

## NACE Rev. 2 Proposals for Changes

In response to Eurostat's invitation for consultation on the review of the Statistical Classification of Economic Activities, NACE Rev. 2 (Regulation EC 1893/2006) sent on 13 May 2019.

This submission is made by the European Federation of Consultancy Associations (EFCA). EFCA, in representing 28 associations from 26 European countries, represents the consulting engineering industry in Europe. The members of these associations are mainly consulting engineering firms which employ some one million staff and have a combined annual turnover of more than EUR 150 billion.

### 1. Summary

EFCA proposes a number of category inclusions, exclusions and modifications as follows (all references to NACE are for NACE Rev. 2):

- Add to NACE 71.12 category inclusions
  - Specific terms (see text)
  - “project supervision services
  - integrated engineering activities for design-build & turnkey projects & other forms of integrated project delivery in the construction, manufacturing, mining, & agriculture sectors”
  - engineering design activities for:
    - manufacturing processes & production
    - the marine & costal environment
    - nature-based infrastructure
  - building information modelling & related systems implementation & operation for buildings, civil engineering works & industrial plant”
  - engineering & engineering design for prefabricated prefinished volumetric construction modules”
  - environmental engineering:
    - site engineering
    - noise abatement engineering
    - health & safety engineering
    - resource management engineering”
- Add to NACE 74.90 category exclusions
  - “environmental site engineering to 71.12
  - “environmental noise abatement engineering to 71.12
  - “environmental health and safety engineering to 71.12
  - “environmental resource management engineering to 71.12”

- Change the title of class 72.19 to “Other research and experimental development on natural sciences n.e.c.”
- Add class “72.12 (Research and engineering development on engineering)”
- Add 72.12 category inclusion:
  - “This class includes experimental development on engineering:
    - elaboration of projects using equipment
    - geophysical, geologic and seismic surveying - geodetic surveying
    - project supervision
    - integrated engineering
    - manufacturing processes & production design
    - building information modelling and related systems
    - marine & costal environment design
    - built environment ecosystems design
    - prefabricated prefinished volumetric construction”

Classification of the following area of engineering activity is discussed, but specific proposals are not made at this stage:

- digitalised drilling, tunnelling, inspection, surveying , and similar activities.

## 2. Introduction

The consulting engineering industry’s principal economic activity is classified under NACE 71.12 (Engineering activities & related technical consultancy) with several exclusions<sup>1</sup>, a class of the NACE 71 (Architectural & engineering activities; technical testing & analysis) division [1].

The industry is however engaged in other economic activities classified elsewhere under NACE Section M (Professional, scientific & technical activities) and under Section A (Agriculture, forestry & fishing), Section B (Mining & quarrying) and Section C (Construction).

## 3. Proposals

Proposals for changes to NACE are organised as follows:

3.1: NACE 71.12

3.2: Classes other than NACE 71.12 that cover engineering and engineering design activities.

### 3.1. NACE 71.12 (Engineering activities & related technical consultancy)

The following proposals refer exclusively to NACE 71.12 on the understanding that corresponding adjustments, in terms of exclusions and class categories and sub-categories, would be required in other Section M classes, and indeed in Sections A, B and C.

### 3.1.1. Overview

NACE 71.12 is primarily a business-to-business activity with little household consumption (about 3% in the European Union). Firms range from single professionals to large international corporations employing over 100,000 staff.

NACE 71.12 is a key economic activity from a number of perspectives (see Annex A).

### 3.1.2 Proposed class, category and sub-category changes

#### 3.1.2.1. Specific terms

Proposed NACE 71.12 sub-category modification (words in capitals added):

“WATER SUPPLY, WASTE WATER TREATMENT, STRUCTURAL ENGINEERING, OFFSHORE & ONSHORE MARINE ENGINEERING, HEALTH & safety to “project elaboration ...” and to consulting activities for project elaboration ...”

#### Rationale

Several major areas of engineering activity (in CAPITALS) are missing. In some cases the proposed additions provide greater clarity in mirroring CPA categories, e.g., CPA 71.12.15 (engineering services for waste management projects) or CPA 71.12.16 (Engineering services for water, sewerage and drainage projects) [17].

#### Impact

For the EU28, the changes mean that the annual NACE 71.12 turnover is increased by 1% of infrastructure demand, including renovation and maintenance, amounting to EUR 1.2 billion.

#### 3.1.2.2. Project supervision activities

Proposed NACE 71.12 category inclusion:

“project supervision activities for:

- industrial plant projects involving civil engineering, hydraulic engineering, traffic engineering
- water management projects
- projects realisation relative to WATER SUPPLY, WASTE WATER TREATMENT, electrical & electronic engineering, mining engineering, chemical engineering, STRUCTURAL ENGINEERING, OFFSHORE & ONSHORE MARINE ENGINEERING, mechanical, industrial & systems engineering, HEALTH & safety engineering”

## Rationale

Project supervision is a major area of engineering activity.

## Impact

For the EU28, the changes mean that the annual NACE 71.12 turnover is increased by EUR 1.3 billion since approximately 1% of the investment in construction, including renovation and maintenance, is spent on project supervision.

### **3.1.2.3. Integrated engineering activities**

Proposed NACE 71.12 category inclusion:

“integrated engineering activities for design-build & turnkey projects and other forms of integrated project delivery in the construction, manufacturing, mining, & agriculture sectors”

## Rationale

Engineering activities are often combined with architectural, manufacturing and construction services making it difficult to classify:

- the “pure engineering component” [18] or the “integrated engineering” as opposed to “traditional engineering” [19]. However, some EU Member State versions of NACE include categories that refer to “integrated engineering activities” and to turnkey projects<sup>4</sup>.
- “non-construction related services, on the other hand, are very often not covered at all: they seem to be harder to tackle, because their appearance varies greatly”<sup>5</sup> [19].

The NACE classification is consistent with the EU’s *Statistical Classification of Products by Activity* (CPA 2008) [17] which has, corresponding to the *Central Product Classification* (CPC 2.1) sub-category 83322 [20], the 71.12.17 sub-category that refers to “engineering services” and not to “integrated engineering services”. CPA 2008 does however refer to “integrated facility and process engineering projects” for mining, metallurgical and petroleum processes.

In the case of engineering services for integrated construction projects delivered using a design-build model, Eurostat recommends that all bundled design-build services are classified under construction, because construction is the principal added value [23]. Detailed guidance for price surveys is provided<sup>5</sup>.

This agrees with the CPA 2008 category that engineering services for “integrated facility and process engineering projects” that principally involve the supply and installation of plant and equipment (i.e., are for mining, metallurgical and petroleum processes) should be classified under NACE 71.12.

However, the issue of “other industries having output of the primary products” where “engineering services are internalized in units from other industries” has been recognised by national statistics agencies<sup>7</sup>. The recommendation is to ensure that secondary products are classified [25].

It is also noted that:

- the CPC 2.1 and the CPA 2008 both recognise NACE 71.12 activities as arising in sub-categories CPC 91137 and CPA 84.13.17 relating to “multipurpose infrastructure projects” which “typically consist of integrated facilities” requiring “planning, design, construction, improvement and operation”;
- the World Trade Organization (WTO) speaks of “integrated engineering services” in the regulation of regional and national trade agreements<sup>8,9</sup> using the *WTO Services Sectoral Classification List* that is based on CPC Ver. 1 [27];
- the OECD speaks of “integrated engineering services” in referring to the ISIC Rev 4 [29] code 711 definition of engineering services where the “important feature is the regulatory complementarity between engineering, architecture and construction services” [30];
- industry surveys reported by the WTO classify firms by the actors involved in the various delivery models, namely “architect, engineer, engineer-contractor, architect-engineer, engineer-architect, environmental, geotechnical engineer, landscape architect, and planner” [31].

These various comments reflect the reality that a considerable amount of engineering-related activity (e.g., planning, design, supervision, inspection, training and verification) is performed in association, and in an integrated manner, with other economic activities (e.g., construction, manufacturing and mining) in the context of certain types of project delivery models (e.g. design-build and turnkey).

Indeed, the construction sector continues to pioneer the development and implementation of new delivery models for integrated projects where NACE 71.12 has a core role in spite of not necessarily being the principal activity in terms of economic added value<sup>10</sup>.

At best, any engineering-related activity for integrated projects will currently only be classified under NACE 71.12 if a project in terms of added value principally involves the supply and installation of plant and equipment. This formulation excludes all integrated projects in the construction sector, and many projects in the manufacturing, mining and agriculture sectors.

### Conclusions

The proposed inclusion to NACE Rev. 2 class 71.12 therefore aims to ensure that all engineering-related activity for all integrated projects is classified under 71.12.

Moreover, integrated projects are defined in this context as those where the 71.12 activity is included with the physical construction in the scope of the contractual arrangements for a project.

## Impact

For the EU28, some 50% of all new build and renovation infrastructure construction projects and 10% of building construction projects are carried out under design-build or turnkey contractual arrangements. This corresponds to an investment of EUR 275 billion of which 8% (EUR 22 billion) corresponds to the increase in annual turnover for NACE 71.12 activities.

### **3.1.2.4. Engineering design activities**

Proposed NACE 71.12 category inclusions:

“engineering design activities for:

- manufacturing processes & production
- the marine & costal environment
- nature-based infrastructure

building information modelling & related systems implementation & operation for buildings, civil engineering works & industrial plant”

## Rationale

### *Overall*

Eurostat’s historic position regarding design is that all design activities are classified to NACE class 74.10, with certain exceptions [36]. The situation is perhaps slightly more nuanced<sup>11</sup>, but broadly true.

NACE 74.10 covers traditional design (interior decoration, fashion, graphic, press, media), industrial design and machinery design, with web page, architectural design and engineering design excluded<sup>11</sup>. The OECD also supports the view that NACE 74.1 represents all design activity [37].

Any proposed inclusion of additional activities should involve the definition of an aligned set of NACE 71.12 design categories that is developed in parallel with the proposal to create an aligned set of NACE 74.10 (specialised design activities) categories [38]. Exclusions corresponding to the NACE 71.12 design categories would also be required for NACE 74.10.

The rationale for each of the four inclusion proposals therefore builds upon NACE 71.12 in the context of:

- the important engineering design activities in manufacturing<sup>12</sup> and aligned design activities equivalent to those proposed by BEDA for NACE 74.10 [38];
- marine and coastal activities, the so-called “blue” activities covered in part by NACE 03.2 (Aquaculture) relating to “techniques designed to increase the production of ...”;
- nature-based built environment activities covered in part by NACE 81 (Services to buildings and landscape activities) relating to the “design of landscape plans and/or the construction (i.e. installation) of walkways, retaining walls, decks, fences, ponds, and similar structures”.

### *Engineering design activities in manufacturing*

The proposed NACE 71.12 category inclusion “engineering design activities for manufacturing processes & production” recognises that engineering design activities are a core component of many manufacturing activities.

### *Aligned digital design categories*

New technologies and digitalisation raise important technical issues related to standard producer price indexes<sup>13</sup> and to the organisation of entire supply chains at all project phases from conception through to operation and eventual re-adaptation or demolition, especially in construction [42].

For engineering design activities, the main effect of digitalisation is to change the way activities are required (through progressive adoption through different infrastructure “bands” [43]), are assessed in terms of risk, have liabilities and responsibilities shared (especially for data), are compensated for in terms of ‘up-front’ costs [44], are transacted, are organised, and are carried out [25]. It is noted however, that the same can be said about the impact of digitalisation on virtually all NACE 71.12 engineering activities.

With building information modelling (BIM) for example being required increasingly by public clients [44], BIM is increasingly integrated into business-as-usual best practice for engineering activities.

Included in digital engineering design apart from BIM are BIM-related digital enabling technologies (e.g., virtual reality modelling, sensor-monitored structures and processes, big-data statistics, aerial, underwater and underground drone imaging and analysis, and the automation of construction and manufacturing).

The inclusion of a NACE 71.12 category “building information modelling and related systems implementation & operation for buildings, civil engineering works & industrial plant” would allow the specialised issues related to the supply of digital-enabled design services in key areas of construction and manufacturing to be recognised in terms of all the perspectives summarised in Annex A (NACE 71.12 perspectives) [see Annex A].

### *Marine and coastal engineering design activities*

Oceans and coastline areas have an enormous potential, both economic and precautionary (to mitigate and adapt to climate change), yet national accounts classify only 5% of EU28 turnover to maritime activities [45]. In spite of difficulties relating to the classification of location-dependent activities, NACE needs to be structured in such way that engineering design and integrated engineering design in the maritime and non-maritime environment can be classified<sup>14</sup>.

NACE 71.12 services are a core component of the blue economy<sup>14</sup>. It is therefore proposed to include “engineering design activities for the marine & coastal environment” as a NACE 71.12 category, with corresponding exclusions elsewhere, if necessary.

### *Nature-based engineering design activities*

Nature-based solutions (NBS) are presented as an overarching concept that builds on, and supports, other closely related concepts, such as the ecosystem approach, ecosystem services, ecosystem-based adaptation and mitigation, green engineering, and green and blue or nature-based infrastructure.

Preliminary steps have been made to classify NBS (e.g., in terms of landscape type, ecosystem service and service category [50] that builds upon CICES [51]). These types of classifications can probably be linked at the urban level to the NACE activity classification provided the location issue can be solved [52].

Through an understanding of the multilevel classification of NBS practices it should also eventually be possible to link so called NBS “Type 3 physical projects” to the requirements for the engineering design and management of ecosystems [53].

Irrespective of ways to classify NBS activities, engineering activities for NBS need to be classified under NACE 71.12 because:

- these activities are already an important sector of economic activity;
- classifications will be incorporated into vital global programmes such as urban modelling (e.g., activity classifications for use with urban metabolism [54] and climate-change carbon stocktaking [55]);
- NACE 81 (services to buildings and landscape activities) only alludes to NBS activities that have a narrow focus<sup>15</sup>;
- the on-going extensive digitalisation of built environment sector value chain, of engineering activities in general and of engineering design activities in particular, will at some stage impact NBS [56].

### Impact

Estimates for the EU28 annual turnover that would be classified under the various proposed NACE 71.12 category inclusions are:

- manufacturing processes & production engineering design: EUR 5 billion
- marine & coastal environment engineering design: EUR 30 billion
- nature-based infrastructure engineering design: EUR 8 billion
- building information modelling: EUR 1.2 billion.

### 3.1.2.5. Prefabricated module construction

Proposed category inclusion:

“engineering & engineering design of prefabricated prefinished volumetric construction modules”

#### Rationale

NACE classifies prefabricated buildings in terms of manufacturing activities (Section C) and construction activities (Section F), and specifically excludes engineering design from NACE 71.12<sup>16</sup>.

This approach accords with the NACE’s overall approach for design-build which is generally the preferred and recommended delivery model for prefabricated buildings and infrastructure. This model in most cases involves the manufacture, supply and installation of permanent modular building elements manufactured off-site<sup>17</sup>.

Missing from the manufacture - construction value chain for construction using prefabricated modules are key engineering design activities as well as the integrated engineering activities<sup>18</sup> discussed above in section 3.1.2.3. The proposal for a NACE 71.12 sub-category inclusion “engineering & engineering design for prefabricated prefinished volumetric construction modules” rectifies the anomaly and provides a coherent treatment of integrated engineering services.

#### Impact

Given that 1% of the EU28’s buildings other than dwellings are constructed using prefabricated modules, an annual turnover of EUR 1.1 billion would be classified under the proposed subcategory.

## 3.2. Classes other than NACE 71.12 that cover engineering and engineering design activities

### 3.2.1. Overview

For classes other than NACE 71.12, it is noted that engineering activities are carried out under:

- NACE 74.90 (Other professional, scientific & technical activities n.e.c)
- NACE 09.90 (Support activities for other mining & quarrying)
- NACE 72.17 category “research and development on engineering and technology”.

### 3.2.2. 74.90 (Other professional, scientific & technical activities n.e.c)

Excluded from NACE 74.90 are the “activities of architecture and engineering consultants” (to 71.11 and 71.12, respectively). However, engineering activities classified under NACE 71.12 are routinely carried out together with activities that are included in class NACE 74.90 categories, notably “environmental consulting”;

Proposed changes to class inclusions and exclusions therefore relate mainly to NACE 74.90 category “environmental consulting”.

It is noted however that there may be several inconsistencies in the treatment of activities. For example, NACE 74.90 includes:

- security consulting, while NACE 71.12 includes “safety engineering” (suppliers of engineering supervision services for construction are generally responsible for site security)
- quantity surveying, but some EU member states still need to exclude “activities of construction economists” from NACE 71.12 to NACE 74.90, owing presumably to the definition of the NACE 71.12 category “geodetic surveying activities”.

### **3.2.2.1. NACE 74.90 - Environmental engineering**

Proposed NACE 71.12 category inclusion:

“environmental engineering:

- site engineering
- noise abatement engineering
- health & safety engineering
- resource management engineering”

Proposed NACE 74.90 exclusions:

- environmental site engineering, see 71.12
- environmental noise abatement engineering, see 71.12
- environmental health and safety engineering, see 71.12
- environmental resource management engineering, see 71.12”

#### Rationale

The classification of environmental goods and services (EGS) was widely discussed up until 2014 [60]. This was followed by the finalisation in 2016 of the regulation of European environmental economic accounts and the publication of the EC’s EGSS guide [61] and handbook [62] for environmental goods and services sector accounts.

Subsequent development of EGS classification was then taken up by the UN’s *System of Environmental Economic Accounting* central framework (SEEA-CF 2012) [63] that has a similar accounting structure as the UN *System of National Accounts*.

SEEA guidelines to standardise the statistical processes have been implemented for energy, water, and agriculture. An experimental ecosystem accounting, presently under revision [64], complements the central framework by considering how individual environmental assets interact as part of natural processes within a given spatial area. By contrast, the central framework

considers how “individual environmental assets”, such as water resources, energy resources, etc. move between the environment and the economy.

This change of perspective has meant that agencies have tended in recent years to give little attention to the classification of environmental activities.

However, discussion at the EC-level resumed recently in the context of the EC Technical Expert Group consultation on the usability of the EU sustainable financing taxonomy - the *EU Taxonomy* [5].

As noted in Annex A, NACE 71.12 is one of the EU’s two climate-change adaptation enabling economic activities since “it contributes to adaptation of other activities and/or addresses systemic barriers to adaptation” [5]. For example, “risk engineering for proactive risk improvement” can contribute to reduce physical climate risk of manufacturing and construction activities).

The *EU Taxonomy* proposal is that climate risk engineering is classified under NACE 71.12 to avoid mis-classification under the NACE 74.90 (Environmental consulting) category.

Conversely, the EC’s EGSS accounts handbook [62] argues that:

- along with other NACE divisions, “some activities providing environmental services may be included under NACE divisions 71 (Architectural & engineering activities, technical testing & analysis)”;
- NACE 71.12 includes “water management projects and may include other engineering activities that have an environmental protection or remediation purpose” (and by implication are classified elsewhere).

The EC handbook concludes that while EGSS data must be split by activity, adequate accounting of EGS by activity may require:

- direct measures of primary and secondary production;
- additional information to identify primary and secondary production.

EU Member States therefore generally combine a variety of economic activity, product and other classifications to identify environmental activities and expenditures [65]. The outcome is a very confusing assessment of environmental engineering activity<sup>19</sup>.

Environmental accounting therefore needs to solve the basic problem, namely that the NACE 74.20 sub-category “environmental consulting” is undefined and not directly related to product (services) classifications.

There is some evidence available showing that engineering-based environmental services tend to be classified to a product (service) class or category that corresponds to the major engineering discipline.

This logic is illustrated by the inverse situation. For example, the CPA 2008 [17] has sub-categories 71.12.15 (Engineering services for waste management projects) and CPA 71.12.16 (Engineering services for water, sewerage and drainage projects), which is one of the reasons why it is proposed above to include WATER SUPPLY, WASTE WATER TREATMENT in NACE 72.12 categories.

The principle of using disciplines to link product and activity classifications are also illustrated above for:

- design engineering, where NACE 71.12 categories for civil and mechanical engineering are excluded in the proposals for engineering design inclusions;
- risk engineering, to link NACE 712.12 to climate adaptation.

This approach is used by Canadian authorities to classify Canada's main environmental services activities. The Canadian model links environmental activities to engineering (and other) disciplines in the following sectors [67]:

- site assessment, reclamation and remediation
- noise and vibration abatement
- health and safety
- resource management (water, waste, air quality, energy, natural resources, fisheries)

Insofar as engineering is concerned, each sector is a well-established engineering activity based on fully developed engineering principles. Some sectors are covered in part by NACE Section M services categories, e.g., "safety engineering" in NACE 71.12 and "plants for protection against noise, ..." in NACE 81.30 (landscape service activities).

Each area of activity however, has activity in both environmental and non-environmental contexts. The boundary may be difficult to establish in some cases. Nevertheless, the situation in these critical and important sectors of activity would be greatly improved by classifying environmental and non-environmental services separately, instead of bundling the environmental component of each of the engineering activities into "environmental consulting", covered at best by an activity class such as the North American activity classification's NAICS 541620<sup>20</sup>.

## Conclusions

The proposal therefore is to clarify and classify the treatment of environmental engineering by including the following, or similar, categories in NACE 71.12:

- site engineering
- noise abatement engineering
- health and safety engineering
- resource management engineering

with the following exclusions in NACE 74.90 categories:

- environmental site engineering
- environmental noise abatement engineering
- environmental health and safety engineering
- environmental resource management engineering

These proposals imply that special treatment is not given, at least at present, to climate-related engineering activities not only because there is a fundamental difference between mitigation and resilience and adaptation activities (the latter are location specific [5], which presents difficulties for NACE) but also because they are already covered by NACE 71.12<sup>21</sup>.

### Impact

For the EU28, the introduction of the four environmental engineering categories into NACE 71.12 means that the annual NACE 71.12 turnover is increased by EUR 3.0 billion.

### **3.2.2. NACE 09.90 – digitalised drilling, tunnelling, inspection, surveying, etc**

#### General discussion of an aligned set of categories based on operation type and location.

NACE presents a fairly complicated classification of location dependent (e.g., underground, seabed, underwater, aerial) inspection-type activities (e.g., drilling, tunnelling, diving inspection, surveying, and manipulation)<sup>22</sup>.

Proposals for a more coherent classification of the various activities operating different locations, and for their closely related larger scale operations such as tunnelling and bore-hole drilling, will not be attempted.

Instead, it is perhaps useful to point out that NACE 71.12 engineering activities are assuming greater importance in all of these activities owing to the increased digitalisation of equipment and processes, notably in the construction, mining and agriculture sectors.

In particular, various activities that were traditionally carried out by operators are increasingly consolidated and integrated into integrated “one-stop shop” engineering services that are supplied to operators of survey, drilling, tunnelling, and manipulation equipment.

The trend is being accelerated because equipment of all types, e.g., drilling rigs, are being developed as standardised hardware – software (digital) platforms into which test, inspection and control systems can be integrated by external suppliers of integrated engineering services.

In the words of an integrated engineering supplier of oil-rig drilling automation: “contractor compliance with these standards will afford service providers a reliable platform upon which to integrate their solutions. Such a platform must allow a generic view of the rig from a programmatic standpoint.” [69]

The integrated engineering activities for manufacturing products and constructing built-environment structures discussed above are in effect increasingly addressing the operation phase

of the manufactured or constructed object. The classification issues for both the manufacture/construction and operation activities are therefore very similar. In particular, as already noted, classification in both areas should encourage the reporting of secondary production.

### **3.2.3. NACE 72 - experimental development on engineering**

NACE 72 class inclusion - 72.12 (Research and engineering development on engineering)

NACE 72.12 category inclusions - “experimental development” listing sub-categories corresponding to the current NACE sub-categories and including the additional proposed NACE 71.12 categories

“experimental development” redefined to include an application/implementation phase by including the phrase “the application of physical laws and principles”.

The UN *System of National Accounts* 2008 that is the basis for the *European System of Accounts* (ESA 2010) [70] extended the asset boundary for intellectual property products to include research and development (R&D) in order to prioritise innovation and its impact, such as ‘spillover’ into all areas of economic activity<sup>23</sup>.

The output of the “architecture and engineering design” (AED) activity was included with R&D in the subsequent updating of national accounts because AED products such as registered designs and/or designs used repeatedly were, at least partly, subject to intellectual property protection and thus already capitalised to some extent in national accounts<sup>24</sup>.

Since proposals to expand the asset boundary originated in the USA [72], the introduction around the year 2000 of the North American activity classification NAICS class “architectural and engineering services” is probably responsible for the term “AED” entering into common use in the context of national accounting.

Analyses to identify market, non-market and own-account<sup>25</sup> AED production are mainly based on employment surveys, since detailed activity classifications for design are lacking. The proposals for the classification of engineering design summarised above are in part motivated by the need to improve the situation.

Estimates of AED production have also highlighted several issues that support the proposals, summarised above, for integrated engineering. For example, the widespread subcontracting of NACE 71.12 activities leads to double counting and omissions [76] if secondary activity is not reported.

A feature of design is that its contribution “... to innovation is still overshadowed by R&D. This is certainly partly a consequence of the fact that much investment in design is not recognised as design activity and is usually hidden in R&D expenditures ...” [77]. As discussed above for several NACE 71.12 categories, ESA 2010 recommends that a) all R&D production of

significant size should be recorded as secondary activity, b) own-account R&D production requires special treatment<sup>26</sup>.

In sum therefore, as for AED, NACE must facilitate the reporting of secondary R&D production.

In the case of engineering R&D activity, the activity is classified to the NACE 72.19 category “research and development on engineering and technology”. Investment in engineering R&D is a key issue. Using Goss Fixed Capital Formation (GFCF) as a proxy, owing to the lack of detailed statistics, the GFCF for engineering R&D is estimated in a fairly roundabout fashion [78] from the GFCF for R&D taken from Eurostat ESA 2010 national accounts. This GFCF is multiplied by:

- the business share of total R&D expenditure in relevant NACE sectors;
- the share of NACE 72.19 in the total NACE 72 turnover.

### Conclusions

In the case of engineering activities, national account estimates, and indeed estimates in many other contexts, would be improved considerably if classes replaced the current NACE 72.19 categories, thereby mirroring NACE 72.11 (Research and experimental development on biotechnology).

First, it is therefore proposed to add a new class (say NACE 72.12) that replaces the NACE 72.19 sub-category “research and development on engineering and technology” and to include in NACE 72.12 categories that mirror the current NACE 72.12 categories as well as the additional NACE 71.12 categories proposed above.

Second, the proposed new class and category inclusions to reinforce the need for a proposed adjustment<sup>27</sup> of the definition of “experimental development” to include “the application of physical laws and principles”.

In summary:

- Change the title of class 72.19 to “Other research and experimental development on natural sciences n.e.c.”
- Add class “72.12 (Research and engineering development on engineering)”
- Add 72.12 category:
  - 
  - “This class includes experimental development on engineering:
    - elaboration of projects using equipment
    - geophysical, geologic and seismic surveying - geodetic surveying
    - project supervision
    - integrated engineering

- manufacturing processes & production design
  - building information modelling and related systems
  - marine & costal environment design
  - built environment ecosystems design
  - prefabricated prefinished volumetric construction”
- “experimental development” redefined to include an application/implementation phase by including the phrase “the application of physical laws and principles”.

### Impact

Adding a NACE class 72.12 (Research and engineering development on engineering) with its category and sub-categories does not change the annual NACE 72 turnover. However, EUR 60 billion would be classified under the proposed class NACE 72.12.

## Notes

### 1. NACE 71.12 exclusions:

- test drilling in connection with mining operations to 09.10, 09.90
- development or publishing of associated software to 58.29, 62.01
- activities of computer consultants to 62.02 and 62.09
- technical testing to 71.20
- research & development activities related to engineering to 72.19
- industrial design to 74.10
- aerial photography to 74.20

2. Drawing on referenced work by the UK Design Council and the OECD, includes NACE 16.29 (Manufacture of other products and woods) and NACE 26.4 (Manufacture of consumer electronics) together with NACE 71.12 as constituting the engineering design sector [10].

3. A standard set NACE classes that make up the built environment sector has not been proposed. Possibly the closest to a unified classification is the ‘wide’ or ‘value chain’ classification [11, 12, 13] that focusses project delivery on the client – value chain relationship [14]. These classifications go well beyond the traditional ‘narrow’ construction sector based definition of the built environment (see for example [15]) [16]).

4. EU Member State versions of NACE that include categories referring to integrated projects and integrated engineering services include:

- Italy: ATECO 2007: has the category 7112/2 (“Integrated engineering design services”) [21];
- UK SIC 2007 has the category 7112/9 (“Other engineering activities, including integrated engineering activities for turnkey projects”) [22].

5. According to Istat [21], while the use of terms such as “financial engineering” and “software engineering” adds to confusion “when categorizing engineering services, one distinction is always made: between construction related and non-construction related services. Non-construction related services are very often not covered; they seem to be harder to tackle, “because their appearance varies greatly”.

The appearance or nature varies greatly because engineering activities that should be classified under NACE 71.12 involve:

- many types of services (e.g., provision of advice, preparation of feasibility studies, preparation of preliminary and final plans and designs, provision of technical services during the construction or installation phase, inspection and evaluation of engineering projects, and related services). [18]
- many industrial sectors to which engineering services are provided;

**6.** The Eurostat-OECD price indices guide [23] notes that in statistical surveys of the ISIC 71.12 class [24], for design-build:

- “engineering service producers focusing on these types of contracts should be reclassified to the construction sector”;
- in the US, for design-build, “in all cases, all construction output, including that from design-build contracts, is considered out of the scope of the survey.

**7.** The case where engineering services are realised by a project owner, manufacturer or contractor in an all-inclusive contract is common [25]. Whether the output is classified under NACE 71.12 depends on how a business survey respondent splits its turnover. Many tend to declare their whole turnover as industrial or construction activities even if engineering is included.

The engineering activity can be ignored if it constitutes a small part of a “global invoice”. This is notably the case for capital-goods manufacturers

At the opposite end of the scale, when “furnishing of goods and other works than engineering are not the most important part of the contract, the company will make an effort to strictly evaluate time spent and value-creation of engineering acts”.

The recommended solution, for example for turnover surveys based on products, is to survey firms for all activities that they carry out [18].

**8.** The Canada-European Union *Comprehensive Economic and Trade Agreement* (CETA) that entered into force in 2017 [26] uses the WTO services sectoral classification list [27] in Annex 19 as a *Universal List of Services* to regulate market access for government procurement. The WTO services classification uses CPC Ver. 1 with “Integrated engineering services” 8673 having five sub-classes [27].

**9.** WTO preferential treatment procedures reported up to 2015 included the treatment of “integrated engineering services” for India corresponding to CPC Ver. 1 [28].

**10.** As an example of the new types of project delivery models have integrated engineering services as a core component there is the shared enterprise delivery model that aims to manage combined resources [32]. Key features are:

- the primary interface is between the client/asset owner/operator and the supply chain [33]; which is facilitated by an “integrator” [34];
- focus on supply-chain relationships instead of project-based transactional relationships [35];

- the supply chain comprises investors, construction clients, contractors, firms in the construction and products supply chain and professional advisors so the types of enterprise participants are the owner, investor, advisor, supplier and integrator [33];
- existing contractual arrangements for design, construction and specialist roles can be amended to work with the integrator[33].

**11.** NACE Rev. 2 classification of design is summarised below (inclusions and exclusions are noted).

Formally, NACE 74.10 (Specialised design activities) covers traditional design (interior decoration, fashion, graphic, press, media), industrial design and machinery design, with web page, architectural design and engineering design excluded

74.10 Specialised design activities

- fashion design
- industrial design, i.e. designs .... that optimise the use, value & appearance of products
- graphic design
- interior decoration
- pre-press and pre-media services (specialised design activities) 18.13
- other building completion & finishing (activities of interior decoration designers) 43.39
- other professional, scientific & technical activities n.e.c. (industrial & machinery design) 74.9

Exclusions:

- design of web pages to 62.01
- architectural design to 71.11
- engineering design to 71.12

03.2 Aquaculture

techniques designed to increase the production

18.13 Pre-press and pre-media services

specialised design activities to 74.10

25.30 Manufacture of steam generators, except central heating hot water boilers

pipe system construction ... generally to make pressure pipes or pipe systems together with the associated design ...

31 Manufacture of furniture

the design of the article ..... is an important aspect of the production process

43.39 Other building completion and finishing

activities of interior decoration designers to 74.10

59.11 Motion picture, video and television programme production activities

activities of own account actors, cartoonists, directors, stage designers and technical specialists to 90.0

59.12 Motion picture, video and television programme post-production activities

sound design activities

62 Computer programming, consultancy and related activities

- planning and designing computer systems of .....

- 62.01 Computer programming activities  
planning and designing the structure and content of .....  
designing computer systems to 62.02
- 62.02 Computer consultancy activities  
planning and designing of computer systems
- 70.22 Business and other management consultancy activities  
design of accounting methods or procedures, .....  
design of computer software for accounting systems to 62.01
- 71.11 Architectural activities  
building design and drafting
- 71.12 Engineering activities and related technical consultancy  
engineering design (details given)  
industrial design to 74.10
- 73 Advertising and market research  
design of display structures and sites.  
advertising design, if carried out by the developer of the concept [35]
- 73.11 Advertising agencies  
showroom design
- 81 Services to buildings and landscape activities  
design of landscape plans and/or the construction (i.e. installation) of walkways, retaining walls, decks, fences, ponds, and similar structures.
- 90.02 Support activities to performing arts  
activities of ..... stage-set designers .....

**12.** A recent and very thorough review of the classification by agencies in Ireland [39, 40] can be summarised as proposing the following structure for the activities of the Irish design industry that are overlapping with those of NACE 71.12:

- design-intensive sectors (at least 30% design staff; traditionally associated with design):
  - specialised design activities (74.10)
  - architecture (71.11)
  - design & development engineering:
    - NACE 71.12 with civil & mechanical engineering excluded
    - NACE 16.29 (manufacture of other products & woods)
    - NACE 26.4 (manufacture of consumer electronics)
- design emphasis sectors (emphasise design-related activity):
  - advanced manufacturing (all NACE manufacturing categories)
  - built environment (NACE-related built environment categories including those gardeners and landscapers).

The structure calls for the inclusion of the following in NACE 71.12:

- manufacturing design, with exceptions for civil and mechanical engineering, essentially for all NACE manufacturing classes and certainly for NACE 16.29 (manufacture of other products & woods) and for NACE 26.4 (manufacture of consumer electronics);

- digital engineering design;
- built environment design, that is possibly excluded to NACE 81 (services to buildings and landscape activities).

**13.** Eurostat's *services producer price index (SPPI)* measures the gross change in the trading price, mainly business-to-business, of a number of services including architecture and engineering [41].

The SSPI is an important measure of inflation as is used to adjust ('deflate') turnover in current prices to allow the volume of services to be measured. It also shows which services consumed by other economic activities are the sources of price increases; in some countries it is used to adjust contract prices [25].

In the case for NACE 71.12, simply treating building information modelling (BIM)-enabled services for example in the same way as "standard services" and not as specialised services would mean that the basis for pricing of NACE 71.12 services would remain unchanged. This would lead to unrecognised productivity gains ("You can see the BIM age everywhere except in the building productivity statistics") and underestimation of price decreases accompanying improvement in the quality of construction [25].

**14.** The World Bank has published a detailed breakdown of the blue economy activities under the following headings [46]:

- harvesting and trade of marine living resources
- extraction and use of marine non-living resources (non-renewable)
- use of renewable non-exhaustible natural forces (wind, wave, and tidal energy)
- commerce and trade in and around the oceans
- indirect contribution to economic activities and environments

It is also recognised that "countries must accurately value the contribution of natural oceanic capital to welfare, ...." while "investment in, and use of the best available science, data, and technology is critical..."

In the United States, industry clusters have begun to form around blue technologies in recognition of the engineering challenges [47]. This activity is in urgent need of classification.

Classification will need to reconcile geographic aspects [48] since the NACE classification and its equivalents to not differentiate activities in terms of their location. Work to resolve this difficulty is underway [49].

As is often the case, NACE 71.12 is relevant to a multitude of sectors of economic activity, including those that are largely maritime.

**15.** NACE 81 (Services to buildings and landscape activities) only alludes to nature-based solutions (NBS) activities that have a narrow focus because the classification:

- includes the “design of landscape plans and/or the construction (i.e. installation) of walkways, retaining walls, decks, fences, ponds, and similar structures”;
- excludes “landscape design & architecture activities” to NACE 71.11 under NACE 81.30 (Landscape service activities).

**16.** NACE classifies prefabricated buildings in terms of manufacturing activities (Section C) and construction activities (Section F) and specifically excludes engineering design from NACE 71.12 (“If only specialised parts of the construction process are carried out, the activity is classified in division 43.”).

NACE 23.6 Manufacture of articles of concrete, cement and plaster

NACE 23.61 Manufacture of concrete products for construction purposes

This class includes:

- manufacture of precast concrete, cement or artificial stone articles for use in construction: tiles, flagstones, bricks, boards, sheets, panels, pipes, posts etc.
- manufacture of prefabricated structural components for building or civil engineering of cement, concrete or artificial stone

NACE 25.1 Manufacture of structural metal products

This group includes the manufacture of structural metal products (such as metal frameworks or parts for construction).

NACE 25.11 Manufacture of metal structures and parts of structures

This class includes:

- manufacture of metal frameworks or skeletons for construction and parts thereof (towers, masts, trusses, bridges etc.)
- manufacture of industrial frameworks in metal (frameworks for blast furnaces, lifting and handling equipment etc.)
- manufacture of prefabricated buildings mainly of metal:

NACE Section F – Construction

..... erection of prefabricated buildings or structures on the site ....

NACE 41.20 Construction of residential and non-residential buildings

This group includes the construction of complete residential or non-residential buildings, ..... If only specialised parts of the construction process are carried out, the activity is classified in division 43.

- assembly and erection of prefabricated constructions on the site

**17.** Modular building elements manufactured (“prefabricated”) off-site in a controlled setting as either non-volumetric components or as volumetric units, for either permanent or non-permanent

buildings or structures. Components are then shipped to a project site and assembled using established construction processes [57 - 59].

**18.** Modular construction will in general require specialised engineering and design engineering:

- Engineering design should take into account the manufacturing process, transportation issues, and sequencing during on-site assembly, some of which but by no means all are conventional construction means and methods.
- The design team will rely on the module manufacturer to provide information and carry out or sub-contract integrated engineering.
- Engineering design usually requires closer specification and control than engineering design for traditional construction projects.
- As for any design-build project, services, roles responsibilities, and liabilities must be clearly and adequately delineated, typically using a contractual arrangement that ensures coordination between all parties that starts at an early stage.
- Areas requiring specialised engineering activities include:
  - engineering design, especially if modules are customised using advanced digital manufacturing processes;
  - engineering for transient design situation (e.g., during handling in the manufacturing plant, during transporting to the site and upon hoisting during erection and assembly during construction);
  - engineering supervision during off-site trial assembly and testing;
  - engineering design for specialised inspection methodologies and for safety measures during construction;
  - engineering design to coordinate the manufacture, installation and coupling of services fittings (water, power, etc.).

**19.** Industry reporting of environmental engineering paints a confusing picture.

National associations representing engineering activities report that up to 7% of engineering turnover is for environmental consulting [66]. The situation arises because some secondary production is classified under NACE 74.90 on the basis of poorly standardised national-level product classifications, even though services represent normal engineering activities.

The same applies to manufacturers of non-environmental products, when they execute an environmental activity as secondary activity. These may be classified in NACE divisions and classes that are not identified as ones with the major part of their gross value added arising from the production of environmental products, or ones with potentially significant production of environmental products [62].

**20.** NAICS Code 541620 (Environmental Consulting Services - This industry comprises establishments primarily engaged in providing advice and assistance to businesses and other organizations on environmental issues, such as the control of environmental contamination from

pollutants, toxic substances, and hazardous materials. These establishments identify problems (e.g., inspect buildings for hazardous materials), measure and evaluate risks, and recommend solutions. They employ a multidisciplined staff of scientists, engineers, and other technicians with expertise in areas, such as air and water quality, asbestos contamination, remediation, and environmental law. Establishments providing sanitation or site remediation consulting services are included in this industry [68].

**21.** Climate-related engineering activities covered by NACE 71.12 are those:

- associated with the design, construction, retrofitting and reconstruction of infrastructure to enhance resilience to the climate-related hazards, through the implementation of the structural adaptation measures or ecosystem based approaches, contribute to the reduction of physical climate risk of other economic activities;
- consulting and planning activities related to engineering activities that take into account climate-related hazards and enable adaptation of the built infrastructure (e.g. building codes; integrated management systems; delivering spatial information on changing risks and vulnerabilities due to climate change) contribute to the reduction of physical climate risk of other economic activities

**22.** NACE presents a fairly complicated picture for location dependent (e.g., underground, seabed, underwater, aerial) inspection operations (e.g., drilling, tunnelling, diving inspection and surveying).

### Operation

“geophysical surveying” is excluded to NACE 71.12 from:

- NACE 06 (Extraction of crude petroleum & natural gas), together with “geologic & seismic”;
- NACE 09.10 (Support activities for petroleum & natural gas extraction) together with “geologic & seismic”;
- NACE 09.90 (Support activities for other mining & quarrying);
- NACE 43.13 (Test drilling and boring), together with “oil & gas field exploration”.

“test drilling & test hole boring” is a NACE 09.90 (Support activities for other mining & quarrying) sub-category.

Tunnelling services are not categorised.

Drilling has been ruled on by Eurostat [36]:

- for any drilling activities other than for mining (to find oil, gas or minerals ), classify to NACE 43.13 (Specialised construction activities);
- for mining classify to NACE 09.

“aerial photography” under NACE 71.12 is excluded to NACE 74.20 (Photographic activities).

## Location

Underground operations: NACE 09.90 (Support activities for other mining & quarrying) has a sub-category “test drilling & test hole boring”; tunnelling services are not categorised.

Underwater operations are not categorised.

Seabed: see surveying operations, above.

“aerial photography” under NACE 71.12 is excluded to NACE 74.20 (Photographic activities).

**23.** The UN *System of National Accounts* (SNA 2008) currently recognises intellectual property products as produced assets. These products are the result of research, development, investigation or innovation leading to knowledge that the developer can market or use to their own benefit in production because use of the knowledge is restricted by legal or other protections. Knowledge remains an asset as long as it is used in production and can create profits or other economic benefits for its owner. [71]

**24.** Citation: “Many national accounts, including those of the U.S., already include some of these expenditures as part of residential investment or as part of the installed value of equipment and structures, but this treatment recognizes the role of the designs in the value of the tangible asset that is used repeatedly, rather than the separate role of the design in multiple uses. As a separate intangible asset, the capitalized component of designs reflects this separate quality. Because their use can be controlled through intellectual property protection, they share many of the qualities of capitalised R&D.” [72]

Indeed, the 1993 version of the UN *System of National Accounts* provides guidance for the reporting of spending that includes spending on architecture and engineering design: “New fixed assets acquired by purchase are valued at purchasers' prices: that is, including not only all transport and installation charges but also all costs incurred in the transfer of ownership in the form of fees paid to surveyors, engineers, architects, lawyers, estate agents, etc.”. [73]

**25.** Citation: “Most large (manufacturing) companies have departments for developing new products, product packing and/or processes. Instead of purchasing new designs, these departments produce them on own account. This expectation is confirmed by the virtual absence of intermediate consumption of architectural and engineering designs by manufacturing industries in the national accounts.” [75]

**26.** According to SNA 2008 guidelines, R&D expenditure for three product groups is required:

- Market R&D: normally the sales and purchases as reported in R&D surveys.

- Non-market R&D: by convention, valued as the sum of production costs.
- Own-account R&D: according to SNA 2008 guidelines own-account production of R&D is not regarded as an ancillary activity. The SNA recommends, if possible, that separate units should be distinguished. If this is not possible, the ESA 2010 recommends that all R&D of significant size should be recorded as secondary activity. To explicitly represent the own-account R&D production, a product group is introduced into national accounts with own-account production recorded explicitly only when used as final consumption (in the case of unincorporated enterprises) or when used as gross fixed capital formation (i.e., for investment). [77]

**27.** The proposed class and category inclusions for NACE 72 reinforce the need for an adjustment of the definition of “experimental development” to include “the application of physical laws and principles”.

The current NACE definition of “experimental development” is: “systematic work, drawing on existing knowledge gained from research and/or practical experience, directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed”.

This definition, as expected, envisages a development processes that progresses from “knowledge gained by research” to “practical experience”.

However, owing to the definition, monitoring of the evolution of the development process is not possible. Introducing an application or development phase would permit a limited but essential measurement of the take-up of technology and of the phases at which take-up falters, especially if reporting systems recorded development expenditure at each phase.

The proposed definition of “experimental development” is therefore: “systematic work, drawing on existing knowledge gained from research AND/OR THE APPLICATION OF PHYSICAL LAWS AND PRINCIPLES and/or practical experience, directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed” (proposed additions in capitals).

## Annex A: NACE 71.12 perspectives

NACE 71.12 is a key economic activity from a number of perspectives:

- NACE 71.12 exports are significant (15% for the EU).
- NACE 71.12 accounts for 5% of total EU services output, excluding financial and insurance services, and about 2% of total output.
- NACE 71.12 was rated the second most important IPR-intensive economic activity in the EU in terms of added value for the period 2010-13 (IPR = intellectual property rights ) [2].
- NACE 71.12 is class of the NACE 71 division which is classified as corresponding to Tier 2 knowledge-intensive market services [3] and is a is class of the NACE 71 division which is classified as corresponding to knowledge-intensive business services [4].
- NACE 71.12 is one of the EU's two climate-change adaptation enabling economic activities since “it contributes to adaptation of other activities and/or addresses systemic barriers to adaptation” [5].
- A revised NACE 91.03 class that includes heritage consulting and engineering activities has been proposed [6].
- NACE 71 is classified with NACE 69-75 as a Tier 4 medium to low R&D intensity industry in the EU in terms of the business R&D expenditure as a percentage of gross value added [7]
- NACE 71.12 mainly comprises occupations that are generally considered as professional whereas NACE 71 includes many non-professional occupations on the basis of their obligations to society and their roles in society [8].
- NACE 71.12 spans construction and manufacturing sectors so is a driving force in the standardisation and industrialisation of construction to raise the sector's low level of productivity [9].
- NACE 71.12 forms the main part of the engineering design sector, together with manufacturing<sup>2</sup> and built environment<sup>3</sup> activities.

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