



European
Commission

FET FLAGSHIPS

Interim Evaluation

Members of the Evaluation Panel

Maria Chiara Carrozza (Chair)

Charlotte Brogren

Michal Kleiber

Matthias Kleiner

Ruth McKernan

Paul T Kidd (Rapporteur)

Senior Advisors

Johan Lindberg

Caroline A Lodemann

Sivasegaram Manimaaran

Calogero M Oddo

Final Report

February 2017

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Executive Summary

The FET Flagship programme represents a huge investment in strategic and collective research and innovation. It aims at undertaking research and innovation activities that will transform science into technology with significant industrial and societal impacts. The objective is to achieve an effect that is greater than the sum of individual efforts found in national initiatives. Through supporting such work, Flagships will help to successfully position and grow innovative European companies, including SMEs and start-ups, in future global value chains.

To evaluate the value of Flagships thus far, a Panel of high-level experts was convened to undertake an interim evaluation of the instrument, and its implementation through the Graphene and Human Brain Projects. The aim was to provide recommendations based on the lessons that can be learned from the implementation and operation of the Flagships. These can then be applied to the implementation of Flagship initiatives that the European Commission may launch in the future.

According to the Terms of Reference given by the European Commission to the Expert Panel, the Panel answered to a number of questions on the Flagship initiatives as they are summarized below.

How *relevant* has the Flagship programme been so far?

The Flagship instrument has increased investments in Research and Innovation. Both Flagships are demonstrating that they are contributing towards excellent science, although there are differences between the two. In particular, the Human Brain Project needs to work further to achieve a more uniform level of research excellence across the project than has been achieved thus far. Both projects are however delivering world-leading results, and are reporting achievements beyond those defined by their Key Performance Indicators, for example, in terms of the number of scientific research publications. They are also raising the profile of Europe's leading edge research, while also moving towards innovation outcomes in the longer term.

If the individual Flagships continue to deliver on their ambitious agendas they will be well placed to make an important contribution towards the Europe 2020 goals of delivering smart, sustainable and inclusive growth. This will subsequently create employment in the resulting industries of the future. And this makes the Flagships of continuing relevance to all involved stakeholder communities and to European citizens.

The key point is that the general objectives of the Flagships are unique to this particular instrument. Such objectives continue to be highly relevant as part of Europe's overall Research and Innovation Strategy. There is a strong justification therefore to continue funding the instrument at EU level. FET Flagships also represent value for money as a Research and Innovation funding instrument. The Flagships are not only moving towards delivering on the general objectives, but are also now essential to Europe's future prosperity.

How *effective* has the Flagship programme been so far?

While the Flagships demonstrate their effectiveness in delivering excellent science, their future effectiveness in supporting innovation still needs to be demonstrated. Additional work should be undertaken on refining this aspect. In particular, the stakeholders need to consider further, how best to achieve, in one instrument, what are often seen as very different objectives – excellent science and excellent innovation.

Further improvements are also desirable to both the strategic and operational management of the Flagships. In particular, more can be done to reduce the burden associated with a two-year funding cycle, which importantly, will also help improve in-year budget flexibility and enable the Flagships to better respond to opportunities and make significant investments in infrastructure or demonstrators.

As for the strategy boards of the Flagships, these need to be more positioned within an international context. This will allow for benchmarking of European leadership in the respective fields and for informing on future investments. Such changes to the strategic management approach will also be important for ensuring the shift of focus towards innovation, as the scientific results become more mature.

It is also the case that some of the Key Performance Indicators (KPIs) used by the Flagships are very traditional in the sense that they are too oriented to describing typical research outcomes. Further development of the KPIs is needed. KPIs can help emphasise and clarify differences with other research and innovation instruments of Horizon 2020.

How *efficient* has the Flagship programme been so far?

It is still too early in the history of the Flagships to be assessing this aspect in detail. Measuring efficiency in terms of share of management cost compared to overall cost, and showing better indicators in the Flagships in comparison to smaller-scale programs, may not be fully satisfactory. This matter needs to be considered in more detail as the Flagships develop, particularly in respect to factors that may affect efficiency in the longer term. The most important matters are those that relate to the efficiency of strategic and operational management, and the efficiency of the mechanisms that link the Flagships to national initiatives.

How *coherent* has the Flagship programme been internally and with other EU actions?

Relating to the issue of the relationship with other Horizon 2020 activities, there is a need for improved interaction across the programme, in order to guarantee the Flagships are informed about decisions taken in other parts of the Horizon 2020 programme and Commission policy elsewhere.

What is the *EU added value* of Flagship programme?

Linking research investments made through private and public funding across Europe with the two current Flagships is proving to be more difficult than expected. The relationship between the Flagships and national initiatives must be seen in the framework of a global view of the interaction between European and National programmes. Thus far the EU added value has yet to be fully demonstrated. To improve this situation two issues are crucial; (i) Flagship selection process and (ii) the mechanisms used to link to national initiatives.

The Flagship selection process needs openness and transparency and must involve all relevant stakeholders. This process also needs to ensure commitment and buy-in from national authorities from the start. It is necessary to be clear as to what conditions make a Flagship an appropriate vehicle for supporting research. The rationale for the choices made and agreement on the distinct features of Flagship when compared with other initiatives should also be clear.

These lessons have been learned and the approach to the creation of new Flagships is now being done in closer collaboration with the national authorities.

The second matter, that of the linking mechanisms between the Flagships and national initiatives, is still under development. These need to be further improved. In particular other mechanisms, beyond those conceived thus far, need to be explored in the quest to find the simplest and most effective means of cooperation and coordination between the Flagships and national level activities.

Summary of recommendations

Based on the interim evaluation and the lessons learned, eight recommendations are made. These are summarised in the table below. The full text of each recommendation can be found in the main body of the report.

Strategic relevance of the Flagship instrument in setting and implementing the European strategy for research and innovation

- 1** The continuing strategic relevance of the Flagship instrument for Europe's research and innovation is confirmed, with a strong endorsement of the thinking underlying the Flagship concept. The funding of the Flagships instrument represents good value for money in terms of the quality of the research and its potential for innovation. It is thus recommended that the Flagship initiative be continued, and new Flagships launched in fields where the concept is relevant.

Increase clarity of purpose and differentiation between the Flagships and other research instruments

- 2** The nature of FET Flagships and how they differ from other research instruments needs to be further articulated if the value commensurate with the scale of the investment being made is to be achieved. The concept of Technology Readiness Levels (TRLs) should be used to differentiate Flagships from other research instruments. In particular it is important to demonstrate how the focus of the Flagships shifts across TRLs with time. Further reflection on the design of the Flagship instrument is needed to reach a situation where science is driving innovation, and in turn, this innovation is driving new science. The Flagships need to demonstrate that they have strategic research and innovation agendas aligned with industrial interests. This should be based on understandings of existing industries, as well as opportunities for new entrants such as via start-up companies able to boost disruptive innovation. More effort should be devoted to involving SMEs in the Flagships.

Establish a standard means of assessing the Flagships based on Key Performance Indicators (KPI) that fully reflect purpose

- 3** The KPIs used by the Flagships should be more sophisticated. They should include the means of assessing future potential. KPIs should be developed to measure the meaningful engagement of industry. Such KPIs should be grounded in realistic potential reflecting the existing industrial landscape and its potential for future developments. KPIs measuring the differences between Flagships and traditional Research and Innovation projects should be developed. A common system of assessing the Flagships should be created so that comparisons of KPIs across Flagships can be made.

Improve operational management to enhance the budget flexibility and reduce administrative overhead

- 4** Funding models and funding time-scales should be changed to reflect the special nature of the Flagships. A longer funding cycle should be implemented to improve the flexibility needed to respond to changing circumstances and opportunities. This will also help further increase administrative efficiency. National and EU level schemes should be examined to see which good practices could be transferred across to the Flagships. A relevant example at national level is the Innovate UK's funding for Catapult Centres.

Improve strategic management to enhance openness of the Flagships towards adopting new directions

- 5** The Flagships should be more open to external inputs that can challenge assumptions and direction. Today, the implementation of separated strategic and advisory activities from day-to-day management help Flagships enhance their capabilities to develop in new directions and towards innovation and exploitation of results. Strategic advisory boards that bring in international perspectives should be implemented in all Flagships to create a global context. These boards should also review the Flagships by defining benchmarks so that an understanding of European leadership can be established.

Improve coherence with other Horizon 2020 activities

- 6** A higher degree of interaction is recommended between initiatives under Horizon 2020 and beyond. It is essential that communication within the Commission is improved to ensure that stakeholders have a clear understanding of the opportunities on offer and the relationship between them.

Improve the process of selecting Flagships

- 7** It is recommended that commitment and buy-in from stakeholders including national authorities is obtained early on, before Flagships topics are finally selected. The process should be grounded in science and technology potential, the potential for impact and EU added value, and should attentively take into account the priorities recommended by Member States.

Improve engagement with national initiatives

- 8** The operation of the model of using national Partnering Projects to engage national level activities with the Flagships should be monitored with a view to finding improvements and simplifications. Additional ways for public and private initiatives to engage with the Flagships should be sought. Outreach activities to all interested parties, including relevant research communities that have not yet been engaged by the Flagships, should be increased with the aim of ensuring a greater structuring effect and avoiding duplication of effort.

1. Introduction

1.1 Background

Future and Emerging Technologies (FET) Flagships are part of the FET programme under the Excellent Science Pillar of Horizon 2020. Flagships are intended to be visionary, large-scale, science-driven research initiatives which tackle grand scientific and technological challenges across scientific disciplines. At the point of inception of the Flagships, the overall FET programme was primarily focused on supporting visionary science and technology projects related to Information and Communication Technologies (ICT). This was done within the context of existing traditional funding instruments.

In 2013 two FET Flagships were launched: the Graphene Flagship and the Human Brain Project Flagship.

As the name suggests, the Graphene Flagship is focused on Graphene (a form of carbon in a one-atom-thick hexagonal layer) and other two-dimensional materials. The unique properties of these materials make them a credible starting point for new disruptive technologies in a wide range of fields.

The Human Brain Project Flagship addresses the development of understandings of the human brain. It also deals with the development of the supporting infrastructures needed by brain researchers to adopt big-science approaches based on the use, for example, of large data sets. The work of the Human Brain Project Flagship is expected to provide profound insights into what makes us human, to enable the building of revolutionary computing technologies, and to provide knowledge that will lead to the development of new treatments for brain disorders.

It is intended that each Flagship will mobilize funding to the level of €1 billion, for up to ten years. The plan is for €500 million of funding per Flagship to be provided through the European Commission's Framework Programmes for Research. Additional funding is expected to come from other partners including universities, national initiatives, and the private sector.

Starting in October 2013, the two Flagships entered a ramp-up phase, with funding provided from the Framework Programme 7 budget. The ramp-up phase came to an end in March 2016. New funding began in 2016, under Horizon 2020. This new funding is worth €89 million for the period April 2016 to March 2018, for each Flagship project.

At the start of 2016, the European Commission invited a Panel of high-level independent experts, to undertake an interim evaluation of the FET Flagship Instrument and its implementation. The evaluation covered the operational period from October 2013 to October 2016. This interim evaluation was not intended as a scientific review of the work undertaken by the Flagships, but as an assessment of the instrument itself, as implemented in the two Flagships. However, the Panel's work did call upon the results of scientific reviews of the Flagships, as well as evidence provided from other sources. More details about the Panel's method are provided below in Section 1.3.

1.2 General objectives of the Flagships

In 2009, the European Commission, in a Communication¹, stressed the need for Europe to address grand scientific challenges through sufficiently long-term multi-disciplinary research initiatives. These initiatives were called FET Flagships. They were intended to help concentrate effort and deliver impact in the ICT domain, reduce fragmentation of research across Europe, and bring critical mass to relevant areas within the FET programme. The concept was then further elaborated by the high-level Information and Communication Technologies Advisory Group (ISTAG) in a report published towards the end of 2009².

From inception, Flagships were designed to be ambitious, long term and large scale (10+ years, ~€1 billion) science-driven research and innovation initiatives. They bring together dozens of excellent research organisations (academia and industry) from all over Europe, with the aim to solve grand interdisciplinary science and technology challenges and to convert scientific advances into concrete innovations that benefit Europe's society and economy.

1 COM(2009) 184 final of 20.4.2009

2 http://cordis.europa.eu/pub/ist/docs/istag/flag-fet-july09_en.pdf

The general objectives of the Flagships as described in a Commission Staff Working Document³ published in September 2014 are to:

- Establish Europe as a global leader in their domain and an attraction pole for international cooperation: building on European S&T excellence; creating collaborations among the best teams in Europe; forming leading initiatives and poles of attraction; creating opportunities for intense international cooperation and for regularly communicating European achievements in the field.
- Develop new talents and new skills: nurturing creativity and talent; attracting the best minds; helping educate and train a new generation of skilful researchers.
- Create a long-lasting structuring effect on research efforts in Europe: creating collaboration amongst hundreds of European research teams across disciplines and across academia and industry; achieving a lasting integration of efforts and resources beyond their duration; creating synergies and coordinated planning among European, national and regional activities; reducing fragmentation and optimising complementarities between EU and national research programmes.
- Deliver a large impact on competitiveness and society: bridging the gap between fundamental research and innovation; jointly developing and implementing a strategy for the efficient translation of scientific advances into concrete innovation opportunities; addressing some of Europe's major societal challenges.

Further information about the Flagships is provided in Appendix 1.

1.3 Interim evaluation Panel's methodology

The Panel consisted of independent high-level experts, all with experience of research policy and strategy, drawn from five countries, assisted by a Rapporteur and four Senior Advisors. The Panel was also assisted by officials from the European Commission. The role of the Panel's Senior Advisors was to advise Panel Members and to assist them in collecting and interpreting the evidence gathered.

The methodology, based on Panel's expertise and judgements, was informed by a range of evidence and data including that provided by the two Flagships and the two support projects, FLAG-ERA and TAIPI (details of which are presented in Appendix 1). As sufficient time had elapsed since the start of the ramp-up phase for stakeholders to form opinions, the Panel Members and Senior Advisors collected evidence, through written questionnaires (Appendix 3) and interviews, from a wide range of stakeholders organised into the following groups:

- FET Advisory Group
- European Commission
- National Ministries and funding agencies
- Participants in the Graphene and Human Brain Project Flagships
- Coordinators of partnering projects to the Flagships
- Non-participants in the Graphene and Human Brain Project Flagships, but working within the respective fields
- Organisations from outside the EU
- Others (not covered by the above)

In total the views of 48 individuals were collected in this way. This process resulted in the gathering of the diverse perspectives of many stakeholders representing a broad range of interests. Some of the views were aligned towards a common position, while others were in part contradictory.

³ SWD(2014) 283 final of 16.9.2014.

During the period of the Panel's work, the European Commission announced the formation of a Quantum Technologies Flagship initiative as part of its Digital Single Market strategy. The European Commission also sought recommendations from the wider research community on potential areas for future FET Flagships in FP9. As a consequence the Panel was also interested in broader findings that point to lessons to be learned, which can then be applied when initiating and launching new Flagships in the future. The Panel was thus kept informed about on-going developments, and sought to understand how the process being followed for setting-up the new Quantum Technologies Flagship differed from that followed in establishing the Graphene and Human Brain Project Flagships.

The Panel also received the technical reports of the two scientific project reviews, undertaken by independent experts, of the on-going Flagship initiatives. These reports provided insights into the views of the technical experts assessing the excellence of the two Flagships. This included their technical assessment of progress to date. In the Panel's report, however, scientific matters and achievements are only referenced as they relate to the purpose of the Flagships as an instrument, and how the instrument itself serves to support the achievement of purpose. The Panel also received from these review experts, responses to more strategic questions posed to them by the Panel. These questions concerned the role and effectiveness of the Flagship instrument as evidenced by the progress they have observed (Appendix 3).

A list of documents consulted by the Panel is given in Appendix 4.

The members of the Panel met formally on three occasions to review evidence and to formulate their conclusions. Telephone conferences among the Panel's Senior Advisors and the Panel Rapporteur were held to plan and implement the evidence gathering work and to discuss the writing of the report.

This is the consensus report resulting from the Panel's interim evaluation.

2. The Panel's findings and recommendations

Findings are organised into five sub-sections, according to the evaluation criteria that were specified in its Terms of Reference: Section 2.1 Relevance; Section 2.2 Effectiveness; Section 2.3 Efficiency; Section 2.4 Relationship with other Activities of Horizon 2020; and Section 2.5 EU Added-Value and Coherence with National Initiatives.

2.1 Relevance

Recommendation 1: There is strong strategic relevance of the Flagship instrument in setting and implementing the European strategy for research and innovation

The continuing strategic relevance of the Flagship instrument for Europe's research and innovation is confirmed, with a strong endorsement of the thinking underlying the Flagship concept. The funding of the Flagships instrument represents good value for money in terms of the quality of the research and its potential for innovation. It is thus recommended that the Flagship initiative be continued, and new Flagships launched in fields where the concept is relevant.

The purpose of the Flagship instrument is to deliver science-driven innovation for Europe.

The nature and scale of the collaborations means that the Flagship concept has created a broad community of researchers working towards a common goal, which in terms of its size and diversity is unique in the world. The Flagship instrument has also increased investment in Research and Innovation. By their nature Flagships also have the potential for creating better exploitation and commercialisation of the outcomes of this investment. Thus if the individual Flagships continue to deliver on their ambitious agendas they will be well placed to make an important contribution towards the Europe 2020

goals of delivering smart, sustainable and inclusive growth. This will subsequently create employment in the resulting industries of the future. *And this makes the Flagships of continuing relevance to all involved stakeholder communities and to EU citizens.*

The Flagship programme thus represents a huge and strategic collective effort. It is clear from the Panel's interactions and the separate technical reviews of both Graphene and the Human Brain Project (undertaken by teams of independent experts) that they have given European Research and Innovation a serious boost. *They have created an international profile for Europe's researchers at the forefront of science and technology developments, and arguably triggered significant investment internationally in these domains.*

The overall point here is that, the generic objectives of the Flagships listed in Section 1.2 (General Objectives of the Flagships) above, are unique to this particular instrument. Such objectives continue to be highly relevant as part of Europe's overall Research and Innovation Strategy. *There is a strong justification therefore to continue funding the instrument at EU level; FET Flagships represent value for money as a Research and Innovation funding instrument.* The case for this is demonstrated via the evidence collected which shows that the *Flagships are not only moving towards delivering on the general objectives, but are also now essential to Europe's future prosperity and well-being.*

More outreach towards interested stakeholders, including the public, is however needed to further raise the profile of the objectives and achievements of the Flagships. The Flagship participants should also be more consistent and clear in emphasising in their scientific outreach and dissemination activities, that their research work is supported by the EU and its Flagships instrument.

2.2 Effectiveness

The independent expert technical reviews of the Graphene Flagship confirm that there has in general been excellent progress made in the science of graphene and related materials. Similarly, there are aspects of the Human Brain Project that are also judged to be outstanding. Innovation impacts are though, understandably, still developing given the early stages of both projects. There are however several important issues surrounding the effectiveness of implementation that the stakeholders need to take into account. The Panel assessed the effectiveness along the following dimensions:

- Effectiveness in supporting excellent science;
- Flagships as an effective means of supporting innovation;
- Measuring effectiveness through KPIs;
- Effectiveness in relation to operational management; and
- Effectiveness in relation to strategic management.

2.2.1 Effectiveness in supporting excellent science

The excellent progress in the science related to development of graphene and related materials reported by the Graphene Flagship, is underpinned by the engagement of many of the leading researchers and groups in Europe. This is in accordance with the strategic objectives set for the Flagships.

Several results show breakthroughs or improvement of existing technologies, and the development of novel solutions. One example of this is the integration of graphene in silicon photonic devices. Similar sensitivity as compared to standard silicon photodetectors was achieved using graphene, which offers substantial advantages as it can be made more simply and cheaply and also covers a wider wavelength range. This is an important step towards a full, low energy optical telecommunication system.

External reviewers⁴ have credited the Flagship for the exceptionally large number of very high quality scientific publications and results exceeding the Key Performance Indicator targets, and with clear progress on technology development.

⁴ For review and highlights of technical achievements of the GRAPHENE Flagship:
http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=17006

Similarly, in the case of the Human Brain Project⁵, there are strong examples of interdisciplinary work integrating modelling with data sets, with the work on neuromorphic computing resulting in the development of prototype chips that are reportedly beyond state-of-the-art. Reviewers also noted that, of the six ICT research infrastructure platforms launched in 2016, three of these platforms are sufficiently mature to attract first users. A process is now in place for further clarifying strategic use-cases and data, and the related tools and necessary content. A European federated infrastructure for data hosting is also being organised.

Here too there are achievements beyond those set by the Key Performance Indicator targets.

Yet there are also some differences in the achievements of the two Flagships. This stems from the difficulties that the Human Brain Project experienced in the early part of the ramp-up phase, which necessitated the need to form a mediation panel (see Appendix 2 for details). This has certainly slowed down the project. But the expert reviewers also note that there is a need for the project to achieve a more uniform level of research excellence than has been achieved thus far. In particular the project needs to create stronger interactions among some of the sub-projects and to prove the value of research infrastructures to all Human Brain Project communities.

The Human Brain Project's problems in its early stages illustrate that while Flagships have demonstrated their contribution to delivering excellent science, there are factors that can create difficulties and hinder the achievement of scientific excellence. Thus the main lessons to be learned for future Flagships are that (i) objectives should be relevant to the involved research communities; (ii) the objectives should be achievable; and (iii) the relevant research communities and Member States should support the objectives.

It is important that all stakeholder communities be aware of these lessons.

2.2.2 Flagships as an effective means of supporting innovation

Recommendation 2: Increase clarity of purpose and differentiation between the Flagships and other research instruments

2.1 The nature of FET Flagships and how they differ from other research instruments needs to be further articulated if the value commensurate with the scale of the investment being made is to be achieved.

2.2 The design of the Flagship instrument should reflect what is sought. Excellent science and excellent innovation require a balance and a shared space of problem-solving research; science should be driving innovation, and in turn, this innovation should be driving new science. Further reflection is needed on how to achieve this.

2.3 The Flagships are fundamental to developing enabling technologies for the next industrial revolution and they should therefore demonstrate that they have strategic research and innovation agendas aligned with industrial interests. This should be based on understandings of existing industries, as well as opportunities for new entrants such as via start-up companies able to boost disruptive innovation.

2.4 There needs to be more effort devoted to involving SMEs, as well as larger companies, in the Flagships. This involvement needs to go beyond watching briefs, to active research engagement driven by clear business objectives. The Flagships should do more to create an entrepreneurial environment by working more with companies prepared to undertake an active engagement.

2.5 The concept of Technology Readiness Levels (TRLs) should be used to differentiate Flagships from other research instruments. In particular it is important to demonstrate how the focus of the Flagships shifts across TRLs with time.

The partners in the Graphene Flagship have generated an exceptionally large number of very high quality scientific publications. This, taken with the numerous patent applications that have been filed, provides a tremendous platform for innovation and economic impact in Europe. When combined with future collaborations at a European level in areas such as standards, standardised manufacturing and quality control methods, and in health and safety, the innovation impact should be significant. Industry engagement in the Graphene Flagship is however essential if such impact is to be achieved here in Europe, but the Flagship has still to fully develop a relevant basis for industrial engagement and impact.

⁵ For review and highlights of technical achievements of the Human Brain Project Flagship: http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=17075

At the moment, some companies are only present with a *watching brief* rather than engaging in deeper cooperation. This may be because the Flagship is still in an early research phase, exploring various directions, which may make it appear to be an unattractive partnering proposition. From a project's perspective it would of course be very limiting to invest in a single direction, but nevertheless more effort should be directed towards responding to industry's priorities and opportunities.

Thus, while the Flagship is clearly demonstrating its industrial potential and relevance, future steps throughout the continuation of the Graphene project must focus more on the industrial applications and exploitation within Europe. This is a challenge that must be vigorously addressed. The Graphene partners are well aware of this challenge and in order to address it they have developed a technology and innovation roadmap in close cooperation with industry⁶. This roadmap complements the Flagship's strategic research roadmap and will be of key importance for the industry to begin to engage more actively. While this engagement should include both large and small companies, it is particularly important that SMEs and start-up businesses should be encouraged to participate. Industry engagement should also be used to develop a shared understanding of market potential, and the extent to which this can be realized by European industry.

Likewise for the Human Brain Project, even though it is still at an early stage. Developments such as the neuromorphic computing architectures have scope for high economic impact. To maintain a leading European position however will require both the involvement of relevant partners in research and industry, but also an effective coordination with, and an understanding of, activities being undertaken at national level, as many of the leading groups are engaging with key industry partners outside the confines of the Flagship.

While the Flagships are key instruments to promote industrial leadership, they are also important for the education and training of young researchers. This education and training aspect should be reinforced to provide the necessary professional, entrepreneurial, and general skills to enable young researchers to become the main actors of future European development and social innovation.

An important issue however, requiring further exploration and elaboration in the future, is the dual purpose of the Flagship instrument; the delivery of world-leading science, while also paving the way, through technology, to innovation. The conditions that make a Flagship an effective structure for undertaking research have to be clearly defined well in advance. In addition, clarity about the outcomes that are sought is needed. This is because seeking high quality science and seeking innovation with social and economic impacts are often seen as separate and possibly conflicting objectives. There is evidently also a need to stress more the differentiation between the Flagships (with this dual focus), and other Horizon 2020 Research and Innovation funding instruments.

The funding model, and the self-sustainability of advanced innovation activities, is a matter for further reflection in future. Consideration however, should be given to deploying an innovation funnel approach. This should help to clearly demonstrate which ideas have been discarded and which pursued further towards innovation. This should also be coupled to Technology Readiness Levels (TRLs)⁷, to create a means of understanding how the Flagships are moving towards the ultimate objective of innovation in markets and society. These matters should then be embedded into Key Performance Indicators (KPIs). This is a matter addressed in the next section.

2.2.3 Measuring effectiveness through KPIs

Recommendation 3: Establish a standard means of assessing the Flagships based on key performance indicators that fully reflect purpose

3.1 The KPIs used by the Flagships should be more *sophisticated*. They should reflect the longer term purpose of the Flagships and be less focused on just assessing initial outcomes.

3.2 KPIs should be developed to measure or assess: the meaningful engagement of industry; future potential driven by industry perspectives grounded in the world of technology, engineering and business; and, investments made in scientific and technical infrastructure. In addition, KPIs measuring impacts very specific to the nature of the Flagship instrument are needed (for example, KPIs measuring potential economic impact, and new collaborations or interdisciplinary research). These will help to differentiate Flagships from other research instruments.

3.3 A common system of assessing the Flagships, including common data collection, should be developed which will enable comparisons across Flagships to be undertaken.

6 <http://graphene-flagship.eu/roadmap-industry-needs-and-perspective-towards-electronics-applications>

7 https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

The Graphene Flagship and the Human Brain Project Flagship have both produced, at the end of the 30 month ramp-up phase, a set of Key Performance Indicators (KPIs). There is a reporting of on-target, or in some cases over achievement, on these KPIs, which is indeed an achievement for the Flagships.

It is the case however that some of the KPIs are very traditional in the sense that they are too oriented to describing typical research outcomes that could apply to most Horizon 2020 Research and Innovation projects. It is important that KPIs should reflect the objectives of the Flagship instrument and not just be oriented towards counting e.g. numbers of PhD students, numbers of papers published, number of industry engagements. Other issues, for example, the number of multidisciplinary authored papers, and the number, nature and success of interdisciplinary collaborations are arguably more relevant and important. Other matters too should be measured; for example, the licensing of intellectual property to businesses outside the Flagship consortia.

Thus, from a strategic perspective, there is a need for a reorientation of some of the KPIs towards indicating potential for impacts. For example, while the number of industry engagements is recorded, this does not necessarily point to the quality or impact of such interactions on either the Flagship or the industry partner. KPIs could also be designed that illustrate how some unpromising research activities are being phased out, so that resources can be directed towards research that is more likely to lead to innovation. Furthermore, some KPIs are left to the future with a statement to the effect that it is “too early to evaluate” (too short time to evaluate) which is not helpful to those seeking to make global assessments.

The development of KPIs should also be linked to matters that are raised in Section 2.2.2 above (Flagships as an effective means of supporting innovation). Of particular importance is the development of KPIs that relate to TRLs and their progress towards higher levels over time, and the innovation funnelling approach.

It is also evident that, at this stage, there is a need for standard assessment method and for common data collection schemes to be put in place as soon as possible, so that KPIs for all Flagships can be compared.

2.2.4 Effectiveness in relation to operational management

Recommendation 4: Improve operational management to enhance the budget flexibility and reduce management workload

4.1 Funding models and funding time-scales should be changed to reflect the special nature of the Flagships. It is recommended that a longer funding cycle should be implemented to improve the ‘in year’ flexibility needed to respond to changing circumstances and new opportunities including with a view to making strategic investments in equipment or demonstrators, for example, which may not be feasible if funding is spread evenly across financial years. This will also help reduce the amount of time spent by project participants in applying for next stage funding. It is recommended that to achieve improved funding-cycle budget flexibility for the Flagships, other schemes, at national and EU level should be examined to see what can be transferred across to the Flagships. A relevant example at national level is the Innovate UK’s Catapult Centres.

The operational management aspect of the implementation model is a key to effectiveness. The Flagship operational management model is however, very similar to that used for smaller scale Research and Innovation projects. This is potentially problematic in terms of the flexibility to manage activity and associated budgets.

Representatives of the Graphene Flagship noted that, as a consequence of the two-year funding cycle for Core Projects, consortia are involved in a constant bidding process. This is complicated by the need to navigate the interests of 100+ partners, which is without doubt an unwieldy exercise. This could however be avoided if the funding window were much longer, with appropriate checks initiated to verify the continued relevance of funded work.

Funding rules should be looked at in the context of, for example, providing opportunities to pursue activities that cannot otherwise be undertaken. Such a situation might be investments in strategically important equipment on a different basis to that established for smaller (in terms of size and duration) research projects.

Regulations and procedures required by the European Commission, which may well work when overseeing small-scale projects, also do not necessarily scale up to the Flagship level. They can result in an enormous overhead, as well as much reporting (which itself is a burden that ultimately will affect efficiency) out of proportion with the value of such grants to individual members of the Flagships.

There is a need therefore to refine the implementation model, capitalizing on the Flagship experience so far and integrating lessons learnt from other initiatives at national and EU level, so to provide enhanced flexibility with regard to budgets.

2.2.5 Effectiveness in relation to strategic management

Recommendation 5: Improve strategic management to enhance the openness of the Flagships towards adopting new directions

5.1 The Flagships should be more open to external inputs that can challenge assumptions and direction. The separation of scientific and advisory activities, from day-to-day management, should be implemented in all Flagships in order to enhance consideration of the development of the Flagships in new directions, beyond the vision and interests of the existing consortia.

5.2 Strategic advisory boards that bring in international perspectives should be implemented in all Flagships to create a global context. These boards should also review the Flagships by defining benchmarks so that leadership compared to developments elsewhere can be established. These advisory boards should also provide an industrially grounded view of the innovation potential of scientific results, and should challenge the assumptions underlying research agendas. These advisory boards should also be involved in making assessments at the level of the specific workplans, rather than just operating at a high-level.

The strategic management aspect of the implementation model is a key element towards ensuring flexibility and adaptation to external changes. Significant efforts have been made by the two Flagships, in collaboration with the European Commission, to establish effective governance structures. These are now more fit for purpose and help to maintain the scientific and technical integrity of the two projects.

Effective strategic management requires a committed and detached management board to set strategy and priorities based on the outcome of the research, with the capability to change direction and consortia more easily. In addition, *external advisors must be involved in continuous assessment*; in the past external advisors have tended to be used only at a very high-level, rather than in the implementation of workplan actions. It is noted however that in the Graphene Flagship an internal assessment at workplan level will be done with the help of external experts at each future Core Project cycle. This is a welcome development and should be applied to all Flagships.

Furthermore, efforts to bring in new partners through open calls have not necessarily been driven by the strategic requirements of the Flagships. It is recommended to introduce new partners when the need becomes evident, because it requires complicated decision processes within the consortium and potentially detract from leveraging significant investments being made elsewhere across Europe. Transparency and openness to the engagement of new partners must be retained, but within the context of a clear vision.

2.3 Efficiency

The TAIPi project has calculated an indicator on efficiency, which is: share of management cost compared to overall cost. It is noted that during the ramp-up phase of the Flagships (i.e., October 2013 to March 2016), about €3.5 million (4.7%) of the overall budget (€75 million) were allocated to management actions. The share of management costs in the Graphene Flagship has been kept at a low level, and at 1.5% it is below the typical percentage figure for management costs in FP7 projects.

Efficiency is also linked to the extent to which the single Core Project model, with external Partnering Projects (illustrated in Figure 1), allows the best and most relevant research to be undertaken within the Flagship. Given the complexities and challenges that have arisen, linking the two in an efficient manner remains an issue to address. Because of this the synergies expected under the model of Core and Partner Projects have yet to be fully realized. The relationship between Partnering Projects and the Core Projects of the Flagships must therefore be improved. This point is examined in greater detail in the context of EU Added-Value below.

At this stage, it is rather too early for judging this aspect in detail. This view is also shared by many stakeholders. The matter should be reviewed in the future.

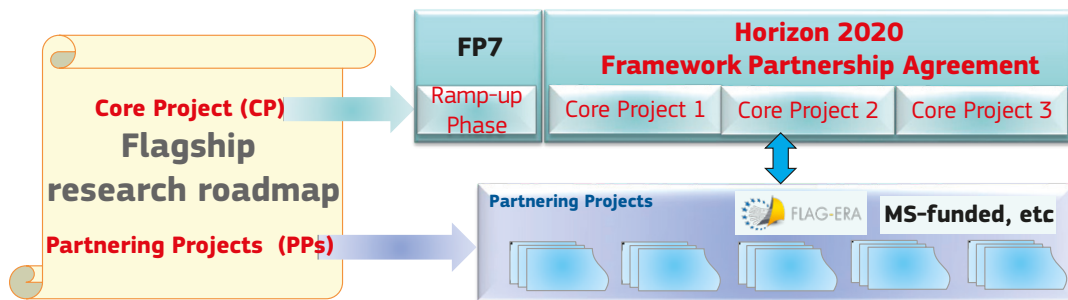


Figure 1: Core Project and Partnering Projects Model

2.4 Relationship with other activities of Horizon 2020

Recommendation 6: Improve coherence with other Horizon 2020 activities

6.1 A higher degree of interaction is recommended between the Flagships and other initiatives under Horizon 2020 and beyond. This should be done with a view to ensuring that coherent support is provided within a FET Flagship initiative. An exchange with related programme areas will also help develop synergies and exploit the outcomes of what are significant investments.

The Flagships provide a basis for collaboration at EU level, as do other Horizon 2020 Research and Innovation actions. The main difference between the two is a global vision and the scale of the effort. Flagships provide to individual partners within the consortia, access to a wider range and number of partners than is typical for a Horizon 2020 Research and Innovation project and there is some evidence that, for some, this networking effect is a value in itself.

The agendas of the current Flagships are particularly relevant to areas such as the ‘Nanotechnologies, Advanced Materials, Biotechnology, and Advanced Manufacturing and Processing’ (NMBP) and the ‘Information and Communications Technology’ (ICT) programme areas of Horizon 2020. More effective two-way information flows are needed. Evidence to date points to Graphene related topics disappearing from other parts of Horizon 2020 when the Flagships emerged, and only now starting to reappear to support for example the development of pilot lines. These links are essential to ensure that participants can take full advantage of the opportunities available, and for those prioritizing future support to make informed judgments.

Coherence with other relevant parts of Horizon 2020 should therefore be improved. This can be done with little effort.

2.5 EU Added-value and coherence with national initiatives

Recommendation 7: Improve the process of selecting Flagships

7.1 The European Commission should ensure an open and transparent process that demonstrates to research communities and other stakeholders that the selection of topics is grounded in science and technology potential, the potential for impact and EU added value.

7.2 The involvement of national funding authorities from the start is important if the current model is to be retained.

7.3 It is recommended that the extent to which there is a consensus across all relevant stakeholder groups concerning the interest in and support for what is to be pursued (objectives) be established at the start.

Recommendation 8: Improve engagement with national initiatives

8.1 As the model of using FLAG ERA and other Partnering Projects is still in its early phase, it is recommended that the European Commission allows time to establish a sound evidence base on its strengths and weaknesses. To do so, it should monitor the operation of the model with a view to finding improvements and simplifications.

8.2 It is recommended that the European Commission should also consider how to enhance and develop further engagement in the Flagships of public and private initiatives. Mechanisms such as COFUND should be considered and investigated as possible instruments.

8.3 Outreach activities to all interested parties, including relevant research communities that have not yet been engaged by the Flagships, should be increased with the aim of ensuring a greater structuring effect and avoiding duplication of effort.

The establishment of the two existing Flagships was a new venture, and much has been learned from the experience. The issues discussed below must therefore be considered as lessons learned to improve the instrument for future initiatives.

EU Added-value and coherence with national initiatives is directly dependent upon two issues: (i) the process used to select Flagship topics; and (ii) the mechanisms used to link the Flagships with national initiatives.

On the first matter of the selection process, the two Flagships established to date, and the proposal for a Quantum Technologies Flagship, have followed different modes of selection.

The creation of the current two Flagships was based on a bottom-up researcher-driven approach, with evaluation achieved by means of the open call mechanism. The selection process also involved the use of pilot projects, which was also useful as a preparatory phase. This in fact may, in some fields, be a necessary first step, especially when there is a lack of consensus about the relevance or importance of Flagships to a particular research field. However, in the selection process there was not enough consideration given to alignment with national priorities. Yet these national funding bodies and stakeholders are critical partners in delivering the Flagship vision in the context of the current model.

The proposed Quantum Technologies Flagship on the other hand, has followed a more top-down approach informed by wider support from the existing scientific community, industries and national authorities.

Evidently what is needed is a clear understanding of what conditions make a Flagship an appropriate vehicle for supporting research, the rationale for the choices made and agreement on the distinct features of Flagship when compared with other initiatives. The topics should be characterised by having significant added value through integrated and collaborative efforts at an EU level, which are also fundamental for achieving critical mass and ensuring industrial leadership. Buy-in from all relevant communities is needed as well. Most importantly, there must be an open and transparent process for selecting Flagships involving all relevant stakeholders.

Thus coexistence of top-down and bottom-up approaches is essential for the Flagships to have the opportunity to build on investments of both the public and private sector at national and regional level.

These lessons have been learned and the approach to the creation of new Flagships is now being done in closer collaboration with the national authorities. This should be continued for all future Flagship selection.

Once selected though the challenge is to ensure there is continuing coherence with national initiatives. At this stage there is little evidence that the launching of new Flagship-relevant national initiatives is always done coherently with the Flagships. This coherence, when it can be observed, is more evident for the Graphene Flagship than it is for the Human Brain Project.

Thus more attention should be paid to improving coherence between the Flagships and national level initiatives; this is fundamental for the future success of the Flagship instrument, as one of the strategic objectives of Flagships is to create a long-lasting structuring effect on research efforts in Europe. Success here will depend on the ability to integrate and harmoniously operate the Flagships, their Core Projects and the Partnering Projects funded by FLAG-ERA or relevant national programmes.

The processes for formalising and maintaining relationships between the Flagship Core Projects, and other researchers and projects, were developed during the ramp-up phase of the Flagships. It is evident however that this mechanism has yet to become an effective means to monitor and stimulate the process. This mechanism therefore needs to be improved in future initiatives. In the current setup, for example, it is difficult to track national investments and their contribution to the Flagships and this challenge needs to be addressed.

The support of scientific communities is fundamental for the final outcome of the Flagships in achieving their objectives, but it is not yet fully demonstrated that the Partnering Projects are the appropriate instruments for improving inclusion. For this reason in future implementation of Flagships, it is important to tune the Partnering Projects system and its incorporation in the Flagships, to the Core Projects. It is therefore important to look beyond the FLAG-ERA initiative, and to consider other means of engaging with national activities, for example through COFUND or the Joint Undertaking instruments, and leveraging investments by the public and private sector elsewhere across Europe.

Creating new fragmentation should also be avoided. Situations could arise where people in the Flagships are working on the topics that they define, while there are others outside the Flagships, who may also be working on the same topics. Additional outreach activities must therefore be designed and implemented in order to improve the integration of all scientific communities in the system, at least at the level of information, and possibility also to interact and propose topics for Partnering Projects.

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Appendix



Appendix 1 – Information on the Flagships

Brief history

In 2009, the European Commission, in a Communication, stressed the need for Europe to address grand scientific challenges through sufficiently long-term multi-disciplinary research initiatives. These initiatives were called FET Flagships. They were intended to help concentrate effort and deliver impact in the ICT domain, reduce fragmentation of research across Europe, and bring critical mass to relevant areas within the FET programme. The concept was then further elaborated by the high-level Information and Communication Technologies Advisory Group (ISTAG) in a report published towards the end of 2009.

In 2010 a global study of large-scale Flagship-like initiatives was undertaken, which identified as a key success factor, the involvement of the research communities in shaping the programmes of such initiatives. The European Commission therefore decided to set up an open and bottom-up process led by researchers and their scientific communities for the elaboration of candidate Flagships.

The selection process started in early 2010 with an open consultation with the scientific community to share and discuss initial ideas for potential Flagships. This was followed by a Call for Proposals, which was published on 20 July 2010, for which 21 eligible proposals were received. These 21 proposals were then evaluated and six pilots (preparatory actions) were selected in January 2011.

The Flagship pilots began work on 1 May 2011. Each of the six contenders received around €1.5 million in funding over one year to refine their strategic research roadmaps, involve the wider relevant research communities, look for the necessary support and develop the operational and financial feasibility.

At the end of October 2012, the six finalists submitted their complete Flagship proposals. These included a roadmap and implementation plan, together with a detailed and thorough justification for the proposed investment, as well as an analysis of the European landscape in their respective fields. Finally, in late 2012, a panel of 25 world-renowned experts evaluated the six Flagship proposals. The result was publicly announced on 28 January 2013.

The Human Brain Project and Graphene were evaluated as the two best proposals.

FET Flagships – Situation at start of Panel’s evaluation

FP7 Ramp-up phase

Following the announcement of their selection in January 2013, the Human Brain Project and Graphene Flagships started in October 2013 a 2.5 year ramp-up phase, which ended in March 2016, funded with 54M€ from FP7.

In October 2013, the European Commission also launched an ERANET action (FLAG-ERA⁸) that brings together funding agencies and research ministries from Member States and Associated Countries with the aim to coordinate transnational support and contributions to the work of the two Flagships.

Commission Staff Working Document

In September 2014, the Commission published a Staff Working Document⁹ to further clarify the FET Flagship model, its implementation and governance. The Flagship funding model is based upon a structure of a large Core Project serving as the leading project for the initiative, which is connected to Partnering Projects, which are essential for achieving the Flagship’s objectives, and which are an integral part of the initiative.

The Core Projects are funded by the European Commission. Most of the Partnering Projects were to be funded by the Member States, Associated Countries, and where appropriate, third countries, at national, regional or transnational level. They may also be funded by private funding sources. It was anticipated that the Core Projects and Partnering Projects will work closely together to realise the Flagship’s research roadmap, starting in the Horizon 2020 phase of the Flagships.

This model was intended to serve as a flexible partnering instrument enabling the participation of the key actors in Europe

⁸ <http://www.flagera.eu/>

⁹ SWD(2014) 283 final, http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=6812

in the Flagships' Science and Technology areas. It is based on a strong commitment of the European Commission, with the expectation that this will attract contributions from the Member States, Associated Countries and third countries – the participating countries.

A governance structure that reflects the multi-faceted multi-stakeholder character of the Flagships has also been designed to provide: efficient decision making, both strategic and operational; the means of assessing the overall progress of the Flagships; and an optimal use of funding and resources. The governance structure, as proposed in the Commission Staff Working Document, includes:

- A Framework Partnership Board (FPB), linking the European Commission and each of the EU funded Core Project consortia. The FPB was expected to provide the mechanisms to discuss the commitments of the participating organisations and the European Commission to the Flagship.
- A Board of Funders, bringing together representatives from the participating countries and the European Commission with the purpose of programming of activities in support of the Flagships. The role of this Board was expected to be essential for defining and planning the financial support to the Flagships for their whole duration.
- A Flagship Governance Forum (FGF), linking the European Commission, the participating countries and representatives from the Core Project and Partnering Projects consortia. The FGF has the form of a non-binding discussion forum which aims at achieving an efficient inter-working and synchronisation of the main stakeholders involved in the implementation of the Flagships and their respective activities. The FGF was expected to contribute to the development of a common European effort around the Flagships.

Horizon 2020 Core Projects

In 2015, in line with its Staff Working Document, the European Commission established a long-term partnership with each Flagship by signing a Framework Partnership Agreement (FPA) with each Core Project consortium. These FPAs will last for the full duration of Horizon 2020.

Within these FPAs, the Core Project consortia were invited, in 2015, to submit a proposal to implement the phase of their work plans covering the period from April 2016 to March 2018. The two proposals were positively evaluated and two grant agreements signed in 2016 with €89 million of EU funding each for a period of two years.

A similar invitation is planned for 2017 and will cover the period from April 2018 to March 2020 with €88 million of EU funding for each Flagship Core Project.

Figure 2 below provides an overview of the Flagship timeline, starting with publication of the European Commission's 2009 Communication.

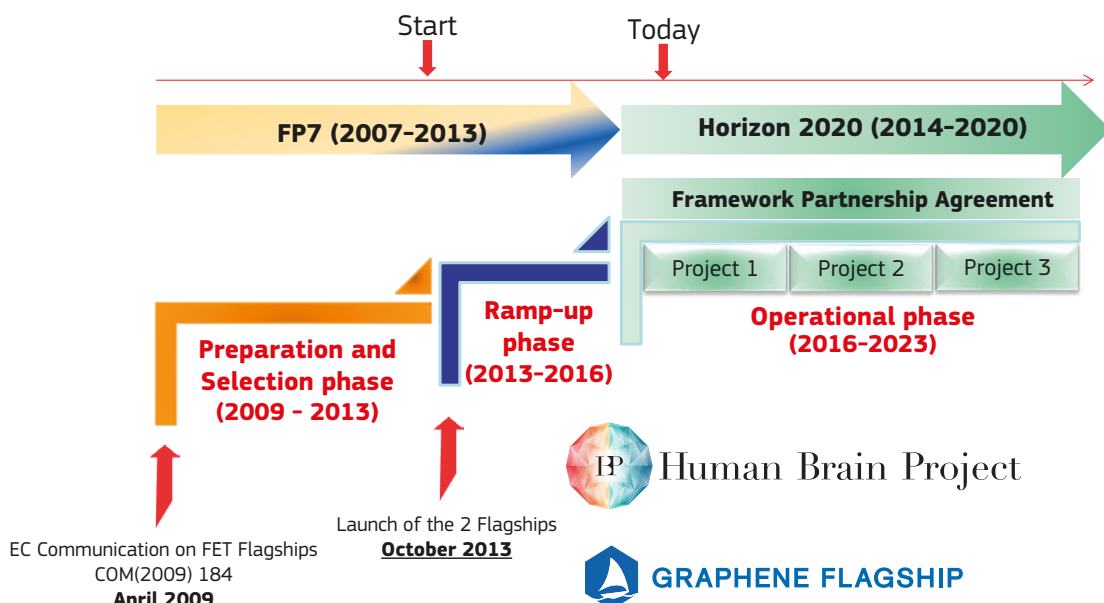


Figure 2: Flagship Timeline

Partnering Projects

In 2015, FLAG-ERA organised its first transnational call, out of which 19 transnational projects have been selected and funded with a total of €13.5 million (13 projects for €9.9 million and six projects for €3.6 million in synergy with Graphene and Human Brain Project respectively). The 19 projects started around January 2016 and joined the Flagships as Partnering Projects in April 2016 at the start of their Horizon 2020 phase.

The mechanisms and conditions for Partnering Projects to join the Flagships^{10,11} were developed in 2015 by the Flagships in dialogue with FLAG-ERA and the European Commission.

As of October 2016, Graphene has welcomed few additional partnering projects – mainly EU funded – corresponding to a total contribution of the current partnering projects of around €23,5 million. On top of the partnering projects, various companies have also joined the Flagship as Associated Members¹².

A Horizon 2020 ERA-NET Cofund, continuing the activities of FLAG-ERA, will start in December 2016 with a further joint transnational call planned for 2017 that would make available another €15 million for transnational projects that would start in spring 2018.

Governance

As for the governance proposed in the Staff Working Document, the Board of Funders was established in 2015 and met for the first time on 17th September 2015 with participation of 35 representatives from 28 Member States and Associated Countries. It met 3 times in 2016 and includes, as of October 2016, delegates from 33 Member States and Associated Countries. Meetings' agendas and presentations are available on the FLAG-ERA website¹³.

The Flagship Governance Forum has not been formally established, although the FLAG-ERA workshops organised two to three times a year with all stakeholders, play a similar role and can be seen as a first instance of this Forum.

The Framework Partnership Boards have not been formally established, although a close collaboration between the Flagships and the European Commission services exists.

The Human Brain Project Flagship

The objective of the Human Brain Project Flagship is to develop a federated ICT infrastructure that would become a research e-infrastructure in the future, helping the neuroscience community collect, analyse, share, integrate and model data about the brain with the aim of better understanding the functioning of the human brain and its diseases.

Understanding the human brain is one of the greatest challenges facing 21st century science. By rising to the challenge, profound insights into what it means to be human can be gained. New treatments for brain diseases may also become possible, and new knowledge may enable revolutionary new computing technologies. For the first time, modern ICT has brought these goals within sight. The main objective of the Human Brain Project, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities.

During the ramp-up phase, the strategic goals of the project were to:

- design, develop and deploy the first versions of six ICT platforms dedicated to: (i) Neuroinformatics, (ii) Brain Simulation, (iii) High Performance Computing, (iv) Medical Informatics, (v) Neuromorphic Computing and (vi) Neurorobotics;
- create a user community of research groups from within and outside the Human Brain Project;
- set up a European Institute for Theoretical Neuroscience;
- complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute;

10 <http://graphene-flagship.eu/project/partnering/Pages/Partnering-Mechanisms-under-Horizon-2020.aspx>

11 <https://www.humanbrainproject.eu/partnering-projects>

12 <http://graphene-flagship.eu/project/Pages/Consortium.aspx>

13 <https://www.flagera.eu/about/policy-context/board-of-funders/>

- develop the scientific and technological capabilities required by future versions of the platforms;
- implement a policy of Responsible Innovation, and a programme of transdisciplinary education; and
- develop a framework for collaboration that links the partners under strong scientific leadership.

In March 2016, Human Brain Project announced the launch of six initial versions of its ICT Platforms, which are the core of the emerging Human Brain Project research infrastructure for brain research. The Platforms embody the key objectives of the Human Brain Project, to gather and disseminate data describing the brain, to simulate and build models of the brain, to develop brain-inspired computing and robotics, and to create a global scientific community around the developing research infrastructure. The Platforms consist of prototype hardware, software tools, databases, programming interfaces, and initial data-sets, which will be refined and expanded on an on-going basis in close collaboration with end-users. The development of the Platforms has been the result of an extensive multidisciplinary effort involving more than 750 scientific collaborators and engineers from 114 institutions in 24 countries.

The Platforms will enable new kinds of collaborative research to be performed in neuroscience, medicine and computing. The prototype tools, hardware systems and initial data sets are designed to enable faster and more efficient research techniques in, for example, modelling, in silico experimentation, or data analysis.

The Human Brain Project however proved to be controversial. In July 2014, the European Commission received an open letter signed by more than 800 neuroscientists, expressing concerns about the Human Brain Project's scientific scope and governance and the role that cognitive neurosciences would play in the Human Brain Project's deployment phase. Besides the scientific controversy of using ICT tools for brain research, the huge community of neuroscientists perceived that the financing of Human Brain Project would drain all the European Union and Member State funds on neuroscience research for the duration of the Flagship.

To address the concerns, in September 2014 the Human Brain Project management set up an independent mediation process. It was carried out by a panel of 27 international experts. Their report was published in March 2015 and confirmed the criticisms of the open letter.

The European Commission then used the mediation panel findings, together with the conclusions of the first project review organised by the European Commission in early 2015, to negotiate with the Human Brain Project the revision of its plans.

The project objectives were adjusted. The scientific aim is to achieve a multilevel integrated understanding of the human brain and its diseases. As for the infrastructure aim, this is now underlined more explicitly as the building of a European infrastructure for brain science. These goals have been endorsed by the European Commission in the more detailed roadmap for the successive funding phase (i.e. the first Core Project under Horizon 2020).

The coherence of the project was reinforced between the scientific and the infrastructure development activities with the creation of co-design projects cutting across both.

A new governance structure has been put in place ensuring a clearer separation between scientific steering, strategic and financial decision-making and the day-to-day implementation.

For more information, the article¹⁴ published in the journal *Neuron* (Volume 92, Issue 3, 02 November 2016) gives an overview of the of the revised aims, main achievements as mid-June 2016 and future potential of the Human Brain Project.

The Graphene Flagship

The Graphene Flagship¹⁵ aims to take Graphene and related layered materials from a state of raw potential to a point where they can revolutionize multiple industries – from flexible, wearable and transparent electronics, to new energy applications and novel functional composites. The main scientific and technological objectives in the different tiers of the value chain are to develop material technologies for ICT and beyond, identify new device concepts enabled by Graphene and other layered materials, and integrate them to systems that provide new functionalities and open up new application areas.

14 <http://www.cell.com/neuron/fulltext/S0896-6273%2816%2930796-6>

15 <http://graphene-flagship.eu/>

In the ramp-up phase, the objectives were supported by operative targets that involved bringing together a large core consortium of European academic and industrial partners and to create a highly effective technology transfer highway, allowing industry to rapidly absorb and exploit new discoveries. Alignment of the Flagship with European and national priorities was also addressed in support of successful long term operation and maximal impact on the national industrial and research communities. Taken together, the scientific and technological objectives and operative targets worked towards the achievement of the societal goals of: (i) contributing to sustainable development by introducing new energy efficient and environmentally friendly products based on carbon and other abundant, safe and recyclable natural resources; and (ii) boosting economic growth in Europe by creating new jobs and investment opportunities.

The first Core Project, building on the ramp-up phase, brings together a larger European consortium with 154 partners in 23 countries. The partners represent academia, research institutes and industries, which will work closely together in 15 technical work packages and five supporting work packages covering the entire value chain from materials to components and systems. As time progresses, the centre of gravity of the Flagship will move towards applications, which is reflected in the increasing importance of the higher (system) levels of the value chain. It is also reflected in the clear trend towards more industrial involvement in the consortium; from 16 industrial partners initially in 2013 to 41 in 2014 and 53 in 2016 in a consortium that grew from 75 to 142 and 154 in the same years.

The first Core Project will therefore place its main focus on components and initial system level tasks and reinforce gradually its innovation related activities.

Future Flagships

During the course of the Panel's work, the European Commission announced its intention to launch a third Flagship in the field of Quantum Technologies. It also launched in 2016 the process for the identification and preparation of potential future Flagships to be funded in the next Framework Programme.

The proposed Quantum Technologies Flagship

In April 2016, the European Commission adopted, the European Cloud Initiative. It was accompanied by a staff working document on Quantum Technologies, announcing the intention to set-up a Flagship initiative worth one billion Euros of joint public/private investment over the next 10 years. The Competitiveness Council in its conclusions from May 2016 welcomed the discussions on the launch of the Quantum Flagship.

This Flagship on Quantum Technologies is planned to be launched in 2018. It will be directed towards science, engineering and application work and is aimed at turning Europe's excellent research results in areas like quantum secure communication, quantum sensing and quantum simulation and computing into concrete technological opportunities that can be taken up by industry.

It builds on almost two decades of EU funding covering a wide variety of quantum technologies; on recent or planned research initiatives in Member States and on transnational cooperation like the QuantERA¹⁶ initiative which gathers 26 countries and a funding of €37 million aiming at aligning national priorities in the area.

In order to prepare the Quantum Technologies Flagship, the European Commission set up an advisory group in September 2016. Its mandate is to work together with the wider community of stakeholders from academia and industry and in close collaboration with Member States, to propose a Strategic Research Agenda with clear and ambitious goals, as well as an efficient approach to the Quantum Technologies Flagship implementation and governance.

The group is chaired by Professor Mlynek and gathers 24 members (half from academia, half from industry) from all over Europe.

Preparation for potential Flagships in the next Framework Programme

In order to be ready for a possible decision to launch new FET Flagship initiatives in the Horizon 2020 successor Programme, the European Commission started preparatory steps in 2016. In spring 2016, the European Commission opened a web-based public consultation on ideas for candidate Flagships. As result, 24 contributions have been received.

¹⁶ <https://ncn.gov.pl/quantera?language=en>

Commissioner Oettinger hosted then on 15th December a round-table conference with representatives from the Member States and from large scientific and industrial communities. The outcome of the Round-table will be used to select four to six most promising candidate topics, to be included in a call for preparatory actions in 2018.

Such preparatory actions, similar to the 6 pilot actions that the European Commission supported before the selection of the first Flagships, will last 12-18 months.

From these preparatory actions, one or two new FET Flagships could be launched in the next Framework Programme.

The FLAG-ERA project

The FLAG-ERA project¹⁷ consists of a consortium of most of Europe's regional and national funding organisations (NRFOs). The goal is to support the two FET Flagships, and also the four non-selected Flagship pilots to help these pilots progress towards their goals with adapted means.

To enhance complementarities and synergies of regional, national and European research programmes and initiatives, the funding organisations share information on these programmes and initiatives, identify gaps and overlaps, and can thus adapt their thematic programme and launch new initiatives according to the identified needs.

The funding organisations in FLAG-ERA can launch transnational calls enabling researchers from different countries to propose joint contributions to the Flagships. In order to encourage the actual construction of the Flagships and take-up of their results, the funding organisations propose networking sessions for the research communities and other stakeholders, including industry. FLAG-ERA thus provides a platform to coordinate a wide range of sources of funding towards the realization of the very ambitious research goals of the FET Flagships.

Dedicated Liaison Groups allow for a direct dialogue between representatives of the two Flagships and the national research funding agencies. FLAG-ERA maintains an inventory of national research projects that are in line with the scientific roadmaps developed by the Flagships, and which could play a role as complementary partnering projects.

The TAIPI project

The TAIPI Project¹⁸ – Tools and Actions for Impact Assessment and Policymakers Information – aims to support and strengthen the FET Flagships and the Flagship instrument by undertaking impact assessment activities and collecting information need for policymaking. This is realised through four specific objectives:

- to develop assessment methodologies along with the required toolkits which will be applied respectively to Human Brain Project and Graphene Flagships;
- to carry out an impact assessment of both Flagships by applying the specifically developed methodology and tools;
- to collect and provide, on the basis of the abovementioned toolkits, information for policy makers and funding organizations participating to Flagship initiatives;
- to transfer these developed toolkits (turned into “dashboards”) to the Flagships, and to enable them to use these tools after the end of TAIPI, thus ensuring the sustainability of the TAIPI project activities.

The project, which began work at the beginning of 2015, provides scientific, technological, economic and societal impact assessments. These assessments include the contribution of the Flagships to EU level of excellence and leadership in the scientific arena, the impact on the competitiveness of industry by leading to breakthrough technologies, potential effects on the creation of new industries and new jobs, societal benefit as well as funding capacity of a Flagship including different sources such as EU, international, national, industrial commitment, associations, private, etc.

17 <http://www.flagera.eu/>

18 <https://taipi.eu/>

Appendix 2 – Additional Flagship specific issues addressed by the Panel

- Efficiency of the Flagship implementation model, in terms of:
 - o Core project/Partnering Projects
 - o Attraction of appropriate funding complementary to the European one (national, regional, from the private sector, etc.).
 - o Enhancement of the coordination of RTD in the Member States and Associated countries

For the individual Flagships:

 - o Appropriateness of the Flagship governance structures to operate efficiently
 - o Appropriateness and effectiveness of the level of supervision/control within the Flagships in monitoring progress in programme implementation

- Research quality
 - o Are the Flagships enabling of world-class research that helps propel Europe to a leadership position globally? In particular, what is the role of the Flagships in positioning Europe on the global map of science and technology in the concerned field
 - o Did the Flagships manage to involve the best teams in Europe? Did they become attraction poles for R&I in their domains?
 - o Do the Flagships nurture creativity and talent? Do they help keep the best researchers in Europe and attract the best minds?
 - o S&T areas, if any, where the Flagships are lagging behind
- Knowledge dissemination and Impact
 - o Are the Flagships efficiently disseminating knowledge to professional, political, media, and public audiences?
 - o Visibility of the Flagships: Impact on the technical media and the national media
 - o What is the contribution of the Flagship in developing key competencies across different areas and strengthening European competitiveness and sustainability
 - o Are there appropriate actions to ensure that relevant European companies are involved in the Flagships?
 - o What has been the progress towards achieving an impact based, where applicable, on the performance indicator(s) of the Flagships? The following dimensions of impact should be considered: scientific impact, impact on the national research agendas, impact on education and training
 - o Is there evidence of socio-economic impact of the Flagships? Creation of new investment opportunities? Number of direct or indirect jobs created?

Appendix 3 – Example of questions posed by the Panel to the interviewed stakeholders

Interview question

1 How relevant are the Flagships to stakeholders, especially to the scientific communities?

Who is accountable? How are related scientific communities and their endeavors affected/inspired?

2 Which further effects do you expect of the flagships at their stakeholders' level and with regard to the scientific community and industry?

Does the model conform to the purpose of the instrument itself – also as to commercialization and scientific development beyond?

Does the model correlate to the purpose given the specific conditions of each scientific community and (industrial) application?

3 What are/is the main outputs/results/impact of the two Flagships

- you expect?
- you observe so far?

Results and potential of both cooperation model and scientific work

How are priorities set, who sets them, how are decision processes installed?

4 How successful is the progress towards output/results/impact so far?

Challenging the model and its implementation

5 Do the activities/outputs/results contribute to and support the H2020 objectives such as:

- fostering excellence in scientific and technological research and positioning Europe on the global map of research and innovation?
- boosting innovation, European industrial leadership, growth, competitiveness and job creation?
- addressing EU societal challenges?

6 Could the alteration of establishing conditions, administration and governance principles positively influence the further success of the Flagships?

In what direction/way concretely?

As a follow-up to earlier answers: What would be desirable for a. conditions, b. administration, c. governance principle?

7 Is the funding situation transparent and sufficient given the objectives of the Flagships?

Again, question aims at accountability, prioritization of interests of member states and within Flagships.

Correlation of funding and goals

8 Are/Were the costs involved justified given the changes/effects which have been achieved?

Correlation between objectives, means and impact

Commitment based on development so far and prospects

9 To what extent are the Flagships working coherently

- with other H2020 initiatives?
- with other EU interventions/policies
- with other global/international/national initiatives/policies?

Links to other programmes, pillars

Advantages/disadvantages in comparison of the Flagship instrument with other instruments

10 What is the additional value resulting from the Flagships, compared to what could be achieved by Member States at national and/or regional levels?

Assessment of EU frame and dedication

Embedding and harmonization with national and regional activities

11 To what extent do the Flagships reduce fragmentation, create synergies and optimize complementarities between European, national and regional research programs?

Possibly asking for amplification with examples, suggestions and recent developments (i.e. handling and additional initiatives of National Ministries etc.)

12 How are the Flagships accepted by stakeholders?

How do uninvolved actors, i.e. potential partners in commercialization view the Flagships?

13 Are there any further suggestions you would like to express from you experience with the Flagships as thematic initiatives and as instrument in general?

Lessons learnt, impressions, best practice examples

Appendix 4 – Documents consulted

Public domain documents

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions “Moving the ICT frontiers: a strategy for research on future and emerging technologies in Europe” <http://ec.europa.eu/transparency/regdoc/rep/1/2009/EN/1-2009-184-EN-F1-1.Pdf>

FET Flagships

<https://ec.europa.eu/digital-single-market/en/fet-flagships>

The FET Flagship model: A brief overview and FAQs on Partnering Projects

http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=8204

COMMISSION STAFF WORKING DOCUMENT FET Flagships: A novel partnering approach to address grand scientific challenges and to boost innovation in Europe

http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=6812

Graphene Flagship Annual Report: 2013-14

http://graphene-flagship.eu/SiteCollectionDocuments/Admin/Annual%20report/Graphene_2013_2014.pdf

Graphene Flagship Annual Report: 2015

http://graphene-flagship.eu/SiteCollectionDocuments/Admin/Annual%20report/Graphene_Annual_report_2015.pdf

GRAPHENE Flagship: Review and highlights of technical achievements:

http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=17006

Human Brain Project Report

<https://www.humanbrainproject.eu/documents/10180/1298661/The+HBP+Report/ddae4bfc-31eb-448e-8974-f5882f926451>

Human Brain Project Mediation Report

<https://www.humanbrainproject.eu/documents/10180/1298661/Mediation+Report/bcff6065-f017-47dc-9265-5cb4dbc43eb8>

Human Brain Project Period 1 Technical Review Report

<https://www.humanbrainproject.eu/documents/10180/1298661/Period+1+Technical+Review+Report/dfd2160f-a4e3-47e3-97ef-aa54fe68823c>

Human Brain Project Flagship: Review and highlights of technical achievements

http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=17075

FET Flagships: Lessons learned from the first 30 months of their operation

<https://ec.europa.eu/digital-single-market/en/news/fet-flagships-lessons-learnt>

European Commission will launch €1 billion quantum technologies flagship

<https://ec.europa.eu/digital-single-market/en/news/european-commission-will-launch-eu1-billion-quantum-technologies-flagship>

Commission Staff Working Document on Quantum Technologies

<https://ec.europa.eu/digital-single-market/en/news/commission-staff-working-document-quantum-technologies>

Consultation on FET Flagships for Horizon 2020 next Work Programme

<https://ec.europa.eu/futurium/en/content/fet-flagships>

Documents confidential to the projects

The Panel was also given access to a number of documents confidential to the Flagships and their supporting projects. Primary documents are those resulting from the scientific project reviews of each Flagship undertaken by a panel of independent technical experts in May/June 2016, documents relating to KPIs produced by the TAIPi project, and self evaluation/reflection documents produced specifically for the Panel by the European Commission, the Flagships and the independent technical expert reviewers.

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