colspan="4">HOUSEHOLD PLAYER FACT SHEET</td></tr>
<tr><td rowspan="2">  </td><td colspan="3">ABOUT</td></tr>
<tr><td colspan="3">Playing a Household puts the player in the shoes of a home owner in the simulated economy. Household player's main ability is being able to play the capital markets, giving them the opportunity to take the role of a trader/investor in order to maximise their financial position and climb the societal wealth ladder.</td></tr>
<tr><td>CONTROLS</td><td colspan="3">INTERACTIONS</td></tr>
<tr><td rowspan="3"></td><td>PLAYER ROLE</td><td>POSITIVE</td><td>NEGATIVE</td></tr>
<tr><td> 
Household</td><td>Households who are employed and pay their tax provide a better financial economy for the rest of the Household players.</td><td>Other Household players may compete for job openings, real estate or investment opportunities on the capital markets.</td></tr>
<tr><td> 
Firm</td><td>Firms that are doing well employee more people which means more jobs in the labour market, also drives competition between firms to produce more products which requires more skilled Households on higher wages.</td><td>If a Firm doesn't make good profits they may want to cut costs by making employed Households redundant.</td></tr>
</table>

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	 Bank	A Bank provides the Household player with a loan (most likely a mortgage).	A Bank may raise interest rates on a loan to a Household from the consequences of Central Bank raising interest rates, causing the Household to pay more interest on the loan.
	 Central Bank	Central Bank may lower interest rates making buying a new/bigger home more affordable.	May raise interest rates in order to stabilize unforeseen events; i.e. real estate market bubble, in the economy. Causing loan interest payments to increase.
	 Government	Government provides subsidies and job for Households. If a household becomes unemployed an unemployment subsidy can be gained from Government to help support the Household.	Government requires tax to be paid. Government may raise tax to increase its spending power having a negative impact on the Household player's income.

FIRM PLAYER FACT SHEET	
	ABOUT
	Players who take control of a ~~Capital Goods~~Consumption Goods Firm (CGP) are able to play the role of a business owner. They can develop new products to take to market, hire employees (Households) and purchase new machinery from Investment Good firms to increase production. Firm players will also need to make difficult decisions such as downsizing when profits aren't good, applying for a loan from a Bank when it's needed for new product innovation or to keep

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	the firm afloat.		
CONTROLS	**INTERACTIONS**		
	PLAYER ROLE	**POSITIVE**	**NEGATIVE**
	 Household	Households provide Firm players with labour in exchange for a wage. Households also purchase products created by a Firm which has a positive effect on the Firms profits.	Households may not consume the Firms products, causing profit to decrease which could cause the Firm to downsize or even shut down.
	 Firm	Firms invest in each other as well as purchase products from each other.	Competition between firms to sell products could prove costly, prices rise for new product innovation and skilled labour can experience a shortfall.
	 Bank	Banks provide loans to Firms which enables them to take on new product innovations in order to increase profits.	A Bank player could raise interest rates on loans which could have negative effects on profits or worse cause the Firm to default on the Loan causing the firm to spiral into debt and out of business.

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	 Central Bank	Central Bank doesn't directly impact a Firm however it does effect Government and Bank players which do have positive and negative effects on a Firm.	Central Bank could raise the interest rates causing the Bank player to raise interest rates on a loan to the Firm having a negative effect on the Firms profits.
	 Government	Government may reduce corporation tax allowing a Firm to increase spending in other areas of its business.	Government may also increase corporation tax which will have a negative effect on profit.

BANK PLAYER FACT SHEET			
	**ABOUT** A Bank player's primary goal is to maximise their profit by providing loans to firms or households. Banks enable Firms and Households to increase their financial position, they allow for new possibilities for both of these roles. However there is a fine balance between making profit and taking on risk, the riskier the loan the better the reward; however there is a chance the loan may default causing the Bank to lose money or in the worst case go insolvent. **Lending** - to Firms and Households, as well as setting the interest rate for these loans.		
CONTROLS	**INTERACTIONS**		
Lending - to Firms and Households, as well as setting the interest rate for these loans.	**PLAYER ROLE**	**POSITIVE**	**NEGATIVE**
	 Household	Households pay their mortgage with added interest which the Bank can use to lend out to other Firms or Households.	Households may default on their mortgage payments; in the worst case they may spiral into debt, causing the mortgage to turn toxic. Meaning

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			it's not profitable for the Bank. Unless quantitative easing is activated by the Central Bank player.
	 Firm	Firms apply for loans for new ventures; these loans have the benefit of being paid with added interest which the Bank can then use for other activities.	Firms which aren't doing too well can default on their loan payments, the Bank will lose money.
	 Bank	Banks don't directly have an effect on each other however they do have an indirect effect through the credit market, where they compete to match the demand of lending to Firms/Households.	
	 Central Bank	If a Bank gets into trouble it can go to the Central Bank for loan to help it stay afloat. The money is created as Fiat money; the money is not taken from the Central Banks cash reserves/liquidity.	Central Bank could raise interest rates which causes the Bank to raise loan rates to make up for the shortfall, but this puts more Firms and Households at risk of defaulting on their loan repayments.
	 Government	Government doesn't have any direct influence over a Bank; however it does directly affect other player roles which do.	

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<table>
<tr><th colspan="4">CENTRAL BANK PLAYER FACT SHEET</th></tr>
<tr><td rowspan="2"> 
</td><td colspan="3">ABOUT</td></tr>
<tr><td colspan="3">A Central Bank’s primary goal is to keep the economy in check; the player can do this by utilising the interest rate. Lowering the interest rate floods the financial market with extra liquidity, which influences the rate of which Banks can lend to firms and households or Raising the interest rates which has the opposite effect. If Quantitative easing is active the Central Bank can buy up bonds and bad assets from banks to help ease lending.

Interest Rate - Central bank can reduce interest rate (flood the market with extra liquidity), which influences the rate of which banks lend to each other and that in turn influences the rate that effects the rate of loans to households and firms.</td></tr>
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<tr><td> 
Household</td><td>Households don’t have any direct affect however if households are in good economic health it will allow interest rates to slowly rise.</td><td>If Households aren’t spending much in the mall (agent) it can cause GDP to slow down, causing the Central Bank to take action such as lowering interest rates to increase liquidity in the economy.</td></tr>
<tr><td> 
Firm</td><td>Firms don’t directly affect Central bank players however they do have effects on economic indicators such as GDP, the same as a Household.</td><td>If Firms aren’t spending much in the mall (agent) it can cause GDP to slow down. (Same as Households)</td></tr>
</table>

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	 Bank	Banks that take loans from the Central Bank have to pay them back with interest which is then turned into a dividend and distributed to the Government player(s).	If Bank players take on too much risk they pose the threat of going under, once they do they need to be bailed out by the Central Bank with a loan. ~~However the loan is not provided from the Central Banks liquidity/cash reserves but from the creation of fiat money.~~
	 Central Bank	Central Bank – Another Central bank does not have an effect on the Central Bank player.	
	 Government	When Government needs money it goes to the Central Bank and asks it to buy Treasury Bonds. The Government essentially asks for a loan (with interest).	Central Bank is not allowed to make a profit, instead the money is given as a dividend to Government - in case of multiple Governments the dividend is equally split between all Governments.

GOVERNMENT PLAYER FACT SHEET	
	**ABOUT**
	A Government player takes the role of the prime minister of a country. Where they affect economic policy such as tax and subsidies. The player's main goal is to increase GDP, reduce the countries deficit and ensure social indicators such as unemployment rate are kept low. **Bonds** – Government can issue bonds in order to gain more spending power.

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<table>
<tr><td></td><td colspan="3">Tax – Government can increase and decrease tax payments made by Firms and Households.

Subsidies – Government can increase and decrease subsidy hand-outs such as unemployment benefit for Households.</td></tr>
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<tr><td> 
Household</td><td>Households which are employed are able to pay tax which allows the Government player to increase spending in other areas or reduce the countries deficit.</td><td>Unemployed Households have a negative effect on Government, requiring more subsidies to support them; they also have little spending power which can have adverse effects on tax income, a countries deficit and GDP.</td></tr>
<tr><td> 
Firm</td><td>Firms which are doing well provide the Government player income from corporation tax. They are also key players in stimulating GDP growth.</td><td>Firms which fail have negative effects on Banks but also Government as the income from the corporation tax doesn’t come in, causing the Government income to be reduced.</td></tr>
<tr><td> 

Bank</td><td>Banks pay Central Bank when they take out loans with interest. ~~The interest is turned into a dividend which is then paid to the Government Player.~~</td><td>When a Bank collapses it turns to Central Bank for a bailout loan, ~~which is created from fiat money which creates more debt increasing the Governments deficit.~~</td></tr>
</table>

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	 Central Bank	Central Bank issues loans to Government through buying treasury bonds. Increasing the Governments spending power.	~~However these l~~Loans come with added interest which increases the Governments deficit. Also if Central Bank isn't careful when raising interest rates the economy could slide causing massive consequences to income, subsidies and tax.

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