▶ **Table of Content**

Author : Paul NOWAK (Program Manager)

Team : Alexis Lasselin (Project Leader), Aurélien Fernandez (Technical Leader), Laurent Bouquin (Software Engineer), Karine Vinette (Quality Assurance)

Harfang 3D Binding - Functional Specification

1. Glossary

We recommend the reader to read this glossary in order to understand the following parts.

- **Harfang 3D** : The society creating different 3D real-time engine solutions.
- **FABGen** : A set of Python scripts to generate C++ binding codes to different languages.
- **Binding** : An use of a software library for a different programming language.
- **Engine** : A program performing a core or essential function, faciliting development and allowing real-time maintenance.
- **Framework** : A set of tools and software components gathered to allow a faster development of softwares.
- **Real-Time 3D** : The method of representation of 3D images that appear to be moving in real time.
- **HMI** : Abreviation of "**H**uman-**M**achine **I**nterface".
- **API** : Abreviation of "**A**pplication **P**rogramming **I**nterface".

2. Introduction

Harfang 3D is a software developpement company which is dedicated to the creation of HMIs (human-machine interfaces) for various sectors. Founded in 2016, its head office is in Orléans (France) and is directed by a team with 15 years of experiences in the video game and industrial sector.

The society is specialized in Real-Time 3D Visualization, they create useful tools to transform the development of real-time 3D imagery in an industrial context. Indeed, their goal is to popularize their use beyond entertainment purposes.

Two developers of the society, Emmanuel Julien and François Gutherz, want to improve the efficiency of their products. One of their popular project, FABGen, a binding generator used to bring the C++ engine to other languages like Python, Lua or Go.

However, it needs to be updated for making more polyvalent and available solutions for their customers. Indeed, they were taking into account the fact that customers didn't want to learn a new programming language while testing their products.

By the way, the society previously used a popular tool named SWIG which can connect a lot of target languages to the engine. Though, it was too old and complex, so they replaced it with FABGen. In fact, their creation is trying to solve its predecessor's issue by implementing new features, and it's still evolving. This is the company's duty to complete FABGen's functionalities for improving their creations.

As a matter of fact, they want to update FABGen, so it could be able to generate a binding for a new programming language: F#. That's how they went to Algosup and are counting on our team to fulfill their library of python scripts.

In theory, our work will allow them to develop the FABGen's technical architecture. This time, we will need to work on several programming languages to create their product.

3. Goal of the project

The goal of this project is to create a binding generator in the F# programming language for FABGen.

3.1. In Scope

Most importantly, we have to find a way to bridge FABGen with the F# programming language.

The issue is that it's not possible to bridge F# with C++. So, the client wants us to use the C language as an intermediary language between C++ and F#.

Anyway, these are the mains features that are planned for the first version of our product :

- integration of the F# language to a C library and to C++.
- creation of a library using native F# code.
- scripting of the required functions for using the native code of F#.
- writing of a working manual for using the F# binding.

3.2. Out Of Scope

Because of the time and resources constraints, we could only include these features in the future versions :

- shown demonstration of using F# language for compiling an engine's project.
- binding with newer version of F#.

3.3. Deadline

The deadline for the V0 is in February 17th 2023.

4. Functional Requirements

4.1. Objectives

- The product must be able to produce C++ code from F# scripts.
- The unit tests to turn native F# into C++ code must all be functionnal.

4.2. End Result

- The user will be able to activate F# binding when he is working on an Harfang 3D scene.
- He will be allowed to use and create F# scripts for his scenes.
- He can test his simulations with objects connected to F# scripts.

5. Personas

5.1 Jean-Charles Magne

5.1.1 Job:

Developer working for the Research Branch of Renault. He is specialized in the F# and Python languages.

5.1.2 Description:

Jean Charles is a 43 years old man living in Tours. He has a passion for cars, likes reading Mangas and playing badminton with his friends.

He divorced 2 years ago, so he has custody of his 2 daughters of 13 years and 12 years old. Though, they live with him from Monday to Friday, his working days.

By the way, he works at the car manufacturer society Renault for 6 years at Tours. To reach his workplace, he takes the tramway each morning for 20 minutes to arrive at 8am. Then, he works until 6pm and takes the tramway again to go home.

His job is to search for new software tools and test them in order to improve the society's productivity. He is part of the IT department and he has to find a solution to design the HUD of a car panel.

5.1.3 Goals:

Jean-Charles wants to spend more time with his daughters during the days he is with them. So, he would like to find a solution where he doesn't have to learn a new programming language at home.

5.2 Didier Delacité

5.2.1 Job:

Developper from Harfang 3D.

5.2.2 Description:

Didier is a 52 years old man who is living in Orleans since he was born. He has a passion for technology, and lives with his wife near the Head Office of Harfang 3D.

He has a great sense of humor usually dines with his colleagues at restaurants each Saturday, but he hates Football.

He studied at the Insitute of Technology in Orleans for getting a degree in electrical engineering and industrial computing, but he decided to specialize himself in software conceptions.

Then, he has been working as a developer at Harfang 3D for 5 years.

5.2.3 Goals:

Didier wants to improve the quality and availability of Harfang 3D products. With that, the society could attract more customers.

5.3 Naisha Kira

5.3.1 Job:

Software developer from Harfang 3D.

5.3.2 Description:

Naisha is a 21 years old woman who is living in an apartment in Orleans since a few months.

She originally came from India, her home country, and was born in Mumbai where she spent her childhood. Since she was 7 years old, she had a passion for programming and wanted to become a software developer. She knows a few programming languages, especially F# and Python.

After she has finished her high school studies, she enrolled herself to an institute of Technology in Mumbai for 2 years. She then got graduated and decided to live in France, after being hired as a software developer by Harfang 3D.

5.3.3 Goals:

Naisha wants to use her F# skills to help Harfang 3D develop more products relying mostly on the F# binding.

Indeed, this would benefit some products on the advantages of the F# language.

5.4 Hélène Ganthe

5.4.1 Job:

CEO of a glove making startup company.

5.4.2 Description:

Hélène is a 31 years old woman who lives at Paris, in an apartment not far from her own company.

She likes reading novels, musical comedy movies, and is fascinated by leather gloves since her youth. She often wears gloves and is a loving single mother of a 6 years old boy.

Each day (except during the week-end), she takes her son to school by walking before she arrives to her workplace at 9am. Then, she leaves at 4pm before taking a coffee with a friend and picking up her kid to school before going home.

A few months ago, she just created a startup glove-making company. Indeed, she is the main person in charge of designing new variations of gloves. She leads her team of designer to find new ideas, but also new tools to create concepts more often.

Though, most of her team have experience in the F# programming, but they don't have time to focus on learning a new programming language.

5.4.3 Goals:

Hélène wants to spend more time with her child by having more control to her creativity. Indeed, she wants her team of glove designers to use a tool they can use to design new products.

This could improve the productivity of her new company.

5.5 Marcus Tohm

5.5.1 Job:

Language designer.

5.5.2 Description:

Marcus is a 29 years old man who is living in Miami in Florida. He loves traveling, chili dogs, and he spends most of his 5 weeks holidays to practise hiking.

However, when he starts working on his computer, nothing can stop him. He has a passion for programming languages since his teenage years, and works from 8am to 8pm. He would sometimes only eat sandwich at lunchtime while working.

Though, he is specialized by the greatness of the F# language, and often communicate with F# users to make the language better. He even communicated with Don Syme, F#'s creator, and works to give improvements to the language.

5.5.3 Goals:

Marcus wants to add more functionalities to the F# language, so he can grant it more freedom. This would indirectly benefit the F# binding for FABGen.

6. Use cases

6.1. Functional Analysis

- UC1 (Activate the F# binding) :
    - Lambert opens Harfang 3D
    - He creates a scene
    - He activates FABGen to change his scripting language
    - Case is closed
- UC2 (Create a new script in F#) :
    - Marcus activates the F# binding
    - He creates a new script in his Harfang template
    - He writes in F# and saves it
    - Case is closed
- UC3 (Test a scene in Harfang 3D using F#) :
    - Linda opens a scene in Harfang 3D
    - She uses a script written in F#
    - She tests her scene
    - Case is closed
- UC4 (Retrieve an existing F# for using it) :
    - Françoise opens a scene in Harfang 3D
    - She opens a window showing existing F# files
    - She selects the F# file she wants
    - Case is closed

6.2. Use Cases Analysis

Here is a more detailed version of the functional analysis above :

Use Case #	Addresses Business/User Requirement n°	Name	Description	Actor(s)	Pre-Conditions	Flow of Events	Post-Conditions	Exit Criteria
UC 1	U.R #1	F# Binding	Lambert wants to activate the F# binding from FABGen so he can code in F# in Harfang 3D	Developer	Lambert must be allowed to use the FABGen project to connect it with Harfang 3D. Indeed, only the authorized users will get to use FABGen and be allowed to use another programming language.	Lambert creates a scene in Harfang 3D so he can work on it. He then select the "Preferences" menu to change his programming language.	A pop-up showing all available language bindings will be displayed and Lambert has to select one.	The case is complete once Lambert has selected and saved the programming language he wants to work with.
UC 2	U.R #2	New F# Script	Marcus wants to create a new script in F# while working on his Harfang 3D scene.	Developer	Marcus has to activate the F# binding in the engine's preferences.	Once he activated the F# binding, Marcus click on "New Script".	A window from the default IDE will open automatically and allow him to write in F#.	The case is complete once Marcus wrote his F# program and saved it, showing it in the scene's database.
UC 3	U.R #3	Scene testing	Linda would like to test the scene she created in Harfang 3D which is using F# scripts	Developer	The scene Linda is working on must have F# scripts connected to the scene. They must be finished so Linda could test her scene.	Linda clicks on "Test" to activate a simulation of her scene in 3D real-time using F# languages.	The objects connected to the f# scripts must have a specific behavior in the scene.	The case is complete once Linda has validated if her F# scripts are working and saved her scene.

Use Case #	Addresses Business/User Requirement n°	Name	Description	Actor(s)	Pre-Conditions	Flow of Events	Post-Conditions	Exit Criteria
UC 4	U.R #4	Retrieving F# script	Françoise wants to get a F# script she created in a previous project to reuse it in her Harfang 3D scene	Developer	There must be at least one existing F# script in her computer's files.	Françoise clicks on "Get script" to open a window showing different scripts.	The files must be scripts written in programming languages, thus being in .fs format for F# case.	The case is complete once Françoise has selected her F# script and clicked on OK, so it could appear in her scene's scripts database.

7. Non-Functional Requirements

7.1. Security

Potentially, we can add a security feature when the F# binding is reading an F# script. Indeed, some nasty program can be harmful for our operating system, so we might implement some security settings to detect any code which could be a source of bugs.

7.2. Availability

With the integration of a binding generator for a new programming language, FABGen would become more available to F# specialists who don't have time to learn another programming language.

7.3. Portability

The F# binding has to be available on both Windows and Mac operating systems.

8. Conclusion

The client helped us by giving us leads on how to work on the project. For example, they gave us a link to a github page for showing how FABGen and creating a binding would work.

Though, it will be necessary to understand how the bindings for existing languages work. This could be benefical for us to understand some functions, but we have to be careful to not lose time while trying to understand them.

This project would give to the clients a view on how a binding for the F# language with FABGen would work, and potentially give them ideas in order to integrate other languages.

We want to thank the stakeholders, Harfang 3D, and particularly François Gutherz and Emmanuel Julien, for giving us details for the project.