Study programme section of the Students' Charter with the 2021-2022 Teaching and Examination Regulations of the Master's programme

Digital Technology Engineering

Study programme code 49156

Full-time

Eindhoven

The study programme section of the Students' Charter was adopted by the institute's director on 26 January 2022, after obtaining the IPC's consent on 18 January 2022.

The Teaching and Examination Regulations of the study programme expand on the institutional section of the Teaching and Examination Regulations of Fontys Master's programmes.

This general section for the **2021-2022** academic year was established by the Executive Board on **15 December 2020**, following the consent of the students' section of the CPC, which was given on **14 January 2021**.

Table of contents

A – Teaching and Examination Regulations

Section 1 General

Article 1 Definitions

Academic year	The period from 1 September up to and including 31 August of the following year.
Accreditation of prior learning	Accreditation of prior learning awarded by a recognised provider of prior learning assessment and recognition.
Assessment	Generic term for tests aimed at assessing a student's competencies in a professional situation that is as authentic and realistic as possible.
Assessor	An examiner that grades the student's progress in acquiring the required competencies.
Certificate	The certificate as referred to in Section 7.11 of the Dutch Higher Education and Research Act (*Wet op het Hoger Onderwijs en Wetenschappelijk Onderwijs*, WHW).
CAA	Centre for Administrative Activities. The CAA is the internal partner within Fontys of the representative and participatory bodies and their discussion partners with respect to optimising how these bodies function.
CPC	Central Participation Council
Cohort	The group of students who are enrolled for the first time in the first year of a study programme on the same reference date to which the prevailing Teaching and Examination Regulations (TER) apply. For students who enrol in a higher year, cohort membership is determined on an individual basis.
Competency	A cluster of related knowledge, skills and attitudes that influences a substantial part of a person's job, is related to the performance of the job, can be measured and tested against accepted standards and can be improved through training and development.
Component test	If an interim examination consists of several tests, each of those tests is referred to as a component test.
Credit	One credit equals 28 standard study-load hours. Students are awarded credits on passing the interim examination of a unit of study. The international term for credits is ECTS credits (EC's).
Education components	The courses offered to students to help their learning process.
CROHO	Central Register of Higher Education Study Programmes, which is a register of all study programmes. Students that pass the interim examinations of a study programme registered in CROHO are entitled to an official higher professional education certificate with the associated degree (associate degree, Bachelor or Master).
Deficiency	Any required prior qualification(s) a student lacks.
Diploma supplement	Document drawn up in accordance with a European format that is added to the certificate and states the nature, level, context, content and status of the study programme.
DTE	Digital Technology Engineering, the name of the master's programme.
Dual-study programme	A dual-study programme is organised in such a way that education is alternated with one or more periods of professional practice related to the study programme. The study programme therefore consists of an educational segment and a professional placement segment, both of which are integral parts of the study programme.
DUO	Short for *Dienst Uitvoering Onderwijs*, a government agency charged with implementing education legislation and regulations.
ECTS	European Credit Transfer System. The system that is used to express credits in order to facilitate international comparison. See also: credits.
EVC (RPL)	*Erkenning van eerder Verworven Competenties* (Recognition of Prior Learning).
Examination	Assessment administered by the Examination Board to determine whether students have successfully completed the educational components of a study programme or the foundation-year phase. The final examination may also include a supplementary assessment conducted by the Examination Board.
Examination Appeals Board	The Board as referred to in Sections 7.60 up to and including 7.63 of the WHW and Articles 45 and 46 of the Students' Charter. The organisation, duties and powers of the Board are laid down in the Rules of Procedure adopted by the Examination Appeals Board and approved by the Executive Board.
Examination Board	The board of persons referred to in Section 7.12 of the WHW.

Examiner	Member of staff who is designated by the Examination Board to administer examinations and assess the results thereof or an external expert.
Executive Board	The administrative body of Fontys University of Applied Sciences, as described in the articles of association and the WHW.
Exemption	Full or partial exemption from meeting enrolment and/or admission conditions and/or sitting interim examinations.
Exit qualifications	Qualifications students must have on completing the study programme.
Fraud	Any act (including plagiarism) or omission that either partially or fully impairs the correct assessment of a person's knowledge, insight, skills, competencies, professional attitude, powers of reflection, etc.
Full-time study programme	A full-time study programme is a study programme whose structure is such that students are assumed not to participate in any activities other than education components.
Hardship clause	A provision in a law or regulation that makes it possible to deviate from regulatory provisions in favour of the student or external student.
He/him	He/him is taken here to refer to men, women and individuals who do not identify as either of these options
IELTS	International English Language Teaching System, a tool used to determine a student's command of the English language.
Institute	The operational unit at Fontys that is, in particular, responsible for organising Fontys's core competencies and that executes the primary processes.
Institute Director	The staff member charged with running a Fontys institution.
Institution	The Fontys Universities of Applied Sciences.
Intake assessment	Portfolio assessment conducted at the student's request to validate previous learning experiences prior to enrolment in the study programme. A fee covering the costs is charged for an intake assessment.
Intake interview	Interview conducted at the student's request prior to the start of the study programme if the student believes that he has competencies acquired previously. An intake interview comprises a general assessment from which no rights can be derived by a student.
Interim examination	An examination of the knowledge, understanding, skills and/or competencies of a student required to conclude a unit of study, including an assessment of the results of such an examination *(Section 7.10(1) of the WHW)*. An interim examination may consist of one or more component tests.
IPC	Institute Participation Council
Main subject	A specific definition of the curriculum within a programme, which begins immediately from year 1 or following the foundation year
Occupational requirements	The legal requirements to which the practice of a particular profession is subject. The legal requirements to which the practice of a particular profession is subject (Section 7.6 of the WHW).
Part-time study programme	A part-time study programme is a study programme whose structure is such that the student is able to participate in supplementary activities, either work-related or educational, alongside education components.
Portfolio	A collection of evidence, digital or otherwise, with which students can demonstrate that they master the competencies of a particular study programme.
Principle	All study programmes offered are based on one of the following principles: non-denominational private education (NPE), Roman Catholic (RC), Protestant Christian (PC) or a combination of non-denominational private education, Roman Catholic and Protestant Christian (NPE, RC, PC).
Profiling Fund Board	Board charged by the Executive Board with implementing the Profiling Fund scheme, formerly known as the FSS Board.
Profiling Fund Scheme	Scheme for the granting of support to students in the form of graduate funding, committee member grants or attendence fee from the profiling fund, now known as the Profiling Fund Scheme.
PC	Opleidingscommissie (Programme Committee, PC), a committee established for a particular study programme of an institute referred to in Section 10.3c of the Act (see the Regulations on the Participation Councils and Degree PC's).
Tailored programme	Special programme which differs from the standard programme.
Teaching period	Period in the academic year during which education components are organised. A teaching period is referred to as a study quarter in the Fontys annual calendar.
Elite athletes scheme	Scheme for elite athletes that specifies which students are eligible to benefit from it and the facilities that they may use under it.

TER	Teaching and Examination Regulations. The TER consists of an institutional section for all study programmes offered by the Fontys Universities of Applied Sciences as well as information specific to individual study programmes. The TER forms a part of the study programme section of the Students' Charter.
Test	Activity used to assess whether a student has certain knowledge, insight, skills and/or competencies.
Student	A person who is enrolled in the institution, as referred to in Sections 7.32 up to and including 7.34 of the WHW.
Student counsellor	Staff member appointed by the Executive Board who is responsible for looking after the students' interests, providing assistance when problems occur and providing information and advice. The student counsellor is part of the Student Facilities Service (*Dienst Studentenvoorzieningen*).
Study Career Centre	Service provided by the Student Facilities Service (*Dienst Studentenvoorzieningen*) to help students with issues involving admission, transfer to another study programme/institute or the termination of their studies.
Studentcoach	Coach who provides guidance on issues relating to student progress, including those that stimulate a student to develop a personal and professional identity, focusing on a student's talents and personal leadership qualities.
Studentcoaching	System of guidance that focuses on the development of the individual student. It stimulates students to reflect on their own development as future practitioners of the profession and to take responsibility for their own development.
Students' Charter	The charter containing the rights and obligations of students, divided into an institutional section and a study programme section.
Study load	The standardised time investment expressed in units of 28 study load hours related to a study programme.
Student entrepreneur scheme	Scheme which is intended to help Fontys students who are deemed student entrepreneurs to combine entrepreneurship and study.
Study programme	A coherent totality of education components in which students participate as part of their education. Every study programme is recorded in the CROHO.
Study programme profile	The entire set of exit qualifications for which the study programme provides training.
Unit of study	Part of a study programme that is concluded with an interim examination as referred to in Section 7.3(2) of the WHW or an additional assessment carried out by the Examination Board, as referred to in Section 7.10(2) of the WHW. Units of study may relate to the assessment of one or more competencies, a component of competencies (knowledge, insight, skills, attitude) or a combination of competencies. Students are awarded the relevant credits on passing the interim examination for the unit of study.
WHW	The Dutch Higher Education and Research Act (*Wet op het Hoger Onderwijs en Wetenschappelijk Onderzoek*, WHW; Bulletin of Acts and Decrees 593, 1992, and later supplements and amendments).

Section 2 Admission to a Master's programme

Article 2 Educational entry requirements

1. The following qualify as proof of admission for enrolment in a Master's programme:
   a. an academic or higher professional education Bachelor's degree; or
   b. possession of knowledge, insight and skills at the level of an academic or higher professional education Bachelor's degree *(Section 7.30(b) of the WHW).*
2. Admission to the study programme is subject to the following qualitative admission requirements.
   A bachelor in Automotive, Aviation, Electrotechniek, Engineering, Industrieel Product Ontwerpen, Logistics Engineering, Luchtvaarttechnologie, Maritieme techniek, Mechatronica, Mens en Techniek, Technische Bedrijfskunde, Toegepaste Wiskunde, Werktuigbouwkunde, HBO-ICT, Informatica, Technische Informatica, Technische Natuurkunde.
3. All students who fulfil the stated requirements will be admitted.

Article 3 Reparation of non-compliance of entry requirements
If the candidate does not comply with the entry requirements as referred to in article 2 and he may be expected to be able to meet them within a reasonable period of time, he will be offered the opportunity to repair them and yet meet the entry requirements.

Article 4 Requirements regarding foreign diplomas/international students

1. Foreign students from outside the EU who are 18 years of age or older on the date of their first enrolment must have a valid residence permit. (*Section 7.32 of the WHW.)*
2. Foreign students with a residence permit are required to earn at least 50% of the available credits each year. The IND will be informed if the student fails to meet this requirement, unless there are special circumstances due to which the student was unable to meet this requirement. Such a notification may be withheld once during the course of each study programme.
3. According to the Code of Conduct regarding International Students, international students[1] seeking admittance to an English-taught Master's programme must be able to prove that their command of the English language is at least equal to a score of 6.0 of the IELTS Test.

Article 5 Professional activity requirements

The study programme exists only as a full-time program, with no requirements for professional practice.

Section 3 Intake assessment, exemptions, short-track/tailored study programmes

Article 6 Intake interview

1. Students entering a study programme will be offered an intake interview if they have competencies previously acquired elsewhere. Students can include the evidence of the competencies previously acquired elsewhere in their portfolios or may use this evidence to substantiate a request for exemption before the Examination Board.
2. Students who re-enrol after an interruption in a study programme in which they were previously enrolled will be required to take an intake interview to determine which part of the study programme still has to be completed. No intake interview is needed if agreements regarding re-enrolment in the study programme were already made with the Executive Board at the time that the student interrupted his study.
3. A study programme will be drawn up based on the assessment of the competencies previously acquired and will be submitted to the Examination Board for approval.

Article 7 Exemptions

Students who believe they are eligible for an exemption must submit an application to that end to the Examination Board. The Examination Board may grant an exemption from one or more interim examinations on the grounds of a review of an assessment or the holding of a diploma or other certificate, accreditation of prior learning or similar document, such as proof of results achieved in a study programme taken at a research university or university of applied sciences and/or proof of administrative activities, with which the student can show that he has already met the requirements of the interim examination in question. Exemptions are recorded in the study progress system. The period of validity of the exemption is stated in the exemption decision. *See Article 27.*

Article 8 Short-track/tailored study programmes

Students who believe they are able to proceed with and/or complete their study programmes at an accelerated pace may submit an application requesting such to the Examination Board. The organisation of the study programme must be able to accommodate the short-track option.

[1] According to the Code of Conduct regarding International Students, 'an international student' is a student with a foreign nationality.

Section 4 Facilities with reference to student coaching, special facilities for students with a functional disability, elite athletes scheme, board memberships

Article 9 Student coaching

Every student will be guided by a studentcoach. Students who, due to special circumstances, need extra guidance make this known to their coach. Extra coaching will be held and ,if necessary, the student will be referred to a form of second-line guidance.

In case of special circumstances, a student is obliged to inform the studentcoach of any circumstances that may lead to a delay in the study progress.

Article 10 Special facilities for students with a functional disability

1. Students with a functional disability are legally entitled to effective adjustments, unless such adjustments would burden the institution disproportionally. *(Section 7.13 of the WHW.)*
2. These adjusted facilities must be aimed at the removal or restriction of any obstacles and encourage the independence and full participation of the student as much as possible. The adjusted facilities may relate to the study programme (including internships), the timetables, and type of study programme, the tests and educational tools.
3. A student who seeks to have adjusted facilities must submit a written and substantiated application in good time to the Examination Board. If necessary, the Examination Board will seek an expert's advice (such as a student counsellor) before taking a decision. If the Examination Board deems it necessary before taking a decision, it may confidentially inspect the medical certificate that may be available with the student counsellor, unless the student objects.
   The Examination Board must decide within four work weeks after receipt of the application, unless it requires further inquiry, in which case the student will be informed as to when more clarity can be given with respect to his application.
4. In the case of a protracted or chronic disability, such an application will only have to be made once for the entire study programme; in all other cases once per testing period or academic year. In its decision to grant the facilities, the Examination Board may also rule that these will apply for the entire duration of the student's study or that the student is to consult with his student coach annually to discuss whether the facilities are still adequate.
5. At the beginning of the academic year the institute will inform students regarding the possibilities for special facilities. Students will be informed of their right to consult a student counsellor.

Article 11 Students with board memberships

1. Students can include any board memberships as part of their portfolios. In order to do so, they must describe, in consultation with their student coach, how the board membership can contribute to the acquisition of one or more competencies of their Master's programme.
2. Board memberships for the DPC, IPC, CPC, or for study associations, student associations and as members of committees at Fontys can be listed on the diploma supplement. The student must request the listing at least 6 weeks prior to the graduation ceremony via the study programme administration.
   At the request of the student's study programme, the Centre for Administrative Activities can confirm that the student has been an active board member of the CPC. In the case of board memberships of a PC or IPC, the study programme can request confirmation from the relevant IPC or PC.
3. Students who believe that their board memberships demonstrate that they have the knowledge, insight and/or skills that are assessed in particular tests may apply for an exemption from such tests from the Examination Board.
4. A student may apply to be included under the Profiling Fund Scheme (FSS Scheme) on the basis of his administrative activities and submit a request for a board membership scholarship from the Profiling Fund Board (FSS Board).
   See also article 14 of the Fontys Regulations on the Participation councils and degree programme committees.

Article 12 Elite Athletes scheme - Student entrepreneurship

1. Students who have been granted an Elite Athletes or Talent status are entitled to facilities from the Elite Athletes Scheme. Facilities regarding the adjustment of tests or test timetables, an adjusted arrangement regarding compulsory attendance, working in groups and an adjusted internship must be sought from examination board.
2. Students who are eligible for the Student Entrepreneurship Scheme may apply to the Examination Board, among others, for facilities regarding the adjustment of tests or test timetables, an adjusted

arrangement regarding compulsory attendance for education components, working in groups and an adjusted internship. These facilities should be sought from examination board.

Section 5 Study programme content

Article 13 Study programme profile – main subjects – occupational requirements

1. The study programme is based on a study programme profile. The exit qualifications of the study programme are described in the education profile. The education profile can be found in attachment 1.
2. The study programme has no main subjects.
3. The study programme is based on the following principle: NPE (non-denominational private education).
4. The study programme does not impose any specific occupational requirements.

Article 14 Study programme layout

The Master's programme has a study load of 120 credits. The nominal study load is 60 credits per year.

Article 15 Overview of units of study and credits

1. Every study programme consists of a coherent set of units of study, which are components of a study programme concluded with an interim examination. Units of study cannot exceed 30 credits.
2. Only whole credits are awarded for units of study. In the overview included in Attachment 2 you will find an overview of the distribution of credits.
3. Study programmes and tests conducted in a foreign language are subject to the Code of Conduct for Study Programmes taught in a Foreign Language; the overview of units of study

Article 16 Education components – learning environment

1. Attachment 2 is an overview of the education components that are part of the study programme. For the educational activities, a reference is made to course manuals. An overview of all learning outcomes can be found in attachment 4
2. Any entry requirements a student must meet before participating in a course or educational activity are stated in the overview as referred to in paragraph 1.
3. Enrolment in education components is not required.
4. The timetable is announced on Canvas no later than 3 weeks prior to the start of classes.
5. Students who have registered for a course or educational activity must ensure that they meet the specific entry requirements. The overview in Article 16, paragraph 1, indicates the education components to which requirements apply for participation as well as the nature of these requirements.

Article 16a - Evaluation of teaching

The teaching provided during the study programme is evaluated in the following way.
Education in the programme is evaluated by quantitative and qualitative evaluations by students at the end of the offer of educational activities. See attachment 6 Quality Cycle DTE.
The educational evaluations and resulting improvement actions are reported back to lecturers and students under the responsibility of the respective coordinators.

Section 6 Tests, evidence, assessment and study progress

Article 17 Types of tests - evidence

1. A test consists may consist of:
    a. one or more mandatory tests or mandatory partial tests;
    b. freely-chosen evidence evaluated as an assessment, such as a portfolio;
    c. a combination of a) and b).
2. Tests are conducted in writing or orally or in a fashion that combines both writing and oral delivery (e.g. product and presentation/interview).

3. An oral examination, including an assessment, is conducted by at least two examiners. A report must always be drawn up of an oral test on a specially designed evaluation form an assessment of the quality of the evaluation afterwards. A test may be conducted by a single examiner only following the approval of the Examination Board and provided the student does not object.
   An oral test is held in public. Interested parties who wish to attend an oral test must submit a request to that effect to the examiner(s) at least two weeks before the test is held. The examiner must inform the student who is taking the test. If the student objects, the request to attend the oral test will in any event be rejected. Any rejection by the examiner will be substantiated.
   When the Examination Board offers students the possibility to sit an additional oral test by way of replacement of a regular test, it will always be conducted and assessed by two examiners.
4. If a test consists of an assessment of freely-chosen evidence, the programme should allow the student to collect such evidence and receive feedback from the examiners, external experts and/or peers. The requirements that the evidence must meet are given in the assessment plan and the 'Master guide', which include measuring & assessing in the master DTE.

Article 18 Tests and assessments

1. The Examination Board will designate one or more examiners for each test. An examiner can also be an external expert.

Article 19 Content of tests, duration of the test and test aids and test timetables

1. The content of the test, including the learning outcomes, is described in 'Master guide', which include measuring & assessing in the master DTE and is made available to students at the start of the programme.
2. The examiner determines the period of time allowed to students to take the test as well as any aids that students may use during the test, subject to the guidelines and instructions provided by the Examination Board. This information must be stated on the examination paper.
3. The test timetable will be published through the portal no later than 3 weeks before the start of the test period in question.

Article 20 Registration for tests

1. Registration for tests is not required.

Article 21 Proof of identity during tests

Students must prove their identity at every test by showing a legally valid form of ID other than a student ID card.

Article 22 Test marking system

1. The assignments, questions, assessment norms and criteria are determined by the examiners with due regard for the guidelines and instructions provided by the Examination Board. The examiner conducts the test and determines the result on the basis of the determined assessment standards and assessment criteria.
2. If one and the same test is conducted and assessed by more than one examiner, the Examination Board will ensure that the examiners adhere to the same standards and criteria.

Article 23 Test results

1. The test results must be announced in writing to the student within ten days of the date of the test unless there are exceptions laid down in the Teaching and Examination Regulations. The study programme administration is responsible for announcing the test results. The privacy of students will be respected when test results are announced. Results of assignments, reports or portfolios should be announced within 15 working days.
2. Students are entitled to inspect all assessed tests and the accompanying assessment criteria used and to be given feedback on the results.
3. Inspection is subject to the procedure described below:
   The results of every examination, including the scores on the criteria on the assessment form, will be published online using Gradework. Students can inspect them at any moment after the publication.
4. Feedback is given according to the following procedure.
   Students will be given written feedback on the assessment form published in Gradework. Students who have failed an assignment and need more specific feedback, can make an appointment with their examiner.
5. Students will receive written notification of their results at least once a year, from which notification students may derive rights.

Article 24 Inability to sit tests

1. Students who have acted in accordance with the registration procedure described in Article 20 but who are unable to sit the test for reasons beyond their control, the legitimacy of which reasons is subject to assessment by the Examination Board, may apply to the Examination Board to sit the test within a period of time to be set by the Board. The student in question must have notified the Examination Board by email before the test that he/she has been prevented from sitting, including the reasons for not attending.
2. The application referred to in the previous paragraph must be submitted in writing to the chairman of the Examination Board and include the necessary evidence (see Article 33 (3)). The Examination Board will then take a decision and inform the student concerned. If the request is granted, the Examination Board will set a date, time and place for the test. Any rejection of the request will be substantiated and the student will be informed of his right to appeal. In assessing the request, the Examination Board's primary criteria are the obstruction of the study progress and the student's personal circumstances.

Article 25 Request for a review

1. Students who do not agree with an assessment can submit a request for a review of the assessment to the Examination Board within 4 working weeks after the date of the assessment (see Article 33 (3) of these Teaching and Examination Regulations and Article 44 of the Students' Charter). The Examination Board must take a decision within 4 work weeks at a maximum.
2. Students may also appeal directly to the Examination Appeals Board within 6 calendar weeks after the date of the assessment via https://connect.fontys.nl/fontysbreed/studentenloket/Paginas/English.aspx. (see Article 45 and Article 46 of the Students' Charter).

Article 26 Resits

1. Tests are conducted at least twice an academic year.
   Students can resit components marked with a pass only once, in which case the highest mark will count.
2. At least two opportunities to take tests that assess the material they have learned will be offered. Following these two test opportunities, the material to be studied for the test may be adapted to the material offered in the teaching block prior to the test. An up-to-date description of the material to be tested can be found via the 'Master guide', which include measuring & assessing in the master DTE.
3. If a test consists of an assessment of freely-chosen evidence, then the programme should offer the student the option of improving or supplementing the evidence.

Article 27 Period of validity of results - evidence

1. The period of validity of successfully completed component tests is 10 years.
   The validity period for evidence is 10 years.
   Results achieved for interim examinations can only lapse if the understanding/knowledge/skills to which these interim examinations relate can be shown to be obsolete. Understanding, knowledge and skills that were assessed more than 10 years ago can evidently be shown to be obsolete.
   The period of validity of successfully completed interim examinations is:
   10 years
   The Examination Board may extend this term.
2. In the event of special circumstances as referred to in the Profiling Fund Scheme, the period of validity of interim examinations will as a minimum be extended by the duration of the support granted on the basis of that scheme.
3. If the study programme has been substantially altered, details on how this term will be restricted can be stated below, whether in the form of a written decision issued to a student or incorporation in the Teaching and Examination Regulations, if it applies to the entire cohort.

Article 28 Final paper - Knowledge bank

Final papers of the study programme are not entered in a knowledge bank.

Article 29 Study progress

The study programme is responsible for recording the test results in the programme administration. Additionally, students must also keep records of the results in their portfolios.

Section 7 Graduation

Article 30 Examinations - certificates - diploma supplement

1. Students have passed the examination of the study programme if they have passed all units of study which form part of the study programme, as referred to in Article 15. *(Section 7.10 of the WHW.)*
2. The certificate will only be given after it has been established that the student is enrolled and has paid his tuition fees for all the enrolment years. *(Section 7.11 of the WHW.)*
3. After successful completion of the examination, the Examination Board awards the certificate. The certificate is dated on the date of the student's final academic activity (test or assessment). The certificate of a study programme comes with a diploma supplement. This diploma supplement may include mention of a student's board activities (see Article 11). Students who have served as members of the Examination Appeals Board may also request that activity to be included on their diploma supplement.
   The Examination Board will determine that the student has passed within a maximum of eight calendar weeks after the last academic activity (test or assessment).
   If the student wishes for the certificate to be dated later, the student must postpone the completion of his final academic activity (test or assessment).
4. The certificate is signed on behalf of the Examination Board by the (deputy) chairman, the (deputy) secretary, the candidate and, if applicable, an external expert. *(Section 7.11 of the WHW).* On behalf of the Executive Board, the Examination Board also confers on the student the degree of the study programme if the student has taken the study programme examination
   For the study programme's examination the master of science degree is awarded.
5. The award ceremony takes place at a time decided by the institute.
6. The diplomas of students whose performance has been extraordinary will state the distinctions referred to below.
   No classification is mentioned on the diploma.
7. The Executive Board reports to DUO the students that have passed the examination of the study programme.

Article 31 Statement on departure

1. Every student who seeks to terminate his enrolment without having passed the study programme's final examination will be invited for an interview.
2. At the student's request, the student may be issued a statement listing any results achieved. *(Section 7.11 of the WHW.)*
3. The statement must specify that the test results will in principle be valid for 10 years. The statement can include a reservation in the event of a substantial overhaul of the study programme (see also Article 27).

Section 8 Irregularities and fraud

Article 32 Irregularities and fraud

1. If irregularities are discovered in connection with a test, as a result of which the Examination Board cannot guarantee the test's quality and any of its results, the Examination Board may forgo having the test checked, or declare a test result void. In such cases, the Examination Board must ensure that an opportunity to resit the test in the near future is offered to the affected students.
2. If a student is guilty of an irregularity committed with respect to (a component of) an examination or fraud, the Examination Board may exclude the student from sitting one or more tests of the study programme for a period to be determined by the Examination Board but which will not exceed one year. If the test has already been assessed, the result will be declared void.
3. In the case of serious fraud, the Examination Board can propose to the Executive Board that the enrolment of the student involved be prematurely terminated *(Section 7.12b of the WHW.)*
4. If the irregularity is only discovered after the examination, the Examination Board may withhold or claim back the certificate of the study programme or decide that the certificate will not be issued unless the student sits a new test or examination in the components to be determined by the Examination Board and in a fashion to be determined by the Examination Board.
5. Before taking a decision, the Examination Board will hear the student and any other interested parties. A report will be drawn up of this hearing, of which a copy is forwarded to the student. The Examination Board must notify the student of its decision without delay, which notification can be given orally if required but must in any event also be issued in writing. Furthermore, the student is informed of his right of appeal.
6. The Examination Board makes up a report of its decision and the facts it is based on.

Section 9 Examination Board, appeal

Article 33 Examination Board

1. The institute director establishes an Examination Board for each study programme or group of study programmes.
2. The Examination Board's duties and responsibilities are laid down in the WHW. *(Sections 7.12, 7.12b and 7.12c of the WHW).* These include the following duties and responsibilities:
   - responsibility for guaranteeing the quality of testing;
   - responsibility for guaranteeing the quality of the organisation of and the procedures surrounding tests and examinations;
   - to determine objectively and professionally whether a student has passed an examination;
   - to award certificates and the diploma supplement;
   - to determine alternative tracks;
   - to assess applications for exemptions and reviews and to award applications for special facilities;
   - to determine whether an interim examination has been conducted in a way other than that prescribed in the TER;

   The composition of the Examination Board can be found in the Appendix 'Composition of the central Examination board of Fontys school of Engineering, opleidingskamer master Digital Technology Engineering'.
3. An application to the Examination Board can be submitted via the following link: Examencommissie Engineering (see also Article 24(2) and Article 25).

Article 34 Appeals

Student who do not agree with a decision of the Examination Board can lodge an appeal against this decision within six calendar weeks after the date of the decision with the Examination Appeals Board via www.studentenloket.nl (see Articles 45 and 46 of the Student's Charter. *(Section 7.61 of the WHW.)* Students can contact the Student Counselling Office (iStudent@fontys.nl) for help on lodging an appeal.

Section 10 Retention and hardship clause

Article 35 Retention of documentation

1. The Examination Board is responsible for retaining the minutes of its meetings and its decisions for a period of seven years.
2. The Examination Board is responsible for retaining its issued statements, among others, the statement on departure of a student who terminates his enrolment without having passed the study programme's final examination, for a period of ten years.
3. The Examination Board will ensure that the following information on each student will remain in the institute's archives for 50 years:
   - information on whether each student has obtained a certificate of higher professional education including the list of marks.
4. The institute director is responsible for retaining test papers/assignments, assessment criteria, marking standardisation, pass marks, test matrices and test analyses for a period of seven years.
5. The institute director is responsible for retaining the lists drawn up and signed by the examiners containing the results achieved for a period of ten years.
6. The institute director is responsible for ensuring that all final papers and other kinds of tests in which students demonstrate their command of all aspects of the final attainment level, including assessments, will be kept for a period of seven years.
7. For the purpose of the external assessment of the programme in connection with accreditation, the institute director will ensure retention of a representative set of tests, including assessments, for a period of two years after the assessment.
8. The institute director is responsible for ensuring that the work completed by the student (written and non-written, including digital work) including assessments, with the exception of the work forming part of the representative set of final papers, is either destroyed or returned to the student after the expiry of a term of at least six months following the publication of the result. This term may be extended if necessary in connection with an appeal procedure.

Article 36 Hardship clause

1. The Examination Board can make provisions for serious injustices that occur as a result of the application of these rules; it can also make decisions in cases not provided for by these rules. In order to decide whether the hardship clause must be applied, the Examination Board must weigh the interests of the student concerned and those of the study programme. Cases requiring immediate action may be heard by the chairperson of the Examination Board or his deputy after which the other members must be notified as soon as possible.
2. Students must apply in writing, stating reasons, to the Examination Board for the application of the hardship clause in accordance with Article 44 of the Students' Charter. The Examination Board decides on the student's application and communicates this decision in writing, stating reasons, to the student concerned, who is also informed of his right of appeal.

Section 11 Final provisions and implementation

Article 37 Entry into force, amendments, publication and official title

1. The TER applies to all students enrolled in the study programme in question during the 2021–2022 academic year, *unless otherwise stated below*.
2. The general section of these regulations and any amendments thereto will be established by the Executive Board, after having obtained the consent of the students' section of the Central Participation Council. PC's will be given an opportunity to issue advice to the CPC. That general section of the TER constitutes the basis on which the study programme-specific TER for each study programme will be drawn up before being submitted to the Examination Board for their advice and the (joint) PC and IPC for their advice/consent. The (joint) PC advises the institute director and sends its advice to the IPC for informational purposes. The IPC advises the institute director and sends its advice to the (joint) PC. The establishment of and amendments to the study programme-specific TER are effected following a proposal from the institute and require the consent of the students' section of the competent IPC and the (joint) PC. (*see Sections 10.3c, 10.20 and 7.13 of the WHW.)*
3. The text of the TER can be amended if warranted by changes to the organisation or organisational components with due observance of the provisions of paragraph 4. In the event of an interim change, the procedure as described in paragraph 2 applies.
4. If the interests of an individual student are prejudiced as a result of interim amendments of the regulations, the student may submit a written application to the Examination Board to protest against the amendment of the rules. The Examination Board examines the student's application and bases its decision on a weighing-up of the interest of the individual student on the one hand and the interest of the quality of the study programme on the other.
5. The institute director adopts the study programme-specific TER before 1 June of the academic year preceding the academic year that starts on 1 September. He ensures the publication of the study programme-specific component of these regulations and any amendments thereto by making them available for inspection with the secretariat of the study programme and placing them on the website.
6. *The official title of these rules is 'Institutional Section of the Teaching and Examination Regulations of Fontys'*.
   The official title of the TER of the Master's programme is Master Digital Technology Engineering.

Article 38 Transitional provisions

When a study programme is subject to a substantial overhaul, the following transitional provisions will apply. After the last regular activities of the 'old' programme and the related test or examination have been completed, this test or examination will be held two more times by way of resits. After that, it will be decided which test or examination that is part of the 'new' programme the student must sit to replace the 'old' one.

Article 39 Unforeseen cases

The Examination Board decides in all cases not provided for by the study programme-specific part of the TER, unless the issue is covered by the institute director's competency.

B - Set-up of the study programme and support facilities

1. Set-up, organisation and execution of the study programmes

Information on the set-up, organisation and execution of the study programmes can be found in:

- *the study programme's digital prospectus*
- the Teaching and Examination Regulations (see under A).

2. Facilities for students

Information on facilities for students can be found at:

- the institutional section of the Fontys Students' Charter (www.fontys.edu/rules)
- the website of the Students Facilities Department (http://www.fontys.nl/studentenvoorzieningen
- the website of Fontys Study Abroad
- *the study programme's digital prospectus*

3. Study support

Information on study support can be found in:

- the Teaching and Examination Regulations (see under A)
- *the study programme's digital prospectus*

C - Internal complaints procedure

Students whose interests are directly affected by acts carried out by a staff member or a student against them, or who have a grievance regarding organisational matters, may lodge a complaint with the Executive Board, as described in Article 47 of the Students' Charter.

Attachment 1 Education profile

See Education profile Master DTE.

Attachment 2 Units related to learning outcomes and study load

Units of Study	Learning outcomes	Supportive courses	Study Load in hours (SBU)
Year 1	Digital Technologies - year 1	• Data retrieval, basic processing and data visualization • AI: hands-on machine learning and neural networks • Deep dive into data analysis: mastering the state-of-the-art	560
	Practice-based research – year 1	• Practice-based research - basic skills • Collecting & analyzing data • Communicating research results	336
	Systems Engineering – year 1	• Understanding perspectives in systems engineering • Designing a value proposition • Optimizing and improving product design in an organizational context	336
	Design Based Working – year 1	• Create and make choices • Design thinking • Human centered approaches	280
	Personal and professional identity – year 1	• Coaching line	168
Year 2	Integrated learning outcome ‘Sensing a local problem’	• Smart devices - sensoring & embedded software • Developing solutions: how to make a product successful • The bigger picture • Visualizing your process	420
	Integrated learning outcome ‘Preliminary research’	• Instructions & supervision	224
	Digital technologies – graduation level	• Supervision	308
	Practice-based research – graduation level	• Supervision	224
	Systems Engineering – graduation level	• Supervision	224
	Design Based Working – graduation level	• Supervision	168
	Personal and professional identity – graduation level	• Coaching line	112

Attachment 3 Assessment program

Year	Unit of study/ learning outcome	Name unit of study	EC	Naam toets	Naam v.d. toets	Examination	Individual or Group	Beoordelingsschaal	Weging toets binnen onderwijs-eenheid	Minimaal te behalen	ingangseisen
Year 1	DADT	Digital Technologies	20	DADTP1	Practical assignment Data-Pipeline with visualization	Practical assignment	Individual	1,0-10,0	1/4	5,5	Not applicable
				DADTP2	Practical Assignment Neural Network	Practical assignment	Individual	1,0-10,0	1/4	5,5	Not applicable
				DADTP3	Practical assignment Human Technology Interaction	Practical assignment	Individual	1,0-10,0	1/4	5,5	Not applicable
				DADTP4	Practical assignment Data Analysis	Practical assignment	Individual	1,0-10,0	1/4	5,5	Not applicable
	DAPBR	Practice-based research	12	DAPBRP1	Assignment Research proposal	Report	Individual	1,0-10,0	1/3	5,5	Not applicable
				DAPBRP2	Assignment Research Data analysis	Report	Group	1,0-10,0	1/3	5,5	Not applicable
				DAPBRP3	Assignment Research report	Report	Group	1,0-10,0	1/3	5,5	Not applicable
	DASE	Systems engineering	12	DASE	Portfolio assessment	Portfolio	Individual	1,0-10,0	1	5,5	Not applicable
	DADW	Design-based working	10	DADW	Portfolio assessment	Portfolio	Individual	1,0-10,0	1	5,5	Not applicable
	DAPPI	Personal and professional identity	6	DAPPI	Portfolio assessment	Portfolio	Individual	1,0-10,0	1	5,5	Not applicable
Year 2	DALP	Integrated learning outcome: 'Sensing a local problem'	15	DALPP	Practical assignment IoT-infrastructure: Digital Technologies	Practical assignment	Individual	1,0-10,0	35/100	5,5	Not applicable
				DALPR	Challenge report	Report	Group	1,0-10,0	65/100	5,5	Not applicable

	DAPR	Integrated learning outcome: 'Preliminary research'	8	DAPR	Design & research strategy	Report	Individual	1,0-10,0	1	5,5	All examinations of year 1 have been passed (with a grade of at least 5.5)
	DAGRAD	Graduation Project	37	DAGRADR	Graduation Report	Report	Individual	1,0-10,0	75/100	5,5	Not applicable
				DAGRADP	Launch: presentation and interview	Presentation & Interview	Individual	1,0-10,0	25/100	5,5	Not applicable

Attachment 4 Overview of all learning outcomes

curriculum matrix master digital technology engineering

Learning outcomes

final qualification	learning outcomes Year 1				
	Digital technologies year 1	Systems engineering year 1	Practice-based research year 1	Design-based working year 1	Personal- & professional identity year 1
1. Digital technologies	■				
2. Systems engineering		■			
3. Practice-based research			■		
4. Leading development		■		■	
5. Communication & teamwork			■	■	■
6. Personal- & professional identity					■

Learning outcomes Year 2						
Integrated learning outcome *'Sensing a local outcome'*	Integrated learning outcome *'preliminary research'*	Digital technologies *Graduation level*	Systems engineering *Graduation level*	Practice-based research *Graduation level*	Design-based working *Graduation level*	Personal & professional identity *Graduation level*
■		■				
■			■			
■	■			■		
■	■		■		■	
■						■
■						■

digital technology engineering

Year 1

learning outcomes + indicators	challenge 1 Courses				challenge 2 Courses				challenge 3 Courses				Year 1	assessment	credits (EC)
	Data retrieval, basic processing and data visualization	Understanding perspectives in systems engineering	Practice-based research basic skills	Create and make choices	AI, hands-on machine learning and neural networks	Designing a value proposition	Collecting & analyzing data	Design thinking	Deep dive into data analytics: mastering the data-driven future	Optimizing and improving product design in an organizational context	Communicating research results	Human centered approaches	Coaching		
digital technologies You have hands-on experience with a number of present-day technologies and understand their application in business processes and know how to integrate them in a new design or existing system. You can evaluate the use of digital technologies from practical and expert examples and scientific literature.															
1 You can describe digital technologies (basic working principles and their fields of application), also considering ethical consequences and sustainability aspects resulting from the use of these technologies.	■				■				■					4 practical and written assignments	20 (4 x 5)
2 You can design, implement, test and validate basic digital technology solutions (a data acquisition, processing and visualization system, a working NN or ML algorithm) based on literature comparison and performance measurements and expectations.					■				■						
3 You evaluate other people's work, you can find academic writing on digital technologies, you use these sources to explain your work, by using correct references.									■						
4 For every digital technology solution, you (co)create, you can explain the ethical considerations and ethical implications for businesses and society.	■				■				■						
practice-based research You are able to conduct a small-scale practice-based research in an increasingly complex context, answering research questions and using research methods that are relevant in the digital technology integration process. You set-up and conduct your research according to the research cycle, and you use the outcomes of your research to strengthen the digital technology integration.															
1 You formulate research questions, select a relevant type of study, make an informed decision about the set-up of the research design, considering research ethics.			■				■				■			3 written assignments	12 (3 x 4)
2 You autonomously conduct the research in accordance with your research design, you analyse and interpret the data, and report the results.							■				■				
3 You reflect critically on the validity and reliability of the research, and its value for your digital technology solution and the involved stakeholders.											■				
systems engineering You use the separate themes of high-end systems engineering (marketing, success factors and development strategy) to determine what you will design. You are able to substantiate and transfer the value of your design in a complex context.															
1 You determine the success factors of your product design by using functional design, modular design, ethical design and circular design.		■				■				■				portfolio	12
2 You make substantiated choices regarding marketing at product level being the 4 P's (product, price, place, promotion) and the relevant markets of your product (local, regional, national, international). Based on these choices, you (re)formulate the design criteria for your product.										■					
3 When designing products for the solutions in the challenges, you determine the unique selling points of the solutions, do competitor research and calculate the price-performance ratio.						■				■					
4 You use the results of analyses of the complex context to create value propositions and business models for your digital technology solutions.		■				■				■					
design-based working You can contribute to the digital technology integration process, using the design-based working approach.															
1 You use a design-based working approach when designing solutions for problems in an increasingly complex context.				■				■				■		portfolio	18
2 You contribute to the design process by executing creative multi-disciplinary sessions.												■			
3 You use lo-fi prototypes and make an iteration based on user tests.				■				■				■			
personal- & professional identity Based on your unique professional identity, you consciously and respectfully make use of the international, cultural and interdisciplinary uniqueness of others while collaborating. You can use your learning strategy in a self-directed way to accomplish learning goals.															
1 Based on your personal background, talents and limitations, you take ownership of the innovation process and perform specific tasks in this process.												■		portfolio	9
2 You approach and analyze a situation from at least two social-economic, political and cultural perspectives, consciously and respectfully discovering the diversity and uniqueness of your team members.												■			
3 You take ownership of the company assignment, act as a team player, while accomplishing the assignment's goals. You take the perspectives of multiple involved stakeholders into account, when designing the solution of the company assignment.												■			

digital technology engineering

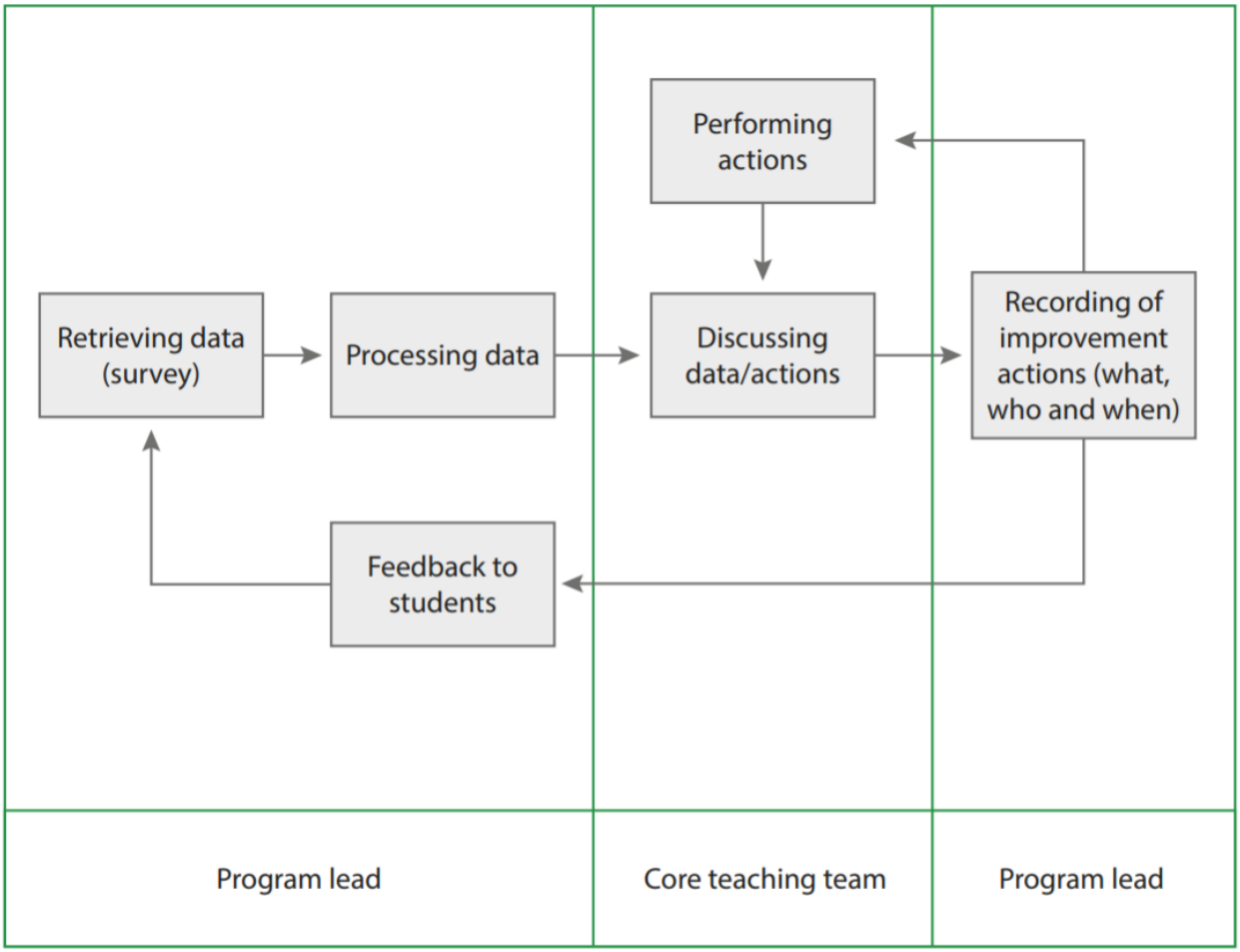
Year 2

learning outcomes + indicators	challenge 4 Courses			preliminary research Course	graduation project Course	Year 2	assessment	credits (EC)
	Stimulating & embedded outcome	Developing a problem, how to make a product successful	Visualizing your process	Instructions & supervision	Supervision	Coaching		
integrated learning outcome 'Xensing a local problem' You can analyze a highly complex problem within a societal context and design a digital technology-based solution to this problem. You integrally use the knowledge and skills acquired in the first year of the master to develop a smart system infrastructure that meets your value proposition. You are able to work on the basis of your own core values and match these with the stakeholders.							practical proof and assessment & design report	15
1 You can develop, or integrate, digital technology to implement a smart system infrastructure (IoT devices, AI technology, robotic and domotic systems).	■							
2 You integrally design the value proposition and a plan for implementation or scale-up for your digital technology solution.		■						
3 You analyze and compare different theoretical frameworks. You select an appropriate framework and use it to make informed choices regarding your design process.			■					
4 You choose the right communication channels for communicating your design process to stakeholders using appropriate visualizations.				■				
5 You take responsibility for the tasks and responsibilities related to your professional role, taking into account your unique identity, background, talents and limitations.						■		
integrated learning outcome 'Preliminary research' You conduct preliminary research on your graduation project to get better understanding on what types of scientific literature is available with the aim to construct a design process and a corresponding research strategy in outline for your graduation project.							design & research	8
1 You can identify relevant literature studies for the development of digital technologies and evaluate the use of state-of-the-art solutions for your project.				■				
2 You can conduct multidisciplinary preliminary studies to (re) design and transfer an innovative system in a complex context.				■				
3 You can construct a conceptual research strategy and can reflect critically on the validity, reliability and value of state-of-the-art literature.				■				
4 You can set up a design-based working approach for solving highly complex problems.				■				
5 You can describe your competences and learning needs and show commitment to specialize yourself in the tasks and responsibilities that belong to your professional role in the graduation project.						■		
digital technologies – graduation level You use your specialized knowledge and understanding of digital technology to contribute to digital technology integration in practice. You synthesize state-of-the-art scientific research on digital technology to increase your knowledge and understanding of digital technology integration. You evaluate the impact of different technologies on humans and society.							graduation report & conclusive board interview	37 (30 report & 7 interview)
1 You use your specialized knowledge and understanding of digital technologies to effectively contribute to the development of a digital technology solution in a design-based project, taking ethical and sustainability aspects into account.					■			
2 You are able to (re)design or extend solutions by using digital technologies (such as real-time data obtained from different sources (craft- to sensors, online platforms and databases).					■			
3 You are able to (re)design or extend solutions by using digital technologies (such as IoT and AI) and synthesizing state-of-the-art research.					■			
4 You conduct a technology impact assessment, in which you analyse the impact of a future digital technology product on stakeholders, society and the environment.					■			
practice-based research – graduation level You are able to conduct small-scale practice-based research in a highly complex context, answering research questions and using research methods that are relevant in the digital technology integration process.								
1 You can implement an appropriate theoretical framework in your research project.					■			
2 You use the research and its outcomes to inform the design process and decisions and strengthen the integration of digital technology.					■			
systems engineering – graduation level You have insight into the total of external factors which are critical for the successful development of your digital technology solution, and you are able to translate those factors into design criteria. You integrally use high-end methods of systems engineering for product development, to technically design an integrated digital technology solution with a value proposition and a plan for implementation or scale-up.								
1 You make a strategy plan including modular production, make or buy decisions, cost price calculations and reliability studies.					■			
2 You make substantiated choices for the development of your integrated digital technology solution, based on the analyses of all the business model elements in a complex context.					■			
3 You use all themes of high-end systems engineering (marketing, success factors and development strategy) to technically design a feasible and sustainable developed xensive solution. You explain the reasoning for choosing that solution above others.					■			
4 You develop plans on how the integrated digital technology solution can be implemented or scaled up, and what is needed to accomplish this.					■			
design-based working You can play a leading role in the digital technology integration process with a design-based working approach.								
1 You apply a design-based working approach when designing solutions for highly complex problems.					■			
2 You use lo-fi and hi-fi prototypes and make multiple iterations based on customized methods of testing with users and other relevant stakeholders.					■			
personal & professional identity As a self-directed professional, you adapt your role as digital technology engineer, and you develop yourself to meet the expectations of the professional community. As a team player, you approach a multidisciplinary and international project from a diversity of perspectives.								
1 You describe your competences and learning needs and show commitment to specialize yourself in the tasks and responsibilities within the technological assignment. You continuously reflect on the execution of your work, improve yourself and show the professional behaviour that is needed to achieve these goals.						■		
2 You take ownership of your future professional role within the graduation phase, taking into account your unique identity, background, talents and limitations.						■		
3 Being a valuable part of an international multidisciplinary team, you analyze a situation from multiple (socio-economic, political and cultural) perspectives, respectfully taking into account the diversity of the organization and its stakeholders.						■		

Attachment 5 Composition of the central Examination board of Fontys school of Engineering, opleidingskamer master Digital Technology Engineering

De centrale kamer	
Voorzitter (een van de voorzitters van de kamers)	Jan van der Linde
Lid en plaatsvervangend voorzitter (een van de voorzitters van de kamers)	Fieke Geurts
Lid en secretaris (een van de voorzitters van de kamers)	Wim Broekman
Lid (een van de voorzitters van de kamers)	Edgar van de Laak
Extern lid (van buiten de 4 opleidingen).	Vacature
Ambtelijk secretaris (medewerker onderwijsbureau), medewerker is geen lid van de examencommissie	Esther van den Berg-Wolfs
Kamer Automotive met de lesplaatsen Helmond en Eindhoven	
Voorzitter kamer Automotive	Edgar van de Laak
Secretaris kamer Automotive	Resi Fuchs
Lid, opleidingsdeskundige voltijdopleiding en plaatsvervangend secretaris van de kamer Automotive	Rob Gulikers
Lid en plaatsvervangend voorzitter, opleidingsdeskundige Voltijdopleiding	Ted Wonders
Ambtelijk secretaris (medewerker onderwijsbureau opleiding Automotive, gecombineerd met lidmaatschap examencommissie, secretaris).	Resi Fuchs
Kamer Elektrotechniek	
Voorzitter kamer Elektrotechniek	Jan van der Linde
Secretaris en plaatsvervangend voorzitter kamer Elektrotechniek	Henk Mandemaker
Lid, opleidingsdeskundige voltijd NL-talig en plaatsvervangend secretaris van de kamer Elektrotechniek	Peter van Kollenburg
Lid, opleidingsdeskundige deeltijd NL-talig	Tekin Yilmaz
Lid, opleidingsdeskundige voltijd Engelstalig	Willem-Jan Verkerk
Ambtelijk secretaris (medewerker onderwijsbureau opleiding Elektrotechniek), geen lid examencommissie).	Tilly van Berlo
Kamer Mechatronica:	
Voorzitter kamer Mechatronica	Fieke Geurts
Secretaris en plaatsvervangend voorzitter kamer Mechatronica	Chris Remmers
Lid, opleidingsdeskundige voltijd en plaatsvervangend secretaris van de kamer Mechatronica	Paul Goede
Lid, opleidingsdeskundige voltijd Engelstalig	Eric de Haas
Ambtelijk secretaris (medewerker onderwijsbureau opleiding Mechatronica), geen lid examencommissie).	Esther van den Berg-Wolfs
Kamer Werktuigbouwkunde:	
Voorzitter kamer Werktuigbouwkunde	Wim Broekman
Secretaris en plaatsvervangend voorzitter kamer Werktuigbouwkunde	Karin van Krijl
Lid, opleidingsdeskundige voltijd Engelstalig en plaatsvervangend secretaris van de kamer Werktuigbouwkunde	Esther Vinken
Lid, opleidingsdeskundige	Ton Gielen
Lid, opleidingsdeskundige deeltijd	Jan van Schijndel
Ambtelijk secretaris (medewerker onderwijsbureau opleiding Werktuigbouwkunde), geen lid examencommissie	Gisela Greijmans
Kamer Toegepaste Wiskunde:	
Voorzitter kamer Toegepaste Wiskunde	Bas van der Wulp
Lid	Jasmina Dahou
Lid	Jean Paul van Leeuwen
Lid	Charlotte Vergouwe
Kamer Master Digital Technology Engineering	
Voorzitter	Lorna Minkman
Secretaris	Sandra Bedaf
Lid	Steffie Ballemans

Attachment 6 Quality Cycle



Data is retrieved at 6 moments:
1) After ‘challenge 1’ (student)
2) After ‘challenge 2’ (student)
3) After ‘challenge 3’ (student)
4) After ‘challenge 4’ (student)
5) Halfway through the ‘graduation project’ (student & work field)
6) After the ‘graduation project’ (student & work field)

Data can be retrieved by means of a survey conducted by the program lead. These data are first processed and made ready to be discussed. In a team context, the improvement actions are carried out and recorded.

1) What must be done?
2) Who carries out the action?
3) When is the action ready?

Monitoring results with KPIs
The continuous improvement cycle must lead to the maintenance attitude or improvement of the elements quality, team performance and organization performance. The following objectives have been defined.

1) Student satisfaction of each course of at least 3,5 out of 5.
2) Student satisfaction of each challenge of at least 3,5 out of 5.
3) Student satisfaction of each teacher of at least 3,5 out of 5.
4) MTO satisfaction of at least 4 out of 5.
5) Study feasibility of at least 3,5 out of 5.
6) Work field satisfaction of at least 3,5 out of 5.

Appendix 1 - Education profile

Master Digital Technology Engineering

Professional Master
Digital Technology Engineering

Education profile

Authors:
Peter Biekens (project leader Master, Pulsed FHENG)
Jochem Goedhals (program leader Pulsed FHENG)
Bart Rooseboom (educationalist/examination expert FHBeNT, Pulsed),
with the cooperation of Sylvia Haerkens van den Brand (Quality management consultant, Service O&O)
Mariëlle Taks (Education innovation consultant, Service O&O)
Judith van den Kerkhof (consultant Service O&O)
Status: Final version
Datum: 16 April 2021

Preface

This educational profile describes the educational framework of the Master Digital Technology Engineering. This professional Master's program will be developed and implemented at the discretion of Fontys School of Engineering.

The educational profile forms the basis for the design of the program, the design of the collaboration with stakeholders (companies, non-profit institutions, lecturers/researchers) and the reporting to the Accreditation Organization of the Netherlands and Flanders (NVAO) for the initial accreditation *Toets Nieuwe Opleiding* (TNO).

Table of contents

1. Developments and trends affecting the professional field

1.1 Introduction

There are a number of large, complex developments taking place in the world, such as climate change, infectious diseases, overpopulation, declining biodiversity, and the exponential growth of technology. The latter development in particular has a direct impact on the Brainport region. The exponential growth of technology manifests itself in the rise of the smart society, in which companies, politicians and residents make data-based decisions that enable us to continuously improve results in the areas of economic prosperity, social welfare, environment and good governance [1]. The relationship between humans, nature and technology is changing, with technology becoming a force of nature in itself and moving towards ever more autonomy and is less under our control [2].

As a result of these developments, the problem we are addressing is the digital transformation and how companies, organizations, people, and society must deal with it. The digital transformation involves the use of new, fast, and often changing digital technologies in combination with the more familiar traditional mono-engineering disciplines to solve problems and challenges and create opportunities [3]. Both technical and non-technical companies are confronted with the same challenges regarding digital technology: how does one deal with a high degree of uncertainty, complexity, interdependency, and adaptations that the application of digital technology requires?

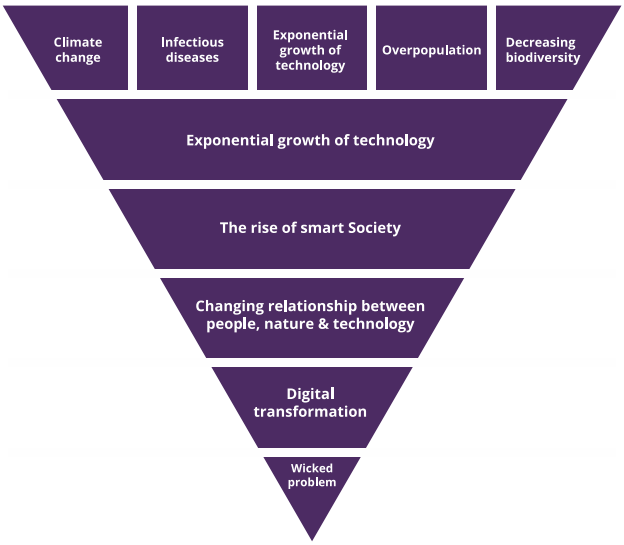


Figure 1. Consequences of exponential growth of technology

The digital transformation in itself can be labelled as a *wicked problem*. Wicked problems are defined as highly interdependent, multi-causal, unstable and socially complex [4]. Companies in the Brainport region have indicated that the emphasis for them lies or will lie on digital technology, both in the innovation of their existing products and/or services and in the change of their internal production and organizational processes.

It is important to realize that technology alone is not the ultimate solution for digital transformation. Investing in the right technology is crucial but attributing too much importance to the role and performance of technology in digital transformation is an obstacle to success. Research has shown that the most successful projects go beyond the role of technology in

digital transformation, considering the role that people, processes and partnerships have played in making it effective [5].

The digital transformation and the challenges and opportunities posed by digital technology apply in particular to the following labor market segments within the technical domain:

1. Tech companies that focus on the application of digital technologies because the core of their activities is the creation of solutions with the help of new digital technologies.
2. Tech suppliers (implementation and integration of knowledge, products, services) that focus on tech (and non-tech) companies, because the core of their activities is to set the direction and content for the technological developments of the customer in an interdisciplinary way.
3. Non-tech companies, which are increasingly affected by the digital technological developments in their sector, given how they are increasingly dependent on technical people who, in a non-technical environment, can set the direction and content for the technological developments in their organization in an interdisciplinary way.

The Master's graduates are able to help the above companies and organizations meet and manage the complex challenges posed by digital transformation and the use of new and fast changing digital technologies. To become the professionals capable of doing this, the Master's provides them with training in the application of integrated solutions and systems approaches, while leveraging existing digital technologies. They learn to go beyond the role of technology in digital transformation and doing so making it effective, by considering and working with the role that people, processes and partnerships play. The program does this in combination with systems engineering, practice-based research, leading development, and personal & professional identity. The Master's graduates know how to deal with a high degree of uncertainty, complexity, interdependency, and adaptations that the application of digital technology requires. Graduates with a technical bachelor's degree in engineering or ICT can enroll in the master's program, as there is a need within the engineering field for technical experts with additional knowledge and skills in digital technologies, like data and AI.

The following developments and trends are influencing the labor market and the professionals required to tackle the problems of digital transformation. But first, the concept of wicked problems will be addressed.

1.2 Wicked problems and small wins

Considering the role that people, processes and partnerships play in the digital transformation, it is crucial to understand the definition and the impact of a wicked problem on organizational processes and society. As originally defined by Churchman (1967) and Rittel and Webber (1973), wicked problems refer to a class of social problems that are ill-defined and continuously changing; where many actors are involved with conflicting values; and where, because of the high levels of interconnectivity, today's solutions often turn out to be tomorrow's problems.

The evaluation of wicked problems inevitably involves a paradox of trying to judge solutions for problems that have 'no solutions' and for which 'additional efforts might increase the chances of finding a better solution' (Rittel & Webber, 1973, p. 162).

Therefore, Termeer and Dewulf have developed an evaluation framework that fits into this perspective, consisting of three steps [6]:

1. Identifying and valuing small wins.

2. Analyzing whether the right propelling mechanisms are activated to accumulate into transformative change.

3. Organizing that results feed back into the policy process where they, in turn, activate new small wins.

The concept of small wins is an essential element in this framework, and can be characterized as follows:

Characteristic	Indicator	Contra-indicator
Concrete outcomes for in-depth changes	Visible results	Promises and ideas only
Moderate importance	Second- and third-order change	More of the same
Positive judgement	Radical new practices	Quick wins
	Micro or local level	Low hanging fruit
	Intermediate	Large scale
	Improvement	Best practice
	Step forward	Small loss for many actors
	Related to shared ambition	

Table 1. Characteristics and indicators of small wins

- Small wins refer to concrete outcomes that can be verified;
- Small wins are examples of in-depth change and have an impact on a change in beliefs and values;
- The steps are located at a micro or local level that allows people to get in contact with the complexity of the wicked problem behind the small win.

The framework presented above for wicked problems and small wins aligns seamlessly with the complex challenges of digital transformation, which are the focus of this Master's program.

1.3 Digital technology

The need to solve new problems

Digital transformation and technology are impacting all industrial sectors, leaving no one immune. There are many issues arising from this transformation, such as the impact of robotization on the labor market. There are also many sectors where technology offers new solutions, such as the numerous applications of technology in healthcare [6].

What does this mean for the professional field?

Many tech companies currently face the challenge of taking advantage of the many social and economic opportunities offered by new technology. The reasons for this can vary, for example: positive economic developments are the order of the day, the company is too small to be able to invest in them, technological developments are too rapid to be able to embrace them, the staff and company are not sufficiently equipped to seize technological opportunities in a creative way and in a responsible manner. Technology is not an end in itself but is necessary to solve problems and support societal innovation. On the other hand, new technological solutions generate their own novel problems. Therefore, it is crucial that future

engineers are able to not only solve existing problems, but even prevent future problems from occurring.

The following trends are emerging

- More and more products and services operate on the basis of artificial intelligence;
- In the smart workplace of the future, everything and everyone is connected [7);
- On-demand society demands human-centered design [8];
- The Internet of Things (IoT) will continue its impressive growth beyond 2019. The IoT has a total current economic impact of $3.9 trillion a year and is expected to rise to $11.1 trillion a year by 2025 [9]
- More and more attention is being paid to moral and ethical dilemmas related to artificial intelligence and robotics [10];
- It is increasingly becoming a prerequisite for governments and companies to be technologically 'vigilant' in the world of today and tomorrow.

From their personal and professional identities, graduates of the Master's program have an attitude of continually learning and keeping up with trends and developments in digital technology and of delving into its applications in various contexts.

1.4 Sustainability

Sustainable Developments Goals

Today, humankind faces enormous challenges, such as climate change, mass urbanization and the exponential growth of technology, with all its myriad consequences. The most urgent global challenges of our time are expressed in UNESCO's 17 Sustainable Development Goals, or the 2030 Agenda [11]. The pursuit of these goals calls on all kinds of partnerships between countries, organizations, and people to find a balance between the three dimensions of sustainable development: economic growth, environmental sustainability, and social inclusion. The 17 Sustainable Development Goals form a universal and integrated set of global ambitions that the world has committed itself to achieve by 2030.

What does this mean for the professional field?

Acting in a socially responsible manner is becoming increasingly a matter of course. The professional field has a special role in relation to global sustainable development. This role means, among other things, that it acts in the interest of conserving natural resources, and that it seeks out or finances profitable business opportunities that contribute to sustainable development. For this reason, it is important for the professional field to find new solutions to issues such as clean technology and healthcare. The professional field also has the potential to find value-creating business opportunities, such as stimulating and participating in social entrepreneurship and impact investment [12].

The following trends are emerging

- A global economy that increasingly focuses on environmental technology to protect our planet.
- Many companies are working on innovative green technologies that can reduce carbon dioxide in order to live more sustainably.
- A new economic approach such as a shared, experienced, meaningful donut economy and circular economy.
- Creative entrepreneurship with a focus on co-creation.

- Consumer expectations of sustainable production and products will drive the marketplace; there will be job growth in sustainable processes and emerging industries around sustainability.

Master's graduates use integrated solutions and systems approaches, so that sustainability aspects and related value-creating business opportunities, are considered and implemented within the innovation and making process.

1.5 Internationalization

Multi-deployability in an internationally oriented region
Societies, regions, and organizations are internationalizing as a result of rapid global changes that have direct impact on their local context. Multiculturalism in society as a result of knowledge immigration and growing diversity within organizations, is introducing new opportunities and challenges [13]. Knowledge and skills are becoming less relevant if employees do not have international competencies, which is particularly relevant in the technological domain within the Brainport region [14].

What does this mean for the professional field?
A culturally diverse working environment develops within the walls of local organizations. This leads to more complex management and requires a different form of cooperation and communication with and within teams. A gap has arisen between the skills, mindset and knowledge of professionals and the changing needs in the technological sector due to an increasingly complex context in which they work. Not only have the organizations become multinational, but this also applies to the stakeholders of the production chains and the end users.
Transversal knowledge, skills and competencies of professionals are crucial. Intercultural communication skills and sensitivity, understanding different perspectives and the development of world citizenship are an essential part of the multi-employability of employees within the sector. From a broader perspective, it can be said that the innovative business community, as well as education, NGOs and the government play an important role in working on UNESCO's Sustainable Development Goals. A new theme here is how value chains of products or services must be changed in order to respond to the globalizing world [15].

The following trends are emerging
- Recruiting international talent (knowledge immigration) to the Netherlands, one of the top 5 knowledge economies worldwide.
- Developing world citizenship.
- Cooperation between the government, the professional field, NGOs, and the education sector in order to achieve social goals.

Master's graduates have an open mindset and international outlook, know how to work together in an intercultural work setting and are able to transfer their own disciplinary knowledge, insights, and experiences to other stakeholders within an intercultural and multidisciplinary context.

1.6 Adaptive capacity of the professional field

Adaptability and lifelong learning

As a result of developments in the fields of artificial intelligence and robotics, robots are not only becoming increasingly intelligent, they are also becoming cheaper and more reliable than ever. The industrial revolution has made our physical strength superfluous; the digital revolution is taking over our thinking. On top of this, the challenges for the professional field are becoming increasingly complex, as indicated above [16]. Moreover, new solutions are also generating new problems. In order to meet these challenges, technology can be used to make our work more enjoyable and interesting. An important condition, however, is that both people and organizations have the ability to adapt quickly and embrace life-long learning in an agile way.

What does this mean for the professional field?

In order to succeed in a professional field that is becoming increasingly dynamic, professionals must be agile lifelong learners and become self-directed learners as well. That means being comfortable with continuous adaptation and not only willing to move to other sectors, but also willing to take the lead in their own career development. When one profession becomes obsolete - a change that can take place almost overnight - professionals should be able to move easily from one profession to another. On the other hand, organizations should be able to respond flexibly to new technological developments that affect their business operations, the labor market or the organization's revenue model.

The following trends are emerging

- It is estimated that 65% of children entering primary school today will end up in jobs that do not yet exist (e.g. cybercrime detective, organ designer, data waiter) [17]
- Other forms of organization are arising (e.g. holacracy) in which there is a shift from vertical leadership to horizontal leadership
- Job crafting: the professional creates or restructures his own job

Master's graduates are self-directed professionals who take ownership of their own learning and work ethic.

2. The digital technology engineer

In this chapter, we describe the digital technology engineer we are training: our 'promise' to the professional field.

2.1 Digital technology engineers are...

Engineers who are results-oriented by applying integrated solutions and systems approaches, while leveraging existing digital technologies to deal with a high degree of uncertainty, complexity and interdependence that the application and integration of digital technology requires. This integration takes place both in the innovation of existing products and/or services and in the change of internal production and organizational processes. They have the inquisitive ability to systematically shape the design process by practice-based research. They take the lead in implementing and integrating digital technology solutions in their own organization and its eco-system, so that their market position is maintained or strengthened. They combine both hardware and software solutions using existing digital technology, such as AI. In this process, they know how to include the various stakeholders in the organization. Lastly, they go beyond the role of technology in digital transformation and doing so making it effective, by considering and working with the role that people, processes and partnerships play.

Digital technology engineers:

- Take a leading role in integrating digital technology solutions in the organization;
- Are able to collect, analyze and evaluate sources (theory, experiences), and know how to fully understand and synthesize this knowledge into new ideas for tackling complex problems posed by the digital transformation;
- Know how to analyze, investigate, communicate, and contextualize solutions and the change process;
- Combine both hardware and software solutions and using existing digital technologies, such as AI;
- Are able to frame problems with stakeholders and work on solutions from there;
- Are able to transfer their own disciplinary knowledge, insights, and experiences to other stakeholders such as colleagues, management, collaboration partners, customers, and users;
- Are able to empower the expert looking at the applicability of technology solutions rather than just looking at improving the technology;
- Possess personal, connecting, entrepreneurial, systemic and integration skills;
- Have a critical, reflective, and practice-oriented research mindset, with a drive for 'lifelong learning';
- Have an open mindset and international outlook and are able to collaborate effectively in intercultural and multidisciplinary teams;
- Recognize the ethical dimension of technology and its relationship to social questions and sustainability issues. They work in a business-oriented manner on the development of sustainable and future-oriented products and organizations;
- Take ownership for their own learning and work ethic; creative and enterprising. They are aware of their own role and responsibilities and know how to act ethically.

2.2 Tasks of the digital technology engineer

The core promise, and the developments and trends, lead to a number of important tasks that await digital technology engineers. These are:

- Proactively contribute to the strategy and development of an organization: from developing technology to developing integral solutions in which digital technology adds value;
- Supporting policy-making with the help of data and solution directions;
- Guiding end-to-end processes (idea to product) and creating new value propositions (product to market);
- Creating new value propositions (idea to product);
- Applying an integrated solutions and systems approach while leveraging existing digital technologies to find new solutions for complex problems (idea to solution);
- Structuring the organizational process of digital transformation within their own context;
- Collaborating with and connecting experts from different (technical) disciplines;
- Analyzing the impact of the use of digital technology on people, society, and the world.

Digital technology engineers are trained in dealing with complex organizational and/or social issues with the help of digital technology, in order to fulfil these tasks. The following are three examples of a work context in which the digital technology engineer may work.

1. Structuring the transformation of an organization into a Solution Company by means of digital technology.

   In this position, digital technology engineers are the ones who proactively contribute to the organization's strategy change. This involves a change from inventing technology to developing integral solutions in which digital technology plays an important role. Thus, they are also well aware of the relevant ecosystems for the company and its stakeholders, ensuring they can make well-balanced choices. They collaborate in a multidisciplinary team in which various technical and non-technical experts are represented. In their role, they will be able to connect with them on both process and content levels and will be able to translate the impact of engineering choices to a higher level of abstraction.

2. Leading the end-to-end process from idea to product, and product to market with (a) new value proposition(s) in the field of digital technology.

   In this position, digital technology engineers can maintain a broad scope on a digital technology project from start to finish and map out everything that is needed to create a workable solution, process, or approach. They are able to plan and monitor a development process with objectives and key results and give feedback to a steering committee on its status. This means that they not only take responsibility for their own work, but also for work by others on their team. In short, they speak both management language and engineering language. The following activities will be part and parcel of their job. Analyzing the problem or business opportunity and designing the initial value proposition for the product/service. Creating an overview of the costs of the product/service and taking this into account when making choices about materials and processes. Developing plans on how the product can be implemented or scaled up, and what costs and resources are needed for this.

3. Applying an integrated solutions and systems approach while leveraging existing digital technologies to find new solutions for complex problems.

In this position, digital technology engineers will be responsible for the further development of existing products and processes based on digital technology. This means that they are looking for new forms of automation in which existing digital technology solutions (hardware and software) are integrated. In addition, they will be able to identify success and risk factors in a timely manner and map them out for the management team. Their digital technology knowledge is broad and deep enough to work with the experts and factor the non-digital technology expert professionals into the equations. They can quickly and effectively connect to both digital technology experts and other related technical disciplines, such as applied mathematics, electrical or mechanical engineering. They have enough depth in the field of digital technology to be a serious discussion partner for the experts, but they are also able to approach the issue from a systemic approach, connecting the other disciplines. The following activities are part of the job. Analyzing the impact of a technological solution that uses digital technology, considering ethical and sustainability aspects. Making well-considered decisions about which applications of digital technology are relevant for which situation, based on their experience and research. Reporting insights and findings in a methodologically sound way. Performing a technology impact assessment, in which the impact of a particular technological solution on stakeholders, society and the environment is analyzed.

2.3 Positions of the digital technology engineer

Possible entry-level positions for digital technology engineers are:

- Test engineer
- Business process analyst
- Process engineer
- Production engineer
- Design engineer

Possible advancement positions for digital technology engineers are:

- Product owner
- Project manager/coordinator
- Improvement engineer
- Process improvement engineer
- Project lead NPI
- NPI production engineer
- LAB production engineer
- Principal scientists/fellows
- Operations researcher
- Field support engineer
- Supplier engineer
- Logistics & supply chain engineer
- Operations & maintenance lead engineer
- Customer support engineer
- Sustainability officer
- Product-market developer

3. The digital technology engineer in action

How do digital technology engineers fulfil the assignment from the previous chapter? What exactly do they do to fulfil the core promise? This chapter is dedicated to the digital technology engineer in action. In other words, the actions this professional performs are based on the T-shaped professional model and the professional products he delivers are based on the concept of design thinking. You will read about the knowledge, skills and mindset they acquire during the program.

3.1 The T-shaped professional

The digital technology engineer is a type of professional that can be described through the T-shaped professional model. The horizontal bar of the T represents a breadth of expertise, an ability to engage with other experts across a variety of systems and intellectual and disciplinary cultures; the vertical part of the T represents a depth of expertise in a specific knowledge domain. Companies are calling for these T-shaped professionals with in-depth knowledge of one discipline and a broad knowledge base in adjacent areas, like practice-based research, or in general business or entrepreneurial fields [18].

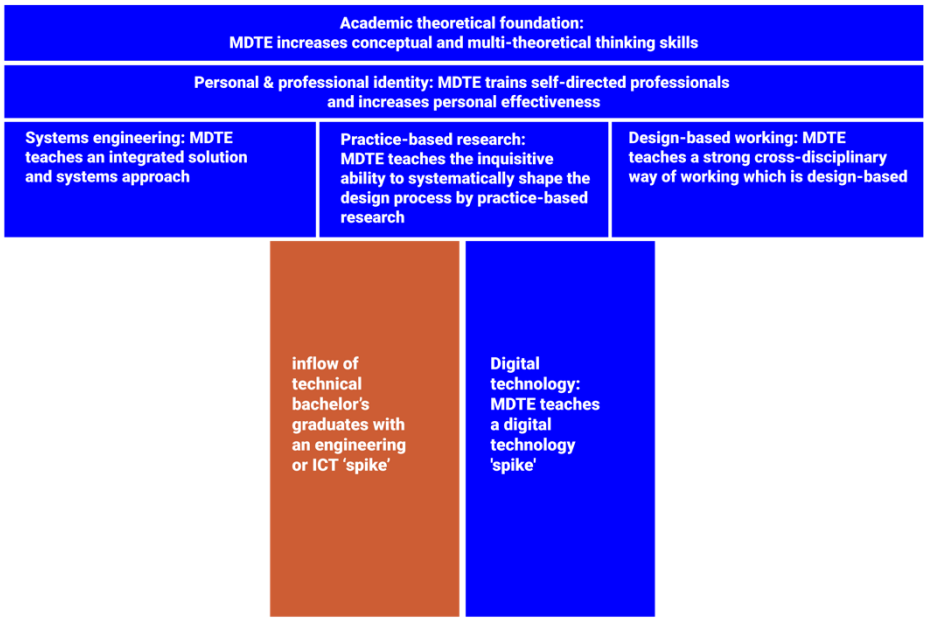


Figure 2. T-shaped professional MDTE

The conceptual frameworks that complement the T-shaped expertise are scholarship on engagement, interactional expertise, socio-technical integration, and trading zones [19]. In short:

Engagement: refers to the intentional inclusion of individuals representing diverse populations and related communities in the decision-making processes. It can systematically bring to bear a diversity of perspective on problem-solving.

Interactional expertise: describes the ability to speak the language of another discipline without being a practitioner. T-shaped expertise includes understanding not only more than one

discipline but also more than one system and incorporates the acquisition of communication skills. Furthermore, how those different disciplines and systems relate or can relate to each other.

Socio-technical integration: it is a type of integration that involves bringing together diverse disciplinary persons and perspectives in a process that results in reflecting on each other's actions, beliefs, and assumptions, thereby opening up new possibilities.

Trading zones: It allows for the exchange of knowledge and solving problems that transcend traditional disciplinary boundaries. Participants in the trading zone have the ability to share knowledge rapidly when one or more members have interactional expertise.

3.2 Digital technology engineer in action

Taking into account all the above, the digital technology engineers work in a human-centered design-based way. This means that their actions are based on the design-based working (DBW) concept, regardless of the assignment and context in which they operate.

The digital technology engineer is able to act on complex challenges. These complex challenges are embedded in our social systems, making it necessary for the future technology professional to have a systemic approach to solving them [20]. In addition to the design approach, they have the inquisitive ability to systematically shape the design process by practice-based research. Furthermore, a high focus on stakeholder involvement is necessary [21].

The digital technology engineers' purpose for designing is not to create a particular product or outcome and implement it in a specific context, but to create designs that can facilitate or support initiatives and opportunities for change. This means that they are still able to develop products, but it is not so much about the products themselves, but rather about the possible long-term impact that their design can have.

Design-based working isn't a subject or a topic or a class. It is a way of solving problems and an iterative process that encourages risk-taking and creativity. Design-based working is a flexible framework for getting the most out of the creative process [22]. It is about creating designs (systems/processes/products/services) that can facilitate or support initiatives and opportunities for change.

For the master's graduate, design-based working is a very appropriate way to approach problems, and one that challenges them to think of and apply new solutions that have never been tried or thought of before. It is an overarching design method that actually transcends and integrates specific design methodologies (specific to each discipline). It is precisely this discipline-transcending methodology that enables the master's graduate to fulfill an integrator function.

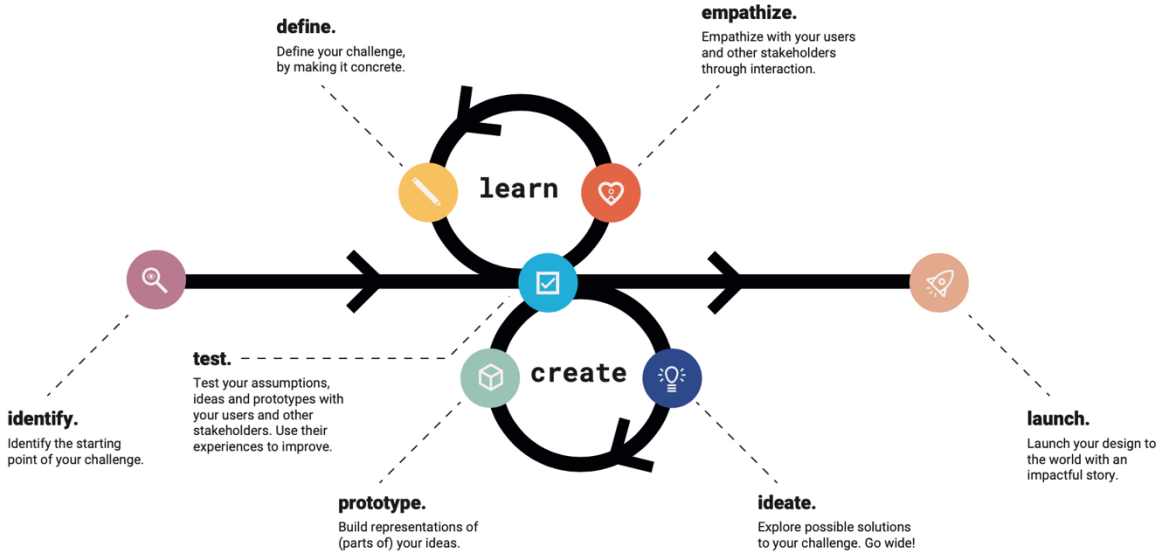


Figure 3. Design-based working concept

3.2 Knowledge & skills

The table below contains an overview of the body of knowledge & skills (BOKS) dealt with in MDTE.

BOKS
Data retrieval, basic processing and data visualization
AI: hands-on machine learning and neural networks
Deep dive into data analysis: mastering the state-of-the-art
Smart devices - sensors and embedded software
Technophilosophy
Understanding perspectives in systems engineering
Designing a value proposition
Optimizing and improving product design in an organizational context
Developing solutions: how to make a product successful
Practice-based research - basic skills
Collecting and analyzing data
Communicating research results
Practice-based research - the bigger picture
Create and make choices
Design thinking
Human centered approaches
Visualizing your process

Table 2. BOKS

3.3 Mindset

The digital technology engineers have an open, international scope. They recognize the ethical dimension of technology and its relationship with sustainability issues, in order to help organizations and people develop in a sustainable and future-oriented way. Moreover, they have an entrepreneurial mindset and focus on developing ethical, philosophical insights about the relationship between humans and technology. Digital technology engineers apply the acquired insights to the solutions for their specific domains and know how to positively increase the desired impact for their future designs by applying integrated solutions and systems approaches, supported by practice-based research and design-based working.

4. Competence

How can one be sure that digital technology engineering graduates are competent? To this end, intended learning outcomes are formulated based on the knowledge, skills, mindset, sustainability and ethics that underlie the actions of the digital technology engineers in the previous chapter. By achieving the intended learning outcomes, students show that they are digital technology engineers who are able to deal with a high degree of uncertainty, complexity, and interdependence that the application and integration of digital technology requires, by applying integrated solutions and systems approaches while leveraging existing digital technologies.

Moreover, the physical learning environment is designed in such a way that teaching and creative activities can be carried out side by side. This also helps to get 'constructive alignment'. Constructive alignment is a principle used for devising teaching and learning activities, and assessment tasks, which directly address the intended learning outcomes in a way not typically achieved in traditional lectures, tutorial classes and examinations. Digital technology engineers also explore different contexts and work in company on a design-based project, both in Year 1 and in Year 2 of the Master's program.

Professional competence can be seen as the extent to which digital technology engineers are able to use their knowledge, skills and mindset to design sustainable solutions to complex organizational and social issues through the use of digital technology.

4.1 Relevant frameworks

The intended learning outcomes demonstrably describe the level of the program (Master's) as defined in the European Qualifications Framework, as well as its orientation (professional). They are geared to the expectations of the professional field, the discipline, and international requirements.

The European Qualification Framework (EQF) has been used for the development of the Master's Digital Technology Engineering. The EQF is a framework for determining possible qualifications, from basic education to PhD. This framework makes European standardization possible. Terminology used for the educational profile is appropriate to the severity of level 7 and the final qualifications have also been worked out at that level. As far as higher education levels are concerned, the EQF has been developed on the basis of the Dublin Descriptors [23].

	1. Digital technologies	2. Systems engineering	3. Leading development	4. Practice-based research	5. Communication & Teamwork	6. Personal & professional identity
Dublin Descriptors						
1) Knowledge and understanding						
2) Applying knowledge and understanding						
3) Making judgements						
4) Communication skills						
5) Learning skills						

Table 3. Relation between Dublin Descriptors and the Master's Final Qualifications.

The professional Master's standard is a relevant point of reference in determining the educational profile and the final qualifications [24]. The Master's program fits in seamlessly with the characteristic established nationally: 'Graduated professional masters work on complex practical issues in a professionally-oriented context. They do this on the basis of a solid theoretical knowledge base, research-based method and mindset. They act professionally on the basis of an ethical and moral awareness and are autonomous and reflective. They have grown to an advanced level and show mastery in their discipline. They work independently and inter-professionally in various networks and contribute to knowledge creation and innovation.'

4.2 Final qualifications

For the Master's Digital Technology Engineering, there are no nationally or internationally established competence profiles. The final qualifications have therefore been developed specifically for this program.

The following steps have been taken in the process:

- Systematic approach for defining the final qualifications: site visits and discussions in the professional field about the Master's education profile and the potential positions and roles of the graduates.
- Analysis of relevant (inter)national frameworks (Dublin Descriptors, EQF, EUR-ACE, and the Professional Master's standard as general frameworks for level 7.
- Formulation of final qualifications with the input of experts.
- Comparison of final qualifications with (international) reference frameworks.
- Validation of final qualifications in the field of work and among experts.

Final qualifications Master's Digital Technology Engineering		
1.	Digital Technologies	The student is able to, autonomously and in a self-directed way, deepen his/her knowledge about the mechanisms, trends, ethics, sustainability aspects, potential and constraints of digital technologies. The student can integrate these technologies in existing technological systems or design methods to integrate the digital technologies in systems that are still under development.
2.	Systems engineering	The student uses the integrative method of systems engineering for product development, to technically design integrated digital technology solutions. The student has a critical awareness of the wider multidisciplinary context and takes into account the interface between needs and constraints of the technological and socio-technological and business fields.
3.	Leading development	The student can play a leading role in processes of designing integrated digital technology solutions using the design-based work approach with an entrepreneurial mindset. The student approaches a problem from a diversity of technical and non-technical perspectives, keeping the intended result in mind to which the technology contributes. The student validates the impact and feasibility of the solution in the appropriate context, while taking ethics and sustainability into account.
4.	Practice-based research	The student conducts cyclical small-scale practice-based research in a valid and reliable way, and systematically utilizes the research outcomes in the design process of the integrated digital technology solution.
5.	Communication & Teamwork	The student has the communication skills to lead the design process of digital technology solutions in the organization. The student effectively communicates and cooperates with various stakeholders in a multidisciplinary and international environment.
6.	Personal & professional identity	As self-directed professionals, the students shape their roles as digital technology engineers. They know their own strength and areas of improvement and develop professional skills to be effective in the specific professional environment.

Table 4. Final qualifications

Each final qualification is elaborated with learning outcomes and indicators that serve as a guide for the program and the assessment. All the final qualifications ensure that the graduates can fulfil their roles as digital technology engineers.

References

1. Haupt, M. (2017) What is a Smart Society? *Project 2030*. Consulted on 11 November 2019: https://medium.com/project-2030/what-is-a-smart-society-92e4a256e852

2. Mensvoort van, K. (2005) Exploring Next Nature. *New Design Worlds.* Consulted on 11 November 2019: https://nextnature.net/2005/03/exploring-next-nature

3. Caudron J. & Van Peteghem D. (2018) Digital transformation: Bereid je organisatie voor op de toekomst. *Van Duuren Management*

4. Fountain, J.E. (2019) The Wicked Nature of Digital Transformation: A Policy Perspective. *Dubai Policy Review,* January. Consulted on 11 November 2019: https://dubaipolicyreview.ae/the-wicked-nature-of-digital-transformation-a-policy-perspective/

5. Ingham, L. (2019) Technology in Digital Transformation. *Verdict, 4 March.* Consulted on 11 November: https://www.verdict.co.uk/technology-in-digital-transformation/

6. Termeer, C & Dewulf, A (2019) A small wins framework to overcome the evaluation paradox of governing wicked problems, Policy and Society, 38:2, 298-314, DOI: 10.1080/14494035.2018.1497933

7. Manyika, J. & Sneader K. (2018) AI, automation, and the future of work: Ten things to solve for. *McKinsey Global Institute,* June.

8. Cascio W.F. & Montealegre R. (2016) How Technology is changing work and organizations. *Research Gate,* March. DOI: 10.1146/annurev-orgpsych-041015-062352

9. Dam R. & Siang T. (2019) Design Thinking: New innovative thinking for new problems. *Interaction Design Foundation*. Consulted on 29 November 2019: https://www.interaction-design.org/literature/article/design-thinking-new-innovative-thinking-for-new-problems

10. Manyika, J. & Chui M. et al. (2015) Unlocking the potential of the Internet of Things. *McKinsey Global Institute, June*

11. Bossmann J. (2016) Top 9 ethical issues in artificial intelligence. *World Economic Forum.* Consulted on 29 November 2019: https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/

12. United Nations (2015) Sustainable Development Goals. Knowledge Platform. Consulted on 15 November 2019: https://sustainabledevelopment.un.org/?menu=1300

13. Bonini S. & Görner S. (2011) The business of sustainability. *McKinsey & Company.* Consulted on 29 November 2019: https://www.mckinsey.com/business-functions/sustainability/our-insights/the-business-of-sustainability-mckinsey-global-survey-results#

14. Jones, E. (2011) Internationalisation, multiculturalism, a global outlook and employability. *ALT Journal, 11*. Consulted on 12 November 2019: http://eprints.leedsbeckett.ac.uk/1194/1/Internationalisation,%20multiculturalism,%20a%20global%20outlook%20and%20employability1.pdf

15. Internationalisering in Brainport Eindhoven. Consulted on 12 November 2019: https://brainporteindhoven.com/nl/voor-jou/onderwijs/internationalisering-onderwijs#c1536

16. Kathleen, L. & Barker M. (2016) The Global Citizen Conceptualized: Accommodating Ambiguity. *Journal of Studies in International Education.* Consulted on 13 November 2019: https://journals.sagepub.com/doi/full/10.1177/1028315316637354

17. Servoz, M. The Future of Work? Work of the future! *European Commission.* Consulted on 11 November 2019: https://skills4industry.eu/sites/default/files/2019-05/AI%20-%20The%20Future%20of%20Work_Work%20of%20the%20Future.pdf

18. Next Nature. Consulted on 11 November 2019: https://nextnature.net/projects/hubot

19. Oskam, I. (2009). T-shaped engineers for interdisciplinary innovation: an attractive perspective for young people as well as a must for innovative organisations. Conference: 37th Annual Conference - Attracting students in Engineering

20. Conley, S.N. et al (2017). Acquisition of T-shaped expertise: an exploratory study. Social Epistemology 31(2):1-19

21. Buchanan, R. (2001). Design Research and the New Learning. Design Issues 17 (4): 3-23

22. Fry, T. (2009). Design Futuring: sustainability, ethics and new practice. Berg publishers, United Kingdom

23. The Design Based Working Framework is based on the design process models of IDEO, d.school, Ashish Goel and Design A Better Business.

24. Bologna Working Group (2005) A Framework for Qualifications of the European Higher Education Area. Copenhagen: Ministry of Science, Technology and Innovation. http://www.bologna-bergen2005.no/Docs/00-Main_doc/050218_QF_EHEA.pdf

25. Vereniging Hogescholen (2019) Professionele masterstandaard geactualiseerd. https://www.verenigninghogescholen.nl/actueel/actualiteiten/professionele-masterstandaard-geactualiseerd

master guide
digital technology engineering

ready to design the future.

assessments of the master

During both years of the master, a number of formal assessments will take place. With each assessment, we assess whether you have achieved one or more (parts of) learning outcomes. We use various types of assessments, each suiting the content of the learning outcome and the phase of the master. Next to the formal (summative) assessments in the master, there are also various opportunities to get feedback, feed-up and feed-forward on your progress on each of the learning outcomes. These opportunities are organized as part of the courses of each learning line. A detailed planning of each course, including these feedback moments, can be found in the course manuals on the portal. On the next pages, we will first provide you with an overview of the assessments in each phase. Subsequently we provide an explanation of the set-up, the instructions and the grading form for each assessment in the master.

assessments in year 1

assessment	credits	first sit	re-sit
Practical assignment Data-Pipeline with visualization	5	Week 13	Week 25
Practical assignment Artificial Intelligence	5	Week 25	Week 39
Practical assignment Human Technology Interaction	5	Week 39	Week 0
Practical assignment Data Analysis	5	Week 39	Week 11 (year 2)
Assignment Research proposal	4	Week 13	Week 25
Assignment Research Data analysis	4	Week 25	Week 39
Assignment Research report	4	Week 39	Week 11 (year 2)
Portfolio assessment Systems engineering	12	Week 39	Week 11 (year 2)
Portfolio assessment Design-based working	10	Week 37	Week 11 (year 2)
Portfolio assessment Personal & professional identity	6	Week 35	Week 11 (year 2)

If you get a pass score (> 5,5) on all assessments, you will earn 60 study credits (ECTS).

The first four assessments are focused on the learning outcome ‘Digital Technologies – year 1’. The research proposal, data analysis and report focuses on the learning outcome ‘Practice-based Research – year 1’. The portfolio assessments focus on the corresponding learning outcomes ‘Systems engineering – year 1’, ‘Design-based working – year 1’, and ‘Personal & professional identity – year’.

assessments in year 2

assessment	credits	weighting	first sit	re-sit	more info
Practical assignment IoT-infrastructure: Digital technologies	15	35%	Week 11	Week 19	Page 45
Challenge report: • Practice-based research • Systems Engineering • Design Based Working • Personal & professional identity		65%	Week 11	Week 19	N/A
Design & research strategy	8	-	Week 18	Week 20	N/A
Graduation Report	37	80%	Week 38	Week 0	Page 71
Launch: presentation and interview		20%	Week 39	Week 0	Page 73

** You can only conduct the presentation and interview, if you get a pass grade on your graduation report.*

practical assignment
data pipeline with visualization

Through the Digital technology assignments, of which this is the first, it will be assessed to what extent you meet the following learning outcome and the indicators a,b, and c. The grading form for this assignment can be found on page 31. This grading form will be used to assess your work.

learning outcomes(s) that are being assessed - digital technologies year 1

learning outcome	You have hands-on experience with a number of present-day technologies and understand their application in business processes and know how to integrate them in a new design or existing system. You can evaluate the use of digital technologies from practical and expert examples and scientific literature.
indicators	**a.** You can describe digital technologies (basic working principles and their fields of application), also considering ethical consequences and sustainability aspects resulting from the use of these technologies. **b.** You can design, implement, test and validate basic digital technology solutions (a data acquisition, processing and visualization system, a working NN or ML algorithm) based on literature comparison and performance measurements/expectations. **c.** You evaluate other people’s work, you can find academic writing on digital technologies, you use these sources to explain your work, by using correct references.

instruction for students

context

It is estimated that in 2020 there were 40 zettabytes (1 zettabyte = 10 to the power 21 bytes) of data in the world. For digital technology professionals, it is critical to actively shape and transform data and information to achieve knowledge and wisdom. The techniques presented in the course allow to systematically deal with data sets from capture, storage, analysis, search, sharing, transfer, visualization, querying and updating. In this assignment you must prepare a proper data presentation out of an initial set of requirements

assignment

You have received the theoretical and practical background with regards of handling data and fundamental statistical data analysis tools. Now you are going to implement a data pipeline (retrieval, analysis) and visualization yourself.
Indicators:

- You are capable to understand complex data and identify appropriate techniques to analyse it and transform it into relevant information.
- You can transform theoretical knowledge into practical application in order to filter, process and analyse data.
- You are capable to establish the relevant detail and quality depending on your stakeholders.
- You can determine if the data you have is appropriate to cover Grice´s conversational maxims: Quantity, Quality, Relevance and Manner;
- You can create data pipelines and appropriate visualizations.
- You are capable to justify, criticize and complement data repositories, pipelines and visualizations.
- You will be given a complex problem based on data. You must create a data pipeline and visualization. In doing so, you will:
- Retrieve, clean, organize and statistically process data;
- Build a story fitting your stakeholders need;
- Apply the fundamentals of Dashboard design;
- Include relevant graphs and access to detailed data if needed;
- Enhance the relevance of the key data relationships through theoretical frameworks.

deliverables

- You must deliver a Technical Report including the following elements when appropriate,
- Title
- Abstract
- Introduction
  - Overview
  - Technology Framework
- Overview of the project
  - Problem to solve
  - Stakeholders
  - Customer analysis
- Project components
  - Data extraction, capture and storage
  - Data search, analysis and sharing
  - Data pipeline
  - Dashboard design
  - Data visualization
  - Code
  - Results
- Conclusions
  - Limitations
  - Self-criticism
  - Conclusions
  - Future scope and recommendations
- References

You will receive feedback on you work. You use the feedback to improve your work. You make sure to iterate and discuss your work in progress with your colleagues. You make sure that your work is satisfactory.

deadlines

problem to solve	**week 6**	You will provide a one page statement of the problem you intend to solve. You will pitch the problem in less than 5 minutes. You will receive feedback on the minimum expected leel of your project.
group assessment	**week 11**	You hand in your first full draft of your technical report. You hand in the progress on the implementation of your solution. You send your technical report to your group member. You have 3 working days to provide feedback to each group member on their project using a feedback form that will be handed out during the course. You may also guide uour criticism using the grading form. You use this feedback yo improve your report and product(s).
first attempt	**week 13**	You hand in your technical report on data pipeline and visualization. The report should present a sound story providing relevnt insights and include a thorough description of the implementation and results.
second attempt	**week 25**	If your first attempt does not meet the criteria, you will fail the assessment. You get feedback from your assessor within 10 working days. You must present a technical report covering all the criteria on you second attempt.

grading form

indicators	assessment criteria	U 0pt	S 2pt	G 3pt
You can make an analysis of the data available, the sources and how this affects the reliability of your deliverables.	The data sources available have been thoroughly analysed and the data retrieving process was thoroughly addressed.	☐	☐	☐
	The quality and reliability of the data has been evaluated in the section problem to solve.	☐	☐	☐
	You present a prediction of your final product´s validity and reliability.	☐	☐	☐
	You propose alternatives to fill data gaps. You provide arguments to justify your choices.	☐	☐	☐
	The results and conclusions presented are consistent with the original data validity and reliability.	☐	☐	☐
You can process the data and create suitable relations, graphs, dashboards and visualisations.	You provide evidence on the relevance of the data you select.	☐	☐	☐
	You demonstrate how you process data to obtain information.	☐	☐	☐
	You show explicitly the different stages to clean and filter data.	☐	☐	☐
	You make use of dashboards, tables and graphs to communicate what is relevant to your stakeholders.	☐	☐	☐
	You create data and information relationships to allow your stakeholders to reach knowledge and wisdom.	☐	☐	☐
	You create a story using clear methodologies. You provide arguments to justify your choices.	☐	☐	☐
You are proficient with fundamental data analysis and you can substantiate your choices with regard to the assignment.	You justify how you lead your stakeholders by visualizing trends, making connections, drawing conclusions.	☐	☐	☐
	You demonstrate the use of Grice´s conversational maxims: Quantity, Quality, Relevance & Manner.	☐	☐	☐
	You create a straightforward story to lead your stakeholders from data and information to knowledge.	☐	☐	☐

Grading scale: we assess each criterion on the assignment using the Unsatisfactory (U), Satisfactory (S) and Good (G).

unsatisfactory (0 points): The work of the student does not meet the criterion or the quality of the work related to this indicator is very poor (EG many mistakes, no or wrong sources).

satisfactory (2 points): The work of the student meets the criterion, but the quality of the work still offers room for improvement

good (3 points): The work of the student completely meets the criterion and the quality of the work is very high.

grading table assignment

score	grade	score	grade
40 - 42	10	18 - 21	5
36 - 39	9	13 - 17	4
31 - 35	8	8 - 12	3
27 - 30	7	3 - 7	2
22 - 26	6	0 - 2	1

question	evaluation	feedback
How do you evaluate the overall assignment report of your colleague?		
How do you evaluate the complexity of your colleague's project?		
How do you evaluate the data elements of the technical report. Please consider the whole data pipeline and visualization.		

Grading scale:
Please provide an evaluation from 0 to 10 where 0 means absent and 10 means excellent.
Please provide clear feedback to your colleagues for all the questions. A minimum of 150 and maximum of 500 words per question.
The feedback you provide to your colleagues will be used to assess your skills to evaluate technologies.
Please take into account that your feedback is crucial for everyone to reach the highest quality in their products.

practical assignment artificial intelligence

Through the Digital technology assignments, of which this is the second, it will be assessed to what extent you meet the following learning outcome and the indicators a,b, and c. The grading form for this assignment can be found on page 35. This grading form will be used to assess your work.

learning outcomes(s) that are being assessed - digital technologies year 1

learning outcome	You have hands-on experience with a number of present-day technologies and understand their application in business processes and know how to integrate them in a new design or existing system. You can evaluate the use of digital technologies from practical and expert examples and scientific literature.
indicators	**a.** You can describe digital technologies (basic working principles and their fields of application), also considering ethical consequences and sustainability aspects resulting from the use of these technologies. **b.** You can design, implement, test and validate basic digital technology solutions (a data acquisition, processing and visualization system, a working NN or ML algorithm) based on literature comparison and performance measurements/expectations. **c.** You evaluate other people's work, you can find academic writing on digital technologies, you use these sources to explain your work, by using correct references.

instruction for students

context

Artificial Intelligence (AI) has been evolving very fast in the last 70 years. AI applications have become part of our everyday life. During the course you had the opportunity to learn about AI and its implications. You had the opportunity to explore machine learning (ML) algorithms and neural networks (NNs) as a powerful AI technique to solve well defined and limited problems. You have also learned NN characteristics within the AI landscape compared to other techniques such as Support Vector Machines, Decision Trees, and ensemble learning. You understand the differences between supervised, unsupervised and reinforcement learning. You have learned the theory and the practice about how to create a ML algorithm or NN for a specific application. In this assignment you have to tackle a complex problem on your own.

assignment

You have received the theoretical and practical artificial intelligence background. Now you are going to implement an AI application yourself. Each group member will solve a specific problem using ML algorithms or NNs. The problem that you intend to solve is indeed complex; if the problem might be solved using fundamental statistical data analysis, then you shouldn't use NNs or other AI techniques.

You can build an AI solution to solve a specific problem within a clear context. You are able to select ML algorithms or NN type according to the problem's nature and complexity. You are able to evaluate the performances of your system and compare it with other Machine Learning and Artificial Intelligence approaches. You can compare the performance of your proposal to other results. You can explain the advantages and disadvantages of your proposal.

Indicators:
• You are capable to define the technical elements required to solve a specific problem using AI;
• You can select an appropriate NN or ML algorithm design and implement all the required elements;
• You can evaluate the results of your proposal and improve it until the solution is reached.

A non-extensive list of problems,
• Classification;
• Prediction;
• Filtering;
• Optimization;
• Pattern recognition;
• Function approximation;
• Dimensionality reduction for data visualization;
• Noise reduction;
• Feature detection;
• Face recognition.

You are going to define the solution characteristics yourself. In doing so, you will:

- Define a suitable NN or ML algorithm design to solve the problem through literature research and knowledge acquired during the course;
- Describe the reasoning to select such design;
- Describe the detailed architecture of your ML algorithm or NN;
- Implement the AI technique into a digital environment;
- Demonstrate that the performance is as expected.

deliverables

You must deliver a Technical Report including the following elements when appropriate,

- Title
- Abstract
- Introduction
  - Overview
  - Technology Framework
- Overview of the project
  - Problem to solve
  - Stakeholders
  - Customer analysis
- Project components
  - Data extraction
  - Feature engineering
  - AI solution architecture
  - Algorithms implementation
  - Performance evaluation
  - Code
  - Results
- Conclusions
  - Limitations
  - Self-criticism
  - Conclusions
  - Future scope and recommendations
- References

You will receive feedback on you work. You use the feedback to improve your work. You make sure to iterate and discuss your work in progress with your colleagues. You make sure that your work is satisfactory.

deadlines

problem to solve	**week 17**	You will provide a one page statement of the problem you intend to solve. You will pitch the problem in less than 5 minutes. You will receive feedback on the minimum expected leel of your project.
group assessment	**week 22**	You hand in your first full draft of your technical report. You hand in the progress on the implementation of your solution. You send your technical report to your group member. You have 3 working days to provide feedback to each group member on their project using a feedback form that will be handed out during the course. You may also guide your criticism using the grading form. You use this feedback to improve your report and product(s).
first attempt	**week 25**	You hand in your technical report on data pipeline and visualization. The report should present a sound story providing relevant insights and include a thorough description of the implementation and results.
second attempt	**week 39**	If your first attempt does not meet the criteria, you will fail the assessment. You get feedback from your assessor within 10 working days. You must present a technical report covering all the criteria on you second attempt.

grading form

indicators	assessment criteria	U 0pt	S 2pt	G 3pt
You can design a AI solution to solve a complex problem.	The problem is analysed and decomposed appropriately.	☐	☐	☐
	The algorithm proposed generates a feasible solution.	☐	☐	☐
	You demonstrate the reasoning behind your own design(s).	☐	☐	☐
	The architecture of your ML algorithm or NN is well described according to the problem and the expected solution(s).	☐	☐	☐
	You describe which requirements should be met by the expected solution(s), in order to be considered successful.	☐	☐	☐
You compare different AI techniques, implement different solutions and compare results.	You select suitable NN topologies or ML algorithms to implement your proposed solution.	☐	☐	☐
	The implementation environment is appropriate for your solution.	☐	☐	☐
	The implementation is well structured and the execution is successful.	☐	☐	☐
	The implementation is well documented. Your assessor and group members should understand your proposed design and solution.	☐	☐	☐
	The steps in the implementation are according to recommended practices.	☐	☐	☐
You analyse the results and describe them appropriately.	Your AI solution works according to the expectations defined at the beginning of the project.	☐	☐	☐
	The report describes clearly how the results are achieved.	☐	☐	☐
	The report include graphs and visualisations to clarify the results.	☐	☐	☐
	The comparisons with other AI techniques are well documented and carefully described.	☐	☐	☐
	The report includes literature references, as well as code sharing sources and tools used for the implementation.	☐	☐	☐

Grading scale: we assess each criterion on the assignment using the Unsatisfactory (U), Satisfactory (S) and Good (G).

unsatisfactory (0 points): The work of the student does not meet the criterion or the quality of the work related to this indicator is very poor (EG many mistakes, no or wrong sources).

satisfactory (2 points): The work of the student meets the criterion, but the quality of the work still offers room for improvement

good (3 points): The work of the student completely meets the criterion and the quality of the work is very high.

grading table assignment

score	grade	score	grade
43 - 45	10	19 - 23	5
38 - 42	9	14 - 18	4
34 - 37	8	8 - 13	3
29 - 33	7	3 -7	2
24 - 28	6	0 - 2	1

question	evaluation	feedback
How do you evaluate the overall assignment report of your colleague?		
How do you evaluate the complexity of your colleague's project?		
How do you evaluate the data elements of the technical report. Please consider the whole data pipeline and visualization.		

Grading scale:
Please provide an evaluation from 0 to 10 where 0 means absent and 10 means excellent.
Please provide clear feedback to your colleagues for all the questions. A minimum of 150 and maximum of 500 words per question.
The feedback you provide to your colleagues will be used to assess your skills to evaluate technologies.
Please take into account that your feedback is crucial for everyone to reach the highest quality in their products.

practical assignment human technology interaction

Through the four digital technology assignments, of which this is the third, it will be assessed to what extent you meet the following learning outcome and the indicators a, b and c. The grading form for this assignment can be found on page 39. This grading form will be used to assess your work.

learning outcomes(s) that are being assessed - digital technologies year 1

learning outcome	You have hands-on experience with a number of present-day technologies and understand their application in business processes and know how to integrate them in a new design or existing system. You can evaluate the use of digital technologies from practical and expert examples and scientific literature.
indicators	**a.** You can describe digital technologies (basic working principles and their fields of application), also considering ethical consequences and sustainability aspects resulting from the use of these technologies. **b.** You can design, implement, test and validate basic digital technology solutions (a data acquisition, processing and visualization system, a working NN or ML algorithm) based on literature comparison and performance measurements/expectations. **c.** You evaluate other people's work, you can find academic writing on digital technologies, you use these sources to explain your work, by using correct references.

instruction for students

context

Is there an app for that? Are you going to solve a problem with (digital) technology? But what exactly is the problem? And how can you be so sure that you are solving the right problem? Are you sure you're not just fighting symptoms? And have you considered the unexpected impact that technology can have? Do you know the stakeholders? Have you thought about privacy? About bad actors? Have you imagined the future? Do you know the shortcomings of data? And the importance of transparency? Is your technology inclusive? And do you understand the impact digital technology can have on our human values?

If you have considered all these questions, do you still think your technology is a good solution? Or would you like to improve your design? In the graduation phase of the master you will work on this for your own solution, but in this general phase you show that you have this way of thinking under control.

assignment

During the general phase you have been provided all kinds of theory on the impact of technology and the ethical considerations. You have done open online courses, we have discussed the implications and practiced using the technology impact cycle tool (www.tict.io). Now you are going to analyze a digital technology yourself. Every group of students will be provided with a unique digital technology
that has to be analyzed using the tool. In doing so, you will:

- Use the technology impact cycle tool to thoroughly analyze a provided digital technology, to do so you will need to research this technology;
- Analyze two other categories of your choice;
- Show that you can apply the theory offered.

deliverables

You will hand in a technology impact analysis on the digital technology in three categories. You will do this by using the technology impact tool (www.tict.io). One category (impact on society) is mandatory. The other two categories are chosen by the student but must be applicable to the technology to be analyzed. The answers are assessed on the application of the theory offered and the level at which the student demonstrates his ability to think fundamentally about the impact of technology. You will receive feedback on your work. You use the feedback to improve your work. You will make sure your work is satisfactory. This assignment helps you prepare for the graduation phase in which you will prove the analysis of your own solution by submitting a full technology impact document.

deadlines

first attempt	**week 39**	You hand in your analysis of the provided digital technology. You use the technology impact cycle tool (ww.tict.io) to create the document.
resit	**week 0 (year 2)**	If your first version does not meet the criteria, you will fail the assessment. You get feedback from your assessor within 5 working days, which you can use to repair and improve your impact analysis.

grading form

aspects	assessment criteria	U 0pt	S 2pt	G 3pt
Impact on society	The level of detail in your answers with regards to the underlying workings of the technology, combined with references to the used sources, show that you thoroughly researched the provided technology on this category.	☐	☐	☐
	The relevant theoretical concepts presented during the course were applied in a correct way	☐	☐	☐
	The answers are carefully formulated and thought through. The answers transcend a common sense approach to the impact of technology.	☐	☐	☐
	The improvements that are deduced from the analysis are practical and are sufficiently elaborated to potentially be shared with the designer of the technology or in a public debate.	☐	☐	☐
You can process the data and create suitable relations, graphs, dashboards and visualisations.	The selected category was appropriate for the analysed technology.	☐	☐	☐
	The level of detail in your answers with regards to the underlying workings of the technology, combined with references to the used sources, show that you thoroughly researched the provided technology on this category.	☐	☐	☐
	The relevant theoretical concepts presented during the course were applied in a correct way	☐	☐	☐
	The answers are carefully formulated and thought through.	☐	☐	☐
	The answers transcend a common sense approach to the impact of technology.	☐	☐	☐
You apply the paradigms DIKW and Storytelling to reach conclusions suitable for your audience and stakeholders.	You show you can select a category that is appropriate for the technology that you are analysing.	☐	☐	☐
	The level of detail in your answers with regards to the underlying workings of the technology, combined with references to the used sources, show that you thoroughly researched the provided technology on this category.	☐	☐	☐
	The relevant theoretical concepts presented during the course were applied in a correct way	☐	☐	☐
	The answers are carefully formulated and thought through.	☐	☐	☐
	The answers transcend a common sense approach to the impact of technology.	☐	☐	☐

Grading scale: we assess each criterion on the report using the Unsatisfactory (U), Satisfactory (S) and Good (G).

unsatisfactory (0 points): The work of the student does not meet the criterion or the quality of the work related to this indicator is very poor (EG many mistakes, no or wrong sources).

satisfactory (2 points): The work of the student meets the criterion, but the quality of the work still offers room for improvement

good (3 points): The work of the student completely meets the criterion and the quality of the work is very high.

grading table assignment

score	grade	score	grade
40 - 42	10	18 - 21	5
36 - 39	9	13 - 17	4
31 - 35	8	8 - 12	3
27 - 30	7	3 - 7	2
22 - 26	6	0 - 2	1

practical assignment
data analysis

Through the four digital technology assignments, of which this is the third, it will be assessed to what extent you meet the following learning outcome and the indicators a, b and c. The grading form for this assignment can be found on page 43. This grading form will be used to assess your work.

learning outcomes(s) that are being assessed - digital technologies year 1

learning outcome	You have hands-on experience with a number of present-day technologies and understand their application in business processes and know how to integrate them in a new design or existing system. You can evaluate the use of digital technologies from practical and expert examples and scientific literature.
indicators	**a.** You can describe digital technologies (basic working principles and their fields of application), also considering ethical consequences and sustainability aspects resulting from the use of these technologies. **b.** You can design, implement, test and validate basic digital technology solutions (a data acquisition, processing and visualization system, a working NN or ML algorithm) based on literature comparison and performance measurements/expectations. **c.** You evaluate other people's work, you can find academic writing on digital technologies, you use these sources to explain your work, by using correct references.

instruction for students

context

The rapid evolution of digital technology manifests itself in the exponential growth of scientific publications. It is estimated that the amount of scientific output doubles roughly every nine years. With this phenomenon comes the challenge, for the industry, to look critically at new scientific claims and identify breakthrough ideas, which must also be applicable to real users' demands. During the course you had the opportunity to deep dive into state-of-the-art literature, looking at recent research outcomes with a critical eye. Inspired by the greatest experts in the data analysis field, you tried to replicate relevant scientific results, deepening your knowledge in specific fields of AI and data processing. You can implement complex architecture and research methods. You mastered the topics you researchedresearched, and you have a good overview of their field of application. You can identify technology trends and foresee technology development opportunities in specific AI fields. In this assignment you have to transfer your knowledge to your fellow student, creating a link between your expertise and their fundamental knowledge of AI.

assignment

During the course you received the resources to explore and become an expert on specific data analysis topics. For this assignment you will use your new expertise to implement a practical example of the new technologies you researched, and you will transfer your knowledge to your fellow students. Now you will present your findings to your fellow students. Each group member will represent their expertise on a specific topic of choice. You will try to give a solid theoretical overview to the other students and support that with implementation examplesyour implementation example, test results and literature references.

Indicators:

1. You are capable tof describeing a complex digital technology in simple terms, using real-world examples;
2. You understand which resources and tools are needed for the implementation of a new digital technology, and you became familiar with the advantages and disadvantages of using these tools.
3. You can identify and describe the implications of the use of scientific innovation, including technology limitations and socio-economic prospects;
4. You can give a personal opinion about the development of digital technology, supporting your opinions with solid references.

You are going to give an overview about your findings and transfer your knowledge to other students. In doing so, you will:

- Describe the current available technology in your field of interest and what are the potentialities of such technology;
- Present an overview of the theoretical foundation for this technology development;
- Highlight technical challenges and present an explanation of possible solutions;
- Present a practical example of your research study and implementation;
- Present a rationale for selecting a particular technology or methodology to address or study an area of research over other available techniques;
- Present an analysis of the applications of this technology in the industry;
- Present an analysis of the effects of these applications on the society.

deliverables

You must deliver a Technical Report including the following elements when appropriate,

- Title
- Abstract
- Introduction
  - Problem to solve
  - Literature research
- Project components
  - Data extraction, capture and storage
  - Data analysis (AI, statistics, etc...)
  - Performance evaluation
  - Results
- Conclusions
  - Comparison with existing state-of-the-art solutions
  - Impact of the studied technology on economy and society
  - Conclusions
- References

During the formative assessments, you will receive feedback on you work based on your technical report. The report can also be used as a source of further information in relation to your final lecture presentation.

For the summative assessment you must prepare a lecture presentation to share your newly acquired knowledge with your fellow students. The presentation must include at least the following elements:

You will receive feedback on you work. You use the feedback to improve your work. You make sure to iterate and discuss your work in progress with your colleagues. You make sure that your work is satisfactory.

- Introduction
  - Overview of the data analysis technique
  - Literature study overview
  - Application to societal developments and business trends
- Theoretical background
  - Summary of foundation knowledge
  - State-of-the-art theory explanation
- Practical implementation and application
  - Examples introduction
  - Used tools
  - Implementation explanation
  - Performances evaluation
- Conclusions
  - Pros and cons of the use of this technology
  - Technology adoption consequences: ethics, business, society
  - Personal recommendations
- References

deadlines

deadline topic of interest and application	**week 30**	You will provide a one- page statement of your topic of interest and application. You will pitch the project in less than 5 minutes. You will receive feedback on the minimum expected level of your project.
deadline group assessment	**week 35**	You hand in the progress on the implementation of your solution. You send your technical report to your group member. You have 3 working days to provide feedback to each group member on their project using a feedback form that will be handed out during the course. You may also use the grading form to guide your criticism. You use this feedback to improve your report and project.
deadline first attempt	**week 39**	You organize and implement your lecture presentation. The lecture material shall be handed in. The presentation shall describe your discoveries and be understandable to stakeholders with different knowledge levels.
deadline second attempt	**week 0 (year 2)**	If your first attempt does not meet the criteria, you will fail the assessment. You get feedback from your assessor within 10 working days. You must present your lecture material and give a presentation, covering all the criteria on your second attempt.

grading form

aspects	assessment criteria	U 0pt	S 2pt	G 3pt
You can understand and describe state-of-the-art technology.	The state-of-the-art is analysed appropriately.	☐	☐	☐
	The state-of-the-art is analysed appropriately.	☐	☐	☐
	You can find related literature and deepen your knowledge independently through literature studies and tutorials.	☐	☐	☐
	You are able to identify the resources necessary to implement state-of-the-art technology.	☐	☐	☐
You can implement state-of-the-art solutions and critically analyse the results obtained.	You select appropriate resources to implement and replicate state-of-the-art studies.	☐	☐	☐
	The implementation environment is appropriate for your solution.	☐	☐	☐
	The implementation is well structured and the execution is successful.	☐	☐	☐
	The implementation is well documented. Your assessor and group members should understand your proposed design and solution.	☐	☐	☐
	Your implementation results are clear and they can be used to evaluate research studies and claims.	☐	☐	☐
You analyse the implications of technology and innovation adoption.	Your understand the context in which the studied new technology will can be adopted.	☐	☐	☐
	You can comment on pros and cons of technology adoption, considering different scenarios and use cases.	☐	☐	☐
	You can identify technology trends and analyse future developments in relation to the industry.	☐	☐	☐
	You can identify technology adoption implications from a societal point-of-view.	☐	☐	☐
	You understand the ethical implications of new technology adoption.	☐	☐	☐

Grading scale: we assess each criterion on the report using the Unsatisfactory (U), Satisfactory (S) and Good (G).

unsatisfactory (0 points): The work of the student does not meet the criterion or the quality of the work related to this indicator is very poor (EG many mistakes, no or wrong sources).

satisfactory (2 points): The work of the student meets the criterion, but the quality of the work still offers room for improvement

good (3 points): The work of the student completely meets the criterion and the quality of the work is very high.

grading table assignment

score	grade	score	grade
40 - 42	10	18 - 21	5
36 - 39	9	13 - 17	4
31 - 35	8	8 - 12	3
27 - 30	7	3 - 7	2
22 - 26	6	0 - 2	1

question	evaluation	feedback
How do you evaluate the overall assignment report of your colleague?		
How do you evaluate the complexity of your colleague's project?		
How do you evaluate the data elements of the technical report. Please consider the whole data pipeline and visualization.		

Grading scale:
Please provide an evaluation from 0 to 10 where 0 means absent and 10 means excellent.
Please provide clear feedback to your colleagues for all the questions. A minimum of 150 and maximum of 500 words per question.
The feedback you provide to your colleagues will be used to assess your skills to evaluate technologies.
Please take into account that your feedback is crucial for everyone to reach the highest quality in their products.

practical assignment
IoT infrastructure: digital technology

Through the Digital technology assignments, of which this is the fourth, it will be assessed to what extent you meet the following learning outcome and the indicators a, b, and c. The grading form for this assignment can be found on page 48. This grading form will be used to assess your work.

learning outcomes(s) that are being assessed - digital technologies year 1

learning outcome	**integrated learning outcome 'sensing a local problem'** You can analyze a highly complex problem within a societal context and design a digital technology-based solution to this problem. You integrally use the knowledge and skills acquired in the first year of the master to develop a smart system infrastructure that meets your value proposition. You are able to work on the basis of your own core values and match these with the stakeholders.
indicators	**a.** You can develop, or integrate, digital technology to implement a smart system infrastructure (IoT devices, AI technology, robotic and domotic systems).

instruction for students

context

The number of IoT devices is expected to grow to 22 billion by 2025. There are important industry trends that require the expertise from an increasing number of specialists. For example:
5G networks are becoming the driving force behind IoT use cases that were not possible due to slow connectivity.
Smart Cities projects achieve higher efficiency and security by optimizing the infrastructure with technology. Smart meters, electrical means of transport and smart buildings are part of a smart city.
Smart health solutions provide better and more personalized care. This provides more space in hospitals, less costs and more safety.

IoT + AI offers solutions by integrating devices, data and self-learning systems. Complex algorithms allow companies to recognize certain machine behaviour and correct a deviation. In this way, production companies prevent unexpected downtime.
Smart agriculture allows producers to take care of livestock and land better and more efficiently by a network of sensors, cameras, drones and other connected devices.

assignment

You have received the theoretical and practical background with regards to handling sensors, actuators, connected devices, devices compatibility, user interfaces, services, platforms, networks interconnections, data analytics and other IoT elements.

You are going to create an IoT solution yourself. In doing so, you will:

- Define the problem your solution aims to solve;
- Analyse the stakeholders involved in the project;
- Define the sensors, devices, networks, protocols, platforms and applications;
- Implement an efficient solution;
- Evaluate the effectivity of your solution's results.

Indicators:

You can build an IoT solution to solve a specific problem within a clear context. You are capable of defining your stakeholders and the needs of your customers. Your solution includes both hardware and software components. You describe the sensors, devices, networks, protocols, platforms and applications included in your solution. You are aware of the limitations of your solution and you can communicate them.

You will show that:

- You are capable of creating an IoT solution to solve a specific problem;
- You can select the appropriate sensors, devices, networks, protocols, platforms and applications;
- You can convince your stakeholders of the benefits of your design and implementation;
- You can evaluate the results of IoT solutions and propose alternatives to improve deficiencies.

deliverables

You must provide the following deliverables:
Physical device(s)
Technical Report including the following elements when appropriate,

- Title
- Abstract
- Introduction
  - Overview
  - Technology Framework
- Overview of the project
  - Problem to solve
  - Stakeholders
  - Customer analysis
- Project components
  - Physical device(s) description
  - Modules
  - Sensors
  - Circuits
  - Algorithms
  - Networks
  - Protocols
  - Platforms
  - Security
  - Applications
  - Testing protocol
- Conclusions
  - Limitations
  - Self-criticism
  - Conclusions
  - Future scope and recommendations
- References

deadlines

deadline problem to solve	**week 7 (year 2)**	You hand in a first draft of your technical report. You hand in the progress on the physical device(s) in your solution. You send your technical report to your group members. You have 3 working days to give feedback to each group member on their project using a feedback form that will be handed out during the course. You may also guide your criticism using the grading form. You use this feedback to improve your report and product(s).
deadline first attempt	**week 11 (year 2)**	You hand in the physical device(s) of your solution. You hand in your technical report. You get feedback from your assessor within 10 working days.
deadline second attempt	**week 19**	If your first attempt does not meet the criteria, you will fail the assessment. You get feedback from your assessor within 10 working days. You must present a technical report and physical device(s) covering all the criteria on you second attempt.

.20

grading form

aspects	assessment criteria	U 0pt	S 2pt	G 3pt
You can document an IoT project within a clear context.	The overall structure and content of the technical report is clear and complete.	☐	☐	☐
	The introduction and overview clearly state the technological context and the purpose of the project.	☐	☐	☐
	The project contents are appropriate and suitable according to the proposed solution.	☐	☐	☐
	The description of the stakeholders and customers is complete and accurate.	☐	☐	☐
	The functionality of the physical IoT device(s) is clearly described. This should include a testing protocol.	☐	☐	☐
	The conclusions are suitable to the initial assumptions of the project.	☐	☐	☐
	The limitations and self-criticism of the project offers a clear path for alternatives to improve deficiencies or future work.	☐	☐	☐
You can create physical IoT device(s) to solve a problem	All the components of the physical IoT device(s) function according to the technical report specifications.	☐	☐	☐
	The hardware and software components interact and communicate properly	☐	☐	☐
	Your IoT device(s) cover the security requirements specified in the technical report.	☐	☐	☐
	The IoT application succeeds in performance according to the testing protocol.	☐	☐	☐
	The user interface is clear and complete according to the technical report.	☐	☐	☐

Grading scale: we assess each criterion on the report using the Unsatisfactory (U), Satisfactory (S) and Good (G).

unsatisfactory (0 points): The work of the student does not meet the criterion or the quality of the work related to this indicator is very poor (EG many mistakes, no or wrong sources).

satisfactory (2 points): The work of the student meets the criterion, but the quality of the work still offers room for improvement

good (3 points): The work of the student completely meets the criterion and the quality of the work is very high.

grading table assignment

score	grade	score	grade
35 - 36	10	16 - 19	5
31 - 34	9	12 - 15	4
28 - 30	8	7 - 11	3
24 - 27	7	3 - 6	2
20 - 23	6	0 - 2	1

question	evaluation	feedback
How do you evaluate the overall assignment report of your colleague?		
How do you evaluate the complexity of your colleague's project?		
How do you evaluate the data elements of the technical report. Please consider the whole data pipeline and visualization.		

Grading scale:
Please provide an evaluation from 0 to 10 where 0 means absent and 10 means excellent.
Please provide clear feedback to your colleagues for all the questions. A minimum of 150 and maximum of 500 words per question.
The feedback you provide to your colleagues will be used to assess your skills to evaluate technologies.
Please take into account that your feedback is crucial for everyone to reach the highest quality in their products.

assignment
research proposal

Through this assignment, it will be assessed to what extent you meet the learning outcome and the indicators. A grading form, with criteria for each indicator, can be found on the page 52. This grading form will be used to assess your research proposal.

learning outcomes(s) that are being assessed	
learning outcome	**practice-based research** You are able to conduct a small-scale practice-based research in an increasingly complex context, answering research questions and using research methods that are relevant in the digital technology integration process. You set-up and conduct your research according to the research cycle, and you use the outcomes of your research to strengthen the digital technology integration.
indicators	**a.** You formulate research questions, select a relevant type of study, make an informed decision about the set-up of the research design, considering research ethics. **b.** You autonomously conduct the research in accordance with your research design, you analyse and interpret the data, and report the results. **c.** You reflect critically on the validity, reliability and value of the research for your digital technology solution and the involved stakeholders.

instruction for students

context

Research proposals are a commonly used way to assess one's ability to design research. Although there are disciplinary differences on what is the expected of such a proposal, the basic contents are general (introduction, a theoretical framework, your research questions and the research design). In order to conduct research on a master level, you should also be able to draft a proposal with this basic content. It is your chance to explain the significance of your project. Ideally, it will demonstrate the quality and importance of your project as well as your ability to conduct the proposed research. The proposal also gives you the opportunity to think through your research project, to refine your focus, and to predict any challenges that may arise. It may be helpful to consult your proposal at various stages in your research process to remind yourself of your focus and to chart how your project has progressed.

assignment

In the first week of PBR-1 you worked with a partner to identify multiple interesting research problems and individually choose one research problem to continue with. For this assignment you have to write a (simplified) research proposal for this research problem. Use the provided research proposal format (see page 51). This format requires you to:

- Formulate your own research question(s), which can be answered through user research;
- Select a qualitative and a quantitative research method you could use to answer your research question(s) and explain why these research methods are appropriate for the proposed research.

You will receive feedback from your peers on your individual research proposal (see page 53). You use this feedback to improve your research proposal for this assessment. You do not need to execute your research proposal.

deadlines

deadline first draft	**week 7 - friday 9:00**	You send your own research proposal to two of your peers. You get feedback on your research proposal from them. You also give feedback to two peers on their proposal. You can use this feedback to improve your research proposal.
deadline final version	**week 13 - friday 9:00**	You hand in the final version of your own research proposal. Through this proposal we assess your mastery of the Practice Based Research learning outcome indicator a.
deadline resit	**week 25 - friday 9:00**	If your first version does not meet the criteria, you will fail the assessment. You get feedback from your assessor within 10 working days, which you can use to repair and improve your own research proposal.

format research proposal

introduction

- Write a short introduction in which you explain the context or your study (i.e. research problem).

research question

- Write down your research question(s), which are formulated accordance with the criteria.
- Make sure the research question can be answered using small-scale practice-based research (limited amount of time available, limited generalisability of the results etc.)
- Include a brief explanation on how you distilled the research question. Why do you ask this question and why is the answer relevant to your process?

research methods

- Describe the basic information on your two selected research methods (one qualitative and one quantitative): what steps does this method require you to take?
- Argue why these are a good research method to answer your research question. Provide arguments based on scientific sources (e.g. scientific articles, academic handbooks or academic websites). Refer to these sources using APA-referencing.
- Provide an example of how you want to use these specific research methods in your study.

grading form

indicators	assessment criteria	U 0pt	S 2pt	G 3pt
You formulate research questions, select a relevant type of study, make an informed decision about the set-up of the research design.	The context of the research is explained (i.e. research problem.	☐	☐	☐
	The research question focusses on a single problem or issue.	☐	☐	☐
	The research question is feasible to answer, using primary or secondary data, within the timeframe and practical constraints of a small-scale practice-based research.	☐	☐	☐
	The research question uses specific, well-defined concepts (i.e. all terms used should have clear meanings).	☐	☐	☐
	The research question is relevant to the process of digital technology integration.	☐	☐	☐
	The basic information on both research method is provided (what steps does this method require you to take).	☐	☐	☐
	Several arguments are provided why both research methods were chosen, based on scientific sources (reference in APA).	☐	☐	☐
	A draft version of how to apply these specific research methods is provided.	☐	☐	☐
	The chosen method fits well with the research question it intends to answer and with the small-scale nature of the research.	☐	☐	☐

Grading scale: we assess each criterion on the report using the Unsatisfactory (U), Satisfactory (S) and Good (G).

unsatisfactory (0 points): The work of the student does not meet the criterion or the quality of the work related to this indicator is very poor (EG many mistakes, no or wrong sources).

satisfactory (2 points): The work of the student meets the criterion, but the quality of the work still offers room for improvement

good (3 points): The work of the student completely meets the criterion and the quality of the work is very high.

grading table assignment research proposal

score	grade	score	grade
26 - 27	10	11 - 13	5
23 - 25	9	8 - 10	4
20 - 22	8	5 - 7	3
17 - 19	7	2 - 4	2
14 - 16	6	0 - 1	1

question	evaluation	feedback
How do you evaluate the overall assignment report of your colleague?		
How do you evaluate the complexity of your colleague's project?		
How do you evaluate the data elements of the technical report. Please consider the whole data pipeline and visualization.		

Grading scale:
Please provide an evaluation from 0 to 10 where 0 means absent and 10 means excellent.
Please provide clear feedback to your colleagues for all the questions. A minimum of 150 and maximum of 500 words per question.
The feedback you provide to your colleagues will be used to assess your skills to evaluate technologies.
Please take into account that your feedback is crucial for everyone to reach the highest quality in their products.

assignment
research data analysis

Through this assignment, it will be assessed to what extent you meet the learning outcome and the indicators. A grading form, with criteria for each indicator, can be found on the page 56. This grading form will be used to assess your research proposal.

learning outcomes(s) that are being assessed	
learning outcome	**practice-based research** You are able to conduct a small-scale practice-based research in an increasingly complex context, answering research questions and using research methods that are relevant in the digital technology integration process. You set-up and conduct your research according to the research cycle, and you use the outcomes of your research to strengthen the digital technology integration.
indicators	**a.** You formulate research questions, select a relevant type of study, make an informed decision about the set-up of the research design, considering research ethics. **b.** You autonomously conduct the research in accordance with your research design, you analyse and interpret the data, and report the results. **c.** You reflect critically on the validity, reliability and value of the research for your digital technology solution and the involved stakeholders.

instruction for students

context

It is not easy to be a student these days. The study pressure is high, the expectations are high and that not only applies to the study. Social life must also be interesting, the social media feeds must be managed as if you were a rock star yourself and more and more work must be done to pay for all of that. This results in a situation in which we see that students are increasingly experiencing stress, study delay or even a burnout.

The self-help books are abundant, and people seek refuge in spirituality and the alternative circuit. The reasoning here is that if students understand themselves better, they can effectively improve themselves. To really give students more insight into themselves, collecting data about them is indispensable (see challenge 1). Data can help you understand yourself, but can it understand others? And, even more important, how does data as fuel for neural networking enable other students to improve themselves regarding their study performance, happiness or wellbeing?

For challenge 2 students (in groups of 2-3 people) have to develop a prototype that helps other students to improve as a student (or a human being that is studying), supported by the use of Neural Networks.

assignment

During the previous challenge, you have already written a (simplified) research proposal. In this challenge you are going to take the next step in doing research as you are going to execute a small-scale research study together with your challenge group. For this assignment we want you together with your challenge group to document your research data analysis. Use the provided format (see page 55). This format requires you to:

- Shortly explain the research problem, the research questions and the chosen research method;
- Write an informed consent for the participants of your study;
- Create an overview of the gathered data and an explanation of how you gathered this data;
- Present the results and explain how you analysed the data.

You will receive feedback on the research data analysis of your group. You use this feedback to improve your research data analysis for this assessment.

deadlines

deadline first draft	**week 19 - friday 9:00**	You hand in the research data analysis. You will receive feedback. You can use this feedback to improve your research proposal.
deadline final version	**week 25 - friday 9:00**	You hand in the final version of your group's research data analysis. Through this document we assess your mastery of the Practice Based Research learning outcome and indicators a & b.
deadline resit	**week 39 - friday 9:00**	If your first version does not meet the criteria, you will fail the assessment. You get feedback from your assessor within 10 working days, which you can use to repair and improve the research data analysis.

format research data analysis

introduction

- Write a short introduction in which you explain the context or your study (i.e. research problem).

research question

- Write down your research question(s), which are formulated accordance with the criteria.

research methods

- Describe the basic information on your two selected research methods (one qualitative and one quantitative): what steps does this method require you to take?
- Argue why these are a good research method to answer your research question. Provide arguments based on scientific sources (e.g. scientific articles, academic handbooks or academic websites). Refer to these sources using APA-referencing.
- Provide an example of how you want to use these specific research methods in your study.

participants

- Describe the characteristics of your research sample.
- Write an informed consent for the participants of your study.

research data analysis

- Explain how you gathered your data and present an overview of you gathered data.
- Explain how you analysed the resulting data and argue why this is a good method to analyse these results. Provide arguments based on scientific sources (e.g. scientific articles, academic handbooks or academic websites). Refer to these sources using APA-referencing.

results

- Write down the results from your data analysis.
- Use these results to answer your research question(s).

reflection

- Are there points of improvement regarding the steps you have taken? Provide arguments based on scientific sources (e.g. scientific articles, academic handbooks or academic websites). Refer to these sources using APA-referencing.

grading form

indicators	assessment criteria	U 0pt	S 2pt	G 3pt
You formulate research questions, select a relevant type of study, make an informed decision about the set-up of the research design, considering research ethics.	The context of the research is explained (i.e. research problem).	☐	☐	☐
	The research question focusses on a single problem or issue and uses specific, well-defined concept (i.e. all terms used should have clear meanings).	☐	☐	☐
	The chosen method fits well with the research question it intends to answer.	☐	☐	☐
	Basic information (what steps does this method require you to take) and several arguments are provided why this research method was chosen, based on scientific sources (reference in APA).	☐	☐	☐
	The informed consent includes all important information for the participants (purpose of the research, duration, description of procedures, confidentiality, voluntary participation).	☐	☐	☐
	The sample design is a representative for the target group.	☐	☐	☐
	The research is conducted in accordance with the chosen research design.	☐	☐	☐
	All steps within the data collection process are explained.	☐	☐	☐
You autonomously conduct the research in accordance with your research design, you analyse and interpret the data, and report the results.	The chosen data analysis method is appropriate and basic information is provided (what steps does this method requires you to take).	☐	☐	☐
	Several arguments are provided why this data analysis method was chosen, based on scientific sources (reference in APA).	☐	☐	☐
	The results are clearly presented.	☐	☐	☐
	The results are used to answer the research question(s)	☐	☐	☐
	The reflection includes points of improvement that are supported by arguments based on scientific sources (reference in APA).	☐	☐	☐

Grading scale: we assess each criterion on the report using the Unsatisfactory (U), Satisfactory (S) and Good (G).

unsatisfactory (0 points): The work of the student does not meet the criterion or the quality of the work related to this indicator is very poor (EG many mistakes, no or wrong sources).

satisfactory (2 points): The work of the student meets the criterion, but the quality of the work still offers room for improvement

good (3 points): The work of the student completely meets the criterion and the quality of the work is very high.

grading table assignment

score	grade	score	grade
37 - 39	10	15 - 19	5
33 - 36	9	11 - 14	4
28 - 32	8	7 - 10	3
24 - 27	7	2 - 6	2
20 - 23	6	0 - 1	1

assignment research report

Through this assignment, it will be assessed to what extent you meet the learning outcome and the indicators. A grading form, with criteria for each indicator, can be found on the page 59. This grading form will be used to assess your research data analysis.

learning outcomes(s) that are being assessed

learning outcome	**practice-based research** You are able to conduct a small-scale practice-based research in an increasingly complex context, answering research questions and using research methods that are relevant in the digital technology integration process. You set-up and conduct your research according to the research cycle, and you use the outcomes of your research to strengthen the digital technology integration.
indicators	**a.** You formulate research questions, select a relevant type of study, make an informed decision about the set-up of the research design, considering research ethics. **b.** You autonomously conduct the research in accordance with your research design, you analyse and interpret the data, and report the results. **c.** You reflect critically on the validity, reliability and value of the research for your digital technology solution and the involved stakeholders.

instruction for students

context

The organization you are going to work with may have a very clear idea of what it wants you to develop. The innovation you are going to develop is a solution for a problem the organization is currently facing or for an opportunity it sees in the market. The main question is to what extent they have a clear view on the real problem from the inside. And that also applies to the opportunity in the market that they see. How real is the opportunity they describe? Are there already competitors or similar solutions out there?

In addition, what are the most plausible paths for the innovation you will work on for the company? The intention is that you don't blindly stare at that one 'best' idea. You really have to make an effort to identify multiple solution directions. Force yourself to think differently, listen carefully to the experts involved and think outside the box.

For challenge 3 you (in groups of 2-3 people) have to develop a solution from idea to prototype to a minimum viable product (MVP) for a company.

assignment

During the previous challenges, you have practiced writing a (simplified) research proposal and research data analysis report which included elements of a research report. During challenge 3 we want you to write a research report together with your challenge group. This research report should include supportive argumentation of the choices made within your project. Use the provided format (see page 58). This format requires you to:

- Shortly explain the research problem, the research questions and the chosen research method;
- Write an informed consent for the participants of your study;
- Create an overview of the gathered data and an explanation of how you gathered this data;
- Present the results and explain how you analysed the data;
- Restate your major findings and summarize other interesting findings;
- Reflect on the validity, reliability and value of your research.

You will receive feedback on the research data analysis of your group. You use this feedback to improve your research data analysis for this assessment.

deadlines

deadline first draft	**week 34 - friday 9:00**	You send your own research proposal to two of your peers. You get feedback on your research proposal from them. You also give feedback to two peers on their proposal. You can use this feedback to improve your research proposal.
deadline final version	**week 39 - friday 9:00**	You hand in the final version of your own research proposal. Through this proposal we assess your mastery of the Practice Based Research learning outcome indicator a.
deadline resit	**week 11 year 2 - friday 9:00**	If your first version does not meet the criteria, you will fail the assessment. You get feedback from your assessor within 10 working days, which you can use to repair and improve your own research proposal.

format research proposal

introduction
- Write a short introduction in which you explain the context or your study (i.e. research problem).

research question
- Write down your research question(s), which are formulated accordance with the criteria.

research method
- Describe the basic information on your research method and argue why this is a good research method to answer your research question. Provide arguments based on scientific sources (e.g. scientific articles, academic handbooks or academic websites). Refer to these sources using APA-referencing.

participants
- Describe the characteristics of your research sample.
- Write an informed consent for the participants of your study.

research data analysis
- Explain how you gathered your data and present an overview of you gathered data.
- Explain how you analysed the resulting data and argue why this is a good method to analyse these results. Provide arguments based on scientific sources (e.g. scientific articles, academic handbooks or academic websites). Refer to these sources using APA-referencing.

results
- Write down the results from your data analysis.

conclusion & discussion
- Restate your major findings as related to the overall purpose of the study (i.e. your research question(s)) and summarize other interesting findings from the results section.

conclusion & discussion
- Analyse whether your research design is valid (i.e. would it produces results that correspond to real properties, characteristics, and variations in the physical or social world). Provide arguments on why your research design is valid or not. If there are points of improvement, provide suggestions on how to increase the validity of your research. Provide arguments based on scientific sources (e.g. scientific articles, academic handbooks or academic websites). Refer to these sources using APA-referencing.
- Analyse whether your proposed research design is reliable (i.e. could the same results be consistently be achieved by using the same methods under the same circumstances). Provide arguments on why your research design is reliable or not. If there are points of improvement provide suggestions on how to increase the validity of your research. Provide arguments based on scientific sources (e.g. scientific articles, academic handbooks or academic websites). Refer to these sources using APA-referencing.
- Explain how the research output can be used in your digital technology integration process. What is the value of your research?

grading form

indicators	assessment criteria	U 0pt	S 2pt	G 3pt
You formulate research questions, select a relevant type of study, make an informed decision about the set-up of the research design, considering research ethics.	The context of the research is explained (i.e. research problem).	☐	☐	☐
	The research question focusses on a single problem or issue and uses specific, well-defined concept (i.e. all terms used should have clear meanings).	☐	☐	☐
	The chosen method fits well with the research question it intends to answer.	☐	☐	☐
	Basic information (what steps does this method require you to take) and several arguments are provided why this research method was chosen, based on scientific sources (reference in APA).	☐	☐	☐
	The sample design is a representative for the target group.	☐	☐	☐
You autonomously conduct the research in accordance with your research design, you analyse and interpret the data, and report the results.	The research is conducted in accordance with the chosen research design.	☐	☐	☐
	All steps within the data collection process are explained.	☐	☐	☐
	The chosen data analysis method is appropriate and basic information is provided (what steps does this method requires you to take).	☐	☐	☐
	Several arguments are provided why this data analysis method was chosen, based on scientific sources (reference in APA).	☐	☐	☐
	The results are clearly presented.	☐	☐	☐
	The results are used to answer the research question(s).	☐	☐	☐
You reflect critically on the validity, reliability and value of the research for your digital technology solution and the involved stakeholders.	Several arguments are provided why the research is valid and suggestions are given on how the validity can be improved, if necessary.	☐	☐	☐
	Several arguments are provided why the research is reliable and suggestions are given on how the validity can be improved, if necessary.	☐	☐	☐
	The student bases the arguments and suggestions about validity and reliability on scientific sources (reference in APA).	☐	☐	☐
	An explanation is given on how the predicted research output can be valuable for the digital technology integration process.	☐	☐	☐

Grading scale: we assess each criterion on the report using the Unsatisfactory (U), Satisfactory (S) and Good (G).

unsatisfactory (0 points): The work of the student does not meet the criterion or the quality of the work related to this indicator is very poor (EG many mistakes, no or wrong sources).

satisfactory (2 points): The work of the student meets the criterion, but the quality of the work still offers room for improvement

good (3 points): The work of the student completely meets the criterion and the quality of the work is very high.

grading table assignment

score	grade	score	grade
43 - 45	10	18 - 22	5
38 - 42	9	13 - 17	4
33 - 37	8	8 - 12	3
28 - 32	7	3 - 7	2
23 - 27	6	0 - 2	1

portfolio assessment systems engineering

Through this assignment, it will be assessed to what extent you meet the learning outcome ‘Systems engineering – year 1’ and its indicators. A grading form can be found on page 62. This grading form will be used to assess your portfolio.

instruction for students

context

During the first year of the master, you will be working on three challenges. In these challenges, you put your newly acquired knowledge and skills to practice. You will be using what you have learned from all five learning lines to design an integrated digital technology solution for each challenge. In the learning line ‘Systems Engineering’ you will learn different perspectives of systems engineering and you will learn how to apply them for designing an integrated digital technology solution. Both the theoretical foundation as well as practical skills on systems engineering will be introduced. You will also get acquainted with systems engineering strategies and the role of systems engineering in innovation processes in practice. Integral part of this learning line is learning how to define, substantiate and transfer the value of your solution from a business and, even broader, from a socio-technical perspective.

assignment

For the learning outcome of ‘Systems engineering’, we want you to create a portfolio. You need to document the work you have been doing, the results you have gotten and the products you have created. In other words: you must create evidence of everything you have been doing in the challenges that is related to this learning outcome. By putting the relevant pieces of evidence in your portfolio, you can show us to what extent you have achieved the learning outcome of systems engineering. The learning outcome consists of 4 indicators. These indicators specify what concrete tasks or activities you should be able to do, related to this learning outcome.

deliverables

In order to complete your portfolio, you need to have at least one piece of evidence for each indicator.
Furthermore, we want you to write a short text (A4) for each indicator, in which you include:

- information on **how and when** you worked on the indicator.
- information on **the piece(s) of evidence** you included: what does it say about the indicator?
- if a piece of evidence was created as **group work:** explain what your contribution was to the creation of the evidence.
- a short **reflection** on what you’ve learned while working on this indicator can be useful during the graduation project in the second year of the master.

The portfolio should be one complete document, which includes both the evidence and the explanatory text for each indicator. Any piece of evidence that cannot be included in the document (such as videos) should be uploaded as separate files. Clearly explain in the document which pieces of evidence are uploaded separately.

what is evidence?
A piece of Evidence is a visible example of work that you did, in relation to an indicator.
It can be a product you created, a video registration of a (design) process,
feedback you’ve gotten from your peers, a reflection you wrote, et cetera.
Our experts on each learning line can help you to create the right evidence!

criteria for good evidence
• The evidence is related to the indicator
• The evidence shows the quality of your work, your activities or your process
• The evidence shows what you did (not what your group did)

what type of evidence to include for each indicator

For each indicator, we have included a suggestion for the kind of evidence that would be most adequate to show your mastery of that indicator. In consultation with the expert of that learning line, it is always possible to include a different kind of evidence if that better suits your work on the challenge(s). You can find the list of suggested evidence as part of the grading form on page 62.

The formulation of most indicators offers quite some freedom in the context and the content in which you work on the indicator. For example: the first indicator of design-based working states: You use a design-based working approach when designing solutions for problems in an increasingly complex context. In practice, that means that you must use the design-based working approach to design a solution for one of the three challenges. The indicator does not specify what the solution should look like. As long as you use the design-based working approach, you can design any solution you see fit!

deadlines

deadline first draft	**week 13 - friday 9:00**	Hand in a first version of your portfolio: • Only focus on one indicator; you can choose which; • Include both an evidence piece and the accompanying text for this indicator; • Create a simple word document with evidence You get feedback from your assessor, who will check whether you understand the set-up of the portfolio
deadline second draft	**week 25 - friday 9:00**	Hand in a second version of your portfolio: • Focus on three indicators; you can choose which; • Include a piece of evidence and the accompanying text forthese indicators; • Create a well-designed magazine style document. You get feedback from your assessor and you can already get points for the three included indicators
deadline final version	**week 39 - friday 9:00**	Hand in the final version of your portfolio: • Include all 4 indicators; • Include piece of evidence and the accompanying text for each indicator; • Create a well-designed magazine style document. This version will be graded. If you do not get a passing grade, you have to repair the portfolio for the resit deadline. You will get clear feedback on how to repair and improve your portfolio.
deadline resit	**week 11 (year 2) - friday 9:00**	Hand in the repaired version of your portfolio. This version will be graded by the same assessor(s) as the previous version, taking your previous results and the feedback you received into account.

grading form portfolio systems engineering

learning outcomes systems engineering - year 1

indicators	suggested type of evidence
a. You determine the success factors of your product design by using functional design, modular design, ethical design and circular design. **b.** You make substantiated choices regarding marketing at product level being the 4 Ps (product, price, place, promotion) and the relevant markets of your product (local, regional, national, international). Based on these choices, you (re)formulate the design criteria for your product. **c.** When designing products for the solutions in the challenges, you determine the unique selling points of the solutions, do competitor research and calculate the price-performance ratio. **d.** You use the results of analyses of the complex context to create value propositions and business models for your digital technology solutions.	**a.** A written reflection on the design methodologies used and the achieved results and impact on your design process **b.** A poster describing and justifying the marketing aspects and design criteria for the solution designed in each of the challenges **c.** An analysis of the unique selling points, competitors and price-performance ration for the solution designed in each of the challenges **d.** * A registration and explanation of the multi-disciplinary sessions and analyses in challenge 1, 2 and 3 in which you demonstrate how stakeholders were involved and value of your solution was substantiated and transferred. * A visualisation and reflection on the designed value proposition for the solution designed in challenge 1, 2 and 3 and the business model for the solution in challenge 3

indicators	justification
The student has included the suggested piece(s) of evidence, or comparable pieces of evidence which have been approved by the learning line expert, to show his/her realisation of this indicator.	The student has justified how the evidence materials show his/her realisation of the indicator. If an evidence piece is the result of group work, the student has adequately described what his/her contribution was.
indicator A ☐ Yes ☐ No **indicator B** ☐ Yes ☐ No **indicator C** ☐ Yes ☐ No **indicator D** ☐ Yes ☐ No	**indicator A** ☐ Yes ☐ No **indicator B** ☐ Yes ☐ No **indicator C** ☐ Yes ☐ No **indicator D** ☐ Yes ☐ No

If the answer on these two questions is 'no' for one or more indicators, we cannot adequately assess whether the student has realised the learning outcome. This means that the student gets a NA for this learning outcome and has to repair the portfolio.
The next question (Quality of the evidence pieces) can be skipped.

quality of the evidence pieces

Good 7,5 - 10	Satisfactory 5,5 – 7,5	Unsatisfactory 1 - 5
The evidence pieces are clearly structured and all relevant information is available. The pieces of evidence contain no or few errors. In the evidence pieces, it is clearly visible that the various theories, methods and tools are applied correctly. The evidence pieces are of high quality and show that the student mastered the content of the indicator on a high level.	The evidence pieces are clearly structured and the most important information is available. There is only a limited number of errors in the evidence pieces. Some theories, methods and/or tools are applied correctly in the evidence pieces, but it would have been possible to utilse more relevant theories, methods and/or tools. The evidence pieces are of acceptable quality and show that the student mastered the content of the indicator on a sufficient level.	The evidence pieces contain many errors (eg. errors in calculations, interpretation mistakes, wrong applications etc.), relevant information is missing in the evidence pieces and/or the evidence pieces are badly structured and therefore incomprehensible. Theories, methods and tools have not been (visibly) applied in the evidence pieces, or they have been applied in a completely incorrect way. The evidence pieces do not show that the student sufficiently mastered the content of the indicator.
indicator A ☐ **indicator B** ☐ **indicator C** ☐ **indicator D** ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐

feedback

Grade for learning outcome Systems Engineering:

(NA if selection of evidence and/or justification was not in order)

portfolio assessment design-based working

Through this assignment, it will be assessed to what extent you meet the learning outcome 'Design-based working – year 1' and its indicators. A grading form can be found on page 65. This grading form will be used to assess your portfolio.

instruction for students

context

During the first year of the master, you will be working on three challenges. In these challenges, you put your newly acquired knowledge and skills to practice. You will be using what you have learned from all five learning lines to design an integrated digital technology solution for each challenge. In the learning line 'Design-based working' you will learn about Design Thinking and how to apply this in a project. You will also get acquainted with other human centered perspectives (e.g. co-design, participatory design, empathic design). Additionally, attention will be paid within this learning line to generating ideas, the creation and usage of prototypes throughout the design process, conducting multi-disciplinary sessions and how to transfer your design process to others using different techniques.

assignment

For the learning outcome of 'Design-based working', we want you to create a portfolio. You need to document the work you have been doing, the results you have gotten and the products you have created. In other words: you must create evidence of everything you have been doing in the challenges that is related to this learning outcome. By putting the relevant pieces of evidence in your portfolio, you can show us to what extent you have achieved the learning outcome of design-based working. The learning outcome consists of 3 indicators. These indicators specify what concrete tasks or activities you should be able to do, related to this learning outcome.

deliverables

In order to complete your portfolio, you need to have at least one piece of evidence for each indicator.
Furthermore, we want you to write a short text (A4) for each indicator, in which you include:

- information on **how and when** you worked on the indicator.
- information on **the piece(s) of evidence** you included: what does it say about the indicator?
- if a piece of evidence was created as **group work:** explain what your contribution was to the creation of the evidence.
- a short **reflection** on what you've learned while working on this indicator can be useful during the graduation project in the second year of the master.

The portfolio should be one complete document, which includes both the evidence and the explanatory text for each indicator. Any piece of evidence that cannot be included in the document (such as videos) should be uploaded as separate files. Clearly explain in the document which pieces of evidence are uploaded separately.

what is evidence?
A piece of Evidence is a visible example of work that you did, in relation to an indicator.
It can be a product you created, a video registration of a (design) process,
feedback you've gotten from your peers, a reflection you wrote, et cetera.
Our experts on each learning line can help you to create the right evidence!

criteria for good evidence
• The evidence is related to the indicator
• The evidence shows the quality of your work, your activities or your process
• The evidence shows what you did (not what your group did)

what type of evidence to include for each indicator

For each indicator, we have included a suggestion for the kind of evidence that would be most adequate to show your mastery of that indicator. In consultation with the expert of that learning line, it is always possible to include a different kind of evidence if that better suits your work on the challenge(s). You can find the list of suggested evidence as part of the grading form on page 65.

The formulation of most indicators offers quite some freedom in the context and the content in which you work on the indicator. For example: the first indicator of design-based working states: You use a design-based working approach when designing solutions for problems in an increasingly complex context. In practice, that means that you must use the design-based working approach to design a solution for one of the three challenges. The indicator does not specify what the solution should look like. As long as you use the design-based working approach, you can design any solution you see fit!

deadlines

deadline first draft	**week 13 - friday 9:00**	Hand in a first version of your portfolio: • Only focus on one indicator; you can choose which; • Include both an evidence piece and the accompanying text for this indicator; • Create a simple word document with evidence You get feedback from your assessor, who will check whether you understand the set-up of the portfolio
deadline second draft	**week 25 - friday 9:00**	Hand in a second version of your portfolio: • Focus on three indicators; you can choose which; • Include a piece of evidence and the accompanying text forthese indicators; • Create a well-designed magazine style document. You get feedback from your assessor and you can already get points for the three included indicators
deadline final version	**week 37 - friday 9:00**	Hand in the final version of your portfolio: • Include all 3 indicators; • Include piece of evidence and the accompanying text for each indicator; • Create a well-designed magazine style document. This version will be graded. If you do not get a passing grade, you have to repair the portfolio for the resit deadline. You will get clear feedback on how to repair and improve your portfolio.
deadline resit	**week 11 (year 2)** **- friday 9:00**	Hand in the repaired version of your portfolio. This version will be graded by the same assessor(s) as the previous version, taking your previous results and the feedback you received into account.

grading form portfolio design-based working

learning outcomes design-based working - year 1

indicators	**suggested type of evidence**
a. You use a design-based working approach when designing solutions for problems in an increasingly complex context. **b.** You contribute to the design process by executing creative multi-disciplinary sessions.	* Visualisation and description of the design process of challenge 1, 2 and/or 3 * Explanation of the chosen path. * A registration of the creative multi-disciplinary sessions in challenge 1, 2 and/or 3. * Brief explanation of how the multi-disciplinary sessions outcomes influenced the design process in challenge 1, 2 and/or 3. * Pictures/movies/registration of the prototypes made in challenge 1, 2 and 3, including a description. * Evidence of the conducted user tests (of challenge 1, 2 and/or 3). * An explanation of the impact that the user tests results had on their design process.

indicators	**justification**
The student has included the suggested piece(s) of evidence, or comparable pieces of evidence which have been approved by the learning line expert, to show his/her realisation of this indicator. **indicator A** ☐ **Yes** ☐ **No** **indicator B** ☐ **Yes** ☐ **No**	The student has justified how the evidence materials show his/her realisation of the indicator. If an evidence piece is the result of group work, the student has adequately described what his/her contribution was. **indicator A** ☐ **Yes** ☐ **No** **indicator B** ☐ **Yes** ☐ **No**

If the answer on these two questions is 'no' for one or more indicators, we cannot adequately assess whether the student has realised the learning outcome. This means that the student gets a NA for this learning outcome and has to repair the portfolio.
The next question (Quality of the evidence pieces) can be skipped.

quality of the evidence pieces

Good **7,5 - 10**	**Satisfactory** **5,5 – 7,5**	**Unsatisfactory** **1 - 5**
The evidence pieces are clearly structured and all relevant information is available. The pieces of evidence contain no or few errors. In the evidence pieces, it is clearly visible that the various theories, methods and tools are applied correctly. The evidence pieces are of high quality and show that the student mastered the content of the indicator on a high level.	The evidence pieces are clearly structured and the most important information is available. There is only a limited number of errors in the evidence pieces. Some theories, methods and/or tools are applied correctly in the evidence pieces, but it would have been possible to utilse more relevant theories, methods and/or tools. The evidence pieces are of acceptable quality and show that the student mastered the content of the indicator on a sufficient level.	The evidence pieces contain many errors (eg. errors in calculations, interpretation mistakes, wrong applications etc.), relevant information is missing in the evidence pieces and/or the evidence pieces are badly structured and therefore incomprehensible. Theories, methods and tools have not been (visibly) applied in the evidence pieces, or they have been applied in a completely incorrect way. The evidence pieces do not show that the student sufficiently mastered the content of the indicator.
indicator A ☐ **indicator B** ☐	☐ ☐	☐ ☐

feedback

Grade for learning outcome Design-based working:

(NA if selection of evidence and/or justification was not in order)

.38

portfolio assessment
personal & professional identity

Through this assignment, it will be assessed to what extent you meet the learning outcome 'Personal & professional identity – year 1' and its indicators. A grading form can be found on page 68. This grading form will be used to assess your portfolio.

instruction for students

context
During the master, you will discover more about your identity as a Digital Technology Engineer. Furthermore, you will work on your mission; what do I want to accomplish as a Digital Technology Engineer? You will also learn how to apply your identity and mission in your goals for your challenges and determine your learning strategy to accomplish these goals.

assignment
For the learning outcome of 'Personal and Professional Identity', we want you to create a portfolio. Use audiovisual media (eg. infographics and a documentary) to show your professional development, including the goals and success criteria you set for yourself and the way in which you worked towards these. Visualize your professional development by showing several products created throughout the master, in which you express your learning process at that moment. Make sure to include various experiences that helped you to explore your personal and professional identity, both as an individual and as a team player.
By putting the relevant pieces of evidence in your portfolio, you can show us to what extent you have achieved the learning outcome of Personal and Professional Identity. The learning outcome consists of 3 indicators. These indicators specify what concrete tasks or activities you should be able to do, related to this learning outcome.

deliverables
In order to complete your portfolio, you need to have at least one piece of evidence for each indicator.
Mandatory evidence is: Two Infographics containing the competences and learning needs regarding the tasks and responsibilities within the digital technology integration process, together with a reflection. A Documentary showing personal and professional development (identity, talent, limitations, criteria for success) during this year's learning process. An analysis of the (professional) situation and the roles one has in these situations. A learning agreement and a mid- and end term evaluation of the learning agreement. A mid- and end term reflection on one's own learning and behavior, related to their (professional) environment.
The portfolio should be one complete document, which includes both the evidence and the explanatory text for each indicator. Any piece of evidence that cannot be included in the document (such as videos) should be uploaded as separate files. Clearly explain in the document which pieces of evidence are uploaded separately.

what is evidence?
A piece of Evidence is a visible example of work that you did, in relation to an indicator.
It can be a product you created, a video registration of a (design) process,
feedback you've gotten from your peers, a reflection you wrote, et cetera.
Our experts on each learning line can help you to create the right evidence!

criteria for good evidence
- The evidence is related to the indicator
- The evidence shows the quality of your work, your activities or your process
- The evidence shows what you did (not what your group did)

what type of evidence to include for each indicator
For each indicator, we have included a suggestion for the kind of evidence that would be most adequate to show your mastery of that indicator. In consultation with the expert of that learning line, it is always possible to include a different kind of evidence if that better suits your work on the challenge(s). You can find the list of suggested evidence as part of the grading form on page XX.

The formulation of most indicators offers quite some freedom in the context and the content in which you work on the indicator. For example: the first indicator of design-based working states: You use a design-based working approach when designing solutions for problems in an increasingly complex context. In practice, that means that you must use the design-based working approach to design a solution for one of the three challenges. The indicator does not specify what the solution should look like. As long as you use the design-based working approach, you can design any solution you see fit!

deadlines

deadline first draft	**week 13 - friday 9:00**	Hand in a first version of your portfolio: • Only focus on one indicator; you can choose which; • Include both an evidence piece and the accompanying text for this indicator; • Create a simple word document with evidence You get feedback from your assessor, who will check whether you understand the set-up of the portfolio
deadline second draft	**week 25 - friday 9:00**	Hand in a second version of your portfolio: • Focus on three indicators; you can choose which; • Include a piece of evidence and the accompanying text forthese indicators; • Create a well-designed magazine style document. You get feedback from your assessor and you can already get points for the three included indicators
deadline final version	**week 35 - friday 9:00**	Hand in the final version of your portfolio: • Include all 3 indicators; • Include piece of evidence and the accompanying text for each indicator; • Create a well-designed magazine style document. This version will be graded. If you do not get a passing grade, you have to repair the portfolio for the resit deadline. You will get clear feedback on how to repair and improve your portfolio.
deadline resit	**week 11 (year 2) - friday 9:00**	Hand in the repaired version of your portfolio. This version will be graded by the same assessor(s) as the previous version, taking your previous results and the feedback you received into account.

grading form portfolio personal & professional identity

learning outcomes personal & professional identity - year 1	
indicators	**suggested type of evidence**
a. Based on your personal background, talents and limitations, you take ownership of the innovation process and perform specific tasks in this process.	* Description of a specific situation where talents and limitations played an important role, followed by a reflection on this indicator
b. You approach and understand a situation from at least two social-economic, political and cultural perspectives, consciously and respectfully discovering the diversity and uniqueness of your team members.	* Description of a specific situation based on two different perspectives related to the diversity of team members, followed by a reflection on this indicator
c. You can explicate your own learning strategy. You use this strategy in a self-directed way to accomplish learning goals and you can reflect on your learning process.	* Explanation of your learning strategy followed by a reflection on your learning process

indicators	**justification**
The student has included the suggested piece(s) of evidence, or comparable pieces of evidence which have been approved by the learning line expert, to show his/her realisation of this indicator.	The student has justified how the evidence materials show his/her realisation of the indicator. If an evidence piece is the result of group work, the student has adequately described what his/her contribution was.
indicator A ☐ **Yes** ☐ **No**	**indicator A** ☐ **Yes** ☐ **No**
indicator B ☐ **Yes** ☐ **No**	**indicator B** ☐ **Yes** ☐ **No**
indicator C ☐ **Yes** ☐ **No**	**indicator C** ☐ **Yes** ☐ **No**

If the answer on these two questions is 'no' for one or more indicators, we cannot adequately assess whether the student has realised the learning outcome. This means that the student gets a NA for this learning outcome and has to repair the portfolio.
The next question (Quality of the evidence pieces) can be skipped.

quality of the evidence pieces		
Good **7,5 - 10**	**Satisfactory** **5,5 – 7,5**	**Unsatisfactory** **1 - 5**
The evidence pieces are clearly structured and all relevant information is available. The pieces of evidence contain no or few errors. In the evidence pieces, it is clearly visible that the various theories, methods and tools are applied correctly. The evidence pieces are of high quality and show that the student mastered the content of the indicator on a high level.	The evidence pieces are clearly structured and the most important information is available. There is only a limited number of errors in the evidence pieces. Some theories, methods and/or tools are applied correctly in the evidence pieces, but it would have been possible to utilse more relevant theories, methods and/or tools. The evidence pieces are of acceptable quality and show that the student mastered the content of the indicator on a sufficient level.	The evidence pieces contain many errors (eg. errors in calculations, interpretation mistakes, wrong applications etc.), relevant information is missing in the evidence pieces and/or the evidence pieces are badly structured and therefore incomprehensible. Theories, methods and tools have not been (visibly) applied in the evidence pieces, or they have been applied in a completely incorrect way. The evidence pieces do not show that the student sufficiently mastered the content of the indicator.
indicator A ☐ **indicator B** ☐ **indicator C** ☐	☐ ☐ ☐	☐ ☐ ☐

feedback

Grade for learning outcome
Personal & professional identity:

(NA if selection of evidence and/or justification was not in order)

master digital technology engineering assessments of the graduation project

The graduation phase of the master consists of two separate assessments:
1) your graduation report (30 credits), and 2) your graduation presentation & interview (7 credits).

You can only conduct the presentation and interview, if you get a pass grade on your graduation report.

Context
You carry out a graduation project in small teams with a substantial research component. You work in a project group on a real and relevant design question within the context of and brought in by an organization that is confronted with the digital transformation. Complex problems do not always have a 1 on 1 solution. That is why a small win is a good outcome of the graduation project. You move within the eco-system of the organization. Application of digital technology in the solution (direction) is a requirement. Moreover, your solution (direction) must be transferable to other contexts or companies.

Related learning outcomes
Through both assessments, we assess your mastery of the following learning outcomes:

- Digital Technologies – Graduation Level
- Systems Engineering – Graduation Level
- Practice-Based Research – Graduation Level
- Design-Based Working – Graduation Level
- Personal & Professional Identity – Graduation Level

Digital Technologies (Graduation Level)
You use your specialised knowledge and understanding of digital technology to contribute to digital technology integration in practice. You synthesize state-of-the-art scientific research on digital technology to increase your knowledge and understanding of digital technology integration. You evaluate the impact of different technologies on humans and society.

1. You use your specialised knowledge and understanding of digital technologies to effectively contribute to the development of a digital technology solution in a design-based project, taking ethical and sustainability aspects into account.
2. You are able to (re)design or extend solutions by using structured, unstructured and real-time data obtained from different sources (such as sensors, online platforms and databases).
3. You are able to (re)design or extend solutions by using structured, unstructured and real-time data obtained from different sources (such as sensors, online platforms and databases).
4. You conduct a technology impact assessment, in which you analyse the impact of a future digital technology product on stakeholders, society and the environment.

Systems Engineering (Graduation Level)
You have insight into the total of external factors which are critical for the successful development of your digital technology solution, and you are able to translate those factors into design criteria. You integrally use high-end methods of systems engineering for product development, to technically design an integrated digital technology solution with a value proposition and a plan for implementation or scale-up.

1. You make a strategy plan including modular production, make or buy decisions, cost price calculations and reliability studies.
2. You make substantiated choices for the development of your integrated digital technology solution, based on the analyses of all the business model elements in a complex context.
3. You use all themes of high-end systems engineering (marketing, success factors and development strategy) iteratively, to create a feasible and successful development solution. You explain the reasoning for choosing that solution above others.
4. You develop plans on how the integrated digital technology solution can be implemented or scaled up, and what is needed to accomplish this.

Practice-based research (Graduation Level)
You are able to conduct small-scale practice-based research in a highly complex context, answering research questions and using research methods that are relevant in the digital technology integration process. \\

1. You can implement an appropriate theoretical framework in your research project.
2. You use the research and its outcomes to inform the design process/decisions and to strengthen the digital technology integration.

Design-based working (Graduation Level)
You can play a leading role in the digital technology integration process with a design-based working approach.

1. You apply a design-based working approach when designing solutions for highly complex problems.
2. You use lo-fi and hi-fi prototypes and make multiple iterations based on customized methods of testing with users and other relevant stakeholders.

Personal & professional identity (Graduation Level)
As a self-directed professional, you adapt your role as digital technology engineer, and you develop yourself to meet the expectations of the professional community. As a team player, you approach a multidisciplinary and international project from a diversity of perspectives.

1. You describe your competences and learning needs and show commitment to specialize yourself in the tasks and responsibilities within the technological assignment. You continuously reflect on the execution of your work, improve yourself and show the professional behavior that is needed to achieve these goals.
2. You take ownership of your future professional role within the graduation phase, taking into account your unique identity, background, talents and limitations.
3. Being a valuable part of an international multidisciplinary team, you analyze a situation from multiple social-economic, political and cultural perspectives, respectfully taking into account the diversity of the organization and its stakeholders.

instructions on the graduation report

Assignment
During the graduation project, you have applied and further developed your knowledge and skills on the four learning lines and the coaching line of our master's program. To show us what you did for each of the learning lines, and to show your mastery of each graduation level learning outcome, we want you to write a graduation report. This is an individual report, that should describe your contribution to the graduation project. The report should cover all relevant aspects of your graduation project.

The graduation report consists of three chapters:
1. A chapter about the **process of designing and researching** the integrated digital technology solution. In this chapter, you show your mastery of the graduation level learning outcomes Design-Based Working and Practice-Based Research.
2. A chapter on **the products you created** as your integrated digital technology solution, including a (technical) justification. This chapter covers the integrated digital technology product, the underlying business models and your overarching system design. In this chapter, you show your mastery of the graduation level learning outcomes Digital Technologies and System Engineering.
3. A chapter on your **identity and professional development**, in which you describe your professional development during the graduation project. In this chapter, you show your mastery of the graduation level learning outcome Personal & Professional Identity.

In each chapter, we want you to create separate sections for each or the learning outcomes. A detailed description of the content, appendices and grading criteria for each chapter can be found on pages 75 - 80 (Appendix A)

Format and style of the report
We want you to design the report as an interactive PDF-magazine, using Indesign. There will be supporting classes and guidance to help you design this format. Next to the interactive magazine, we want you to create a plain-text version of the report (excluding evidences/appendices and all other visualisations). This version will be used as a plagiarism check.

Grading criteria
The grading criteria for each chapter can be found on pages 81 - 84 (Appendix B)

Formal requirements for the report
Not meeting the formal requirements will result in a fail grade.
- The report and appendices should be in English
- The readability and consistency of the text is not hindered by a severe amount of language and grammatical errors
- Use hyperlinks to directly link to your evidence/appendices in the text of the relevant section.
- The chapters should not exceed the following amount of words:
  chapter 1 – maximum 4000 words
  chapter 2 – maximum 6000 words
  chapter 3 – maximum 1500 words
- At the end of the report, you have to include a table with all pieces of evidence (appendices) used in the three chapters. For each piece, give the following information: name of the piece, the type of evidence (photo, document, video, etc.), the date the evidence was created, the name of the creator of the evidence (did you make it yourself, did you make it as part of a group, et cetera).

Deadlines

Type of Deadline	Date	What to hand in?	Function of the deadline
Deadline first draft	Week 23 Friday 9:00	You hand in a draft outline of your graduation report, and for each chapter/ section you include the evidence (appendices) that you already made during the first weeks of your DBP.	You get formative feedback on the outline of your report and the included appendices. Feedback will be mainly on structure, not on content level.
Deadline second draft	Week 30 Friday 9:00	You hand in an elaborated draft of your graduation report, including the sections of at least 3 learning outcomes. These sections do not have to be complete yet, but should be as complete as possible.	You get formative feedback by one of our examiners, focusing on the content and appendices of the 3 (or more) near-complete sections.
Deadline final version	Week 38 Monday 9:00	You hand in the final version of your graduation report. Through this report we assess your mastery of all learning outcomes on graduation level.	You get a formal (summative) assessment by two examiners, using the assessment form found in appendix A.
Deadline resit	Week 0 Monday 9:00	If your final version was graded as insufficient for one or more learning outcomes, you have to repair your report before the resit deadline.	You get a formal (summative) re-assessment by two examiners, using the assessment form found in appendix A.

Examiners
You will be assigned two examiners by the Board of Examiners. One was involved in supervising your graduation project, but the other one is independent. Both examiners are members of the teaching staff of the master and have been appointed by the board of examiners.

Procedure
- You have to upload both the plain-text version and the Indesign magazine version of the report through Gradework. A link will be provided on the portal.
- The examiners will each independently assess your report and grade each chapter. Afterwards, they will discuss their observations and assessment, and come to a consensus on the grade of each chapter and the resulting final grade.
- You will receive your grade and feedback within 10 working days after the official deadline.

Education and support, that help you prepare for the graduation report
In the course on practice-based research, you will learn how to report adequately and refer to the sources used. In the learning line design-based working you will learn how to make use of Indesign to create the magazine version of your report. The tutor of your graduation project will also discuss the progress of your graduation report with you. If you need specific help or support for the content of your report, you can contact the teacher(s) of the relevant learning line(s).

instructions on the graduation presentation and interview

Entry Requirements
You can only conduct the graduation presentation and interview if you passed all other examinations of the master with a sufficient grade. This includes the graduation report.

Assignment
Prepare a presentation, with a length of 15 – 20 minutes, about your individual contribution to the graduation project. The presentation should have the following structure:
1. Briefly present your design and research process;
2. Present your results, consisting of the integrated digital technology solution, with accompanying business model and the overarching engineered system;
3. Shortly recap your professional development;
4. End by presenting your ideas on the possibility to transfer the designed digital technologies solution or the lessons learned in the innovation process, to comparable problems or innovation-opportunities in other (international) contexts.

After the presentation, you will be asked several questions. This interview will also take 15 – 20 minutes. The questions will partially be about the project itself, based on the report and the presentation, and partially on the possibilities of transferring the project or process to other situations and contexts.

Format and style of the presentation
There is no prescribed format or style of the presentation. The style of the presentation should reflect your personal identity, and be suitable for your desired professional context.

Grading criteria
The grading criteria for the presentation and interview can be found in appendix C: Grading form Graduation Presentation & Interview.

Formal requirements for the presentation
Not meeting the formal requirements will result in a fail grade.
- Presentation and interview should be in English
- Total length is 15 – 20 minutes
- All the given topics are covered (process, results, development and transfer)
- The style and delivery of the presentation is are suitable for the desired professional context of the student

Deadlines

Opportunity	When?	Information on the opportunity
First Opportunity	**Week 39** (see schedule for exact date)	This is the first official opportunity to conduct the graduation presentation and interview.
Second opportunity (Resit)	**Week 0** (see schedule for exact date)	This is the second official opportunity to conduct the graduation presentation and interview. Students who did not meet the requirements for the first opportunity, or who failed the first opportunity, can conduct the graduation presentation and interview at this moment.
Extra opportunities	Scheduled on individual basis by master coordinator	Every student is entitled to two opportunities, per study year, to do the graduation presentation and interview. If a student does not meet the requirements to conduct this examination during the first / second official opportunity, a new opportunity can be scheduled on an individual basis.

Examiners
The two examiners of your graduation report will also be the examiners of your graduation presentation and interview. In addition, an external advisor might also attend the presentation and ask some questions during the interview. This advisor is a representative from a company or organisation of the professional field of the master. This should be a different organisation from the one in which you did your project. The external advisor only has an advisory role and does not assess you. The advisor therefore has no influence on your grade for this examination.

In some cases, a representative from the Board of Examiners can be an independent observer during the interview. This is done for quality assurance purposes and this person will not assess you or influence your grade.

Procedure
- You have 10 minutes to set-up the presentation, before the examiners come in
- Deliver your presentation in 15 to 20 minutes
- For again 15 to 20 minutes, questions will be asked about your presentation, your graduation project, the learning outcomes and your ideas on transferring the project or process to other situations and contexts.
- After the questions, you have to leave the room. The examiners will come to a consensus on your grade and fill out the assessment form.
- Afterwards, you come back in. The examiners will share the final grade and give you their feedback.

Education and support, that help you prepare for the assessment
Students are supported in the preparation of their assessment in the field of communication and presentation skills in the coaching line and in the Design-based working and Practice-based reserch learning lines. This involves the presentation of data, appropriate language tailored to the target group, and personal presentation as a professional. Moreover, students receive feedback, feed up and feed forward on their presentation skills during coaching sessions and product presentations.

Appendix A: Guideline graduation report

Chapter 1 – The design and research process
The chapter should consist of two sections: one on the design process of the digital technology solution, and one on the research process which supported the design process. Both sections should contain a description of the process and a justification of the choices made in that process. In addition, we want you to include a selection of evidence of the different moments and phases of these processes.
More detailed guidelines for each section can be found in the table below:

Chapter section	Design Process	Research process
Related learning outcome	Design-Based Working - Graduation Level	Practice-Based Research - Graduation Level
Guidelines for the content of this section	Explicate your design process, using both a description and a visualisation of this process. Explain the chosen path and the iterations made with regard to your digital technology solution, refering to the appropriate appendices.	Describe and explain the small-scale practice-based research studies that you have conducted. For each study, refer to the appropriate appendices. Describe how each research study has strengthened your digital technology solution. Reflect on the validity and reliability of the conducted research and on the value of the research output.
Mandatory evidence (appendices)	• The set-up, results and conclusions of all creative multi-disciplinary sessions. • Pictures/movies/etc. of all prototypes (lo-fi and hi-fi) including a description of how these prototypes individually contributed to your final digital technology solution. • Evidence of the conducted user tests or tests with other stakeholders.	For each small-scale practice-based research study the following should be included: • The research proposal • Informed consents of participants • The analysed research data / research results • A reflection on the validity, reliability and the value of the conducted research and the relevant literature.
Optional evidence (appendices)	• Evidence of the creative multi-disciplinary sessions.	• The gathered research data • Analysis of the research data • Audio or video-registrations of the research (or other material that was gathered during the research studies)

Grading criteria for chapter 1	
Design Process	**Research process**
Criteria are used to assess the learning outcome Design-Based Working - Graduation Level	Criteria are used to assess the learning outcome Practice-Based Research - Graduation Level
✓ The student used a design-based working approach. ✓ The student explained his/her individual design process in regard to their digital technology solution. ✓ The student used clear visualisations to illustrate the design process. ✓ The student conducted at least two creative multi-disciplinary sessions and explained how these contributed to the digital technology solution. ✓ The student made at least one lo-fi and one hi-fi prototype and explained how these contributed to the digital technology solution. ✓ The student justified at least two iterations during their design process based on the outcomes of the user tests with users and other relevant stakeholders.	✓ The student conducted and described at least three small-scaled practice-based research studies, of which at least 2 are user tests. ✓ The student formulated research questions relevant to the process of digital technology integration. ✓ The student selected and explained appropriate (qualitative or quantitative) practice-based research (or user testing) methods to answer the research question. ✓ The student made an informed decision about the set-up of the studies considering research ethics. ✓ The student autonomously conducted the research in accordance with the research design. ✓ The student analysed and interpreted the data of the research studies. ✓ The student reported and explained the research results. ✓ The student reflected critically on the validity and reliability of the conducted research and the relevant literature. ✓ The student explained the value of the research output for the digital technology solution and the involved stakeholders and how these research studies and outcomes have strengthen the digital technology integration.

Chapter 2 – The designed products

The chapter should consist of three sections: 1) the digital technology solution, with a technical justification, 2) the business models underlying this solution, and 3) the overarching system design. Each section should include a description of the relevant product(s), evidence of these products and a justification of the design of the product(s). More detailed guidelines for each section can be found in the table below:

Chapter section	Technical design justification	Engineered system justification
Related learning outcome	Digital Technologies - Graduation Level	Systems Engineering - Graduation Level
Guidelines for the content of this section	Describe and explain (the minimal viable) product you have created for the customer, and the phases of the technical development of the product. This should consist out of several phases (e.g. design, create, validate) as chosen to best fit the technical development. Explain the automated process steps, the impact on the business, with consideration on ethical impact. Describe the results of your Technology Impact Assessment. Code, used data (test set) and other technical documentation should be added to the appropriate appendices.	Describe and explain the engineered system (from customer demand to customer delivery) and its business case. Account for the chosen break-down structure of the complete system by explaining the individual function of each subsystem, referring to the appropriate appendices that show the (sub)system(s). Make sure your business case includes a sustainable value proposition, sound business model and a plan for implementing or scaling up your designed system. Explain how you developed the set of high end user and stakeholder requirements and how you translated them into system requirements and set-up of the business case. Justify the system and business case, by showing how you tested whether the engineered system matches the system requirements, and by showing how you validated if the system and business case meets the high end user and stakeholder requirements.
Mandatory evidence (appendices)	• Methodology choice (phasing of the development) • Source list of used scientific sources in regard to the product you have developed (APA style) • Data sources, named and explained • Feedback from customer, experts, colleagues and teachers, which support the choices made • Technology Impact Assessment	• The set of high end user requirements • The set of system requirements, based on your analysis of the relevant influence factors • The relative weight of each system requirement • The engineered system • Results of the tests of subsystems to prove your system requirements • Results of the validation of the engineered system to prove the user requirements
Optional evidence (appendices)	• Code (Link or Reference) • Data sets (test sets) • Explanation of chosen IoT Technology • Visualizations	• The results of your (partially quantified) analyses of the relevante influence of factors on the system and its value proposition and business model • Feedback from experts, colleagues and teachers which support the choices made • Multimedia in which is shown how the stakeholders were involved in designing the engineered system, its value proposition, • business model and plan for implementation and/or scale up • Multiple iterations of the design of the engineered (sub) systems, its value proposition and business model

Grading criteria for chapter 2	
Technical design justification	**Engineered system justification**
Criteria are used to assess the learning outcome Digital Technologies - Graduation Level	Criteria are used to assess the learning outcome Systems Engineering - Graduation Level
✓ The student has successfully used structured, unstructured and/or real-time data in the solution. ✓ The student has successfully used at least one digital technology (such as Data, AI & IoT) in the solution. ✓ The student demonstrates the ability to develop and evaluate products, processes, systems, methods, or technical solutions in a methodically sound way ✓ In the technology impact assessment, the student takes into account circumstances and needs, as well as society's goals in terms of ethical, social, and ecological sustainable development. ✓ The student has based design choices on information from scientific sources and has correctly referred to these sources. ✓ The student has visibly used the collected feedback (from customer, experts, colleagues and teachers), to make design choices or validate earlier made choices.	✓ The student thoroughly explains the design of the engineered system, the design of the involved subsystems, the set-up of a strategy plan for implementation and the set-up of its business case ✓ The student provides a sound argument for each of the high user and stakeholder requirements ✓ The student explains the interaction of different parts of the system (digital solutions, analog circuits, mechanical parts, etc..) and its impact on the overall performances of the final product. ✓ The student translated the system requirements from a wide range of relevant influence factors ✓ The student shows a sounds value proposition of the engineered system which fits with the designed business model and relevant ecosystem in which it will be used. The related implementation and/or scale-up plan is realistic, well-argued and accepted by relevant stakeholders. ✓ The student conducted various (partially quantified) analyses and tests with proven methodologies to determine wether the relevant subsystems of the engineered system and business case elements match the system and stakeholder requirements. The tests are valid and the results are sufficiently reliable ✓ The student explains how (s)he validated whether the engineered system and business case meet the high user and stakeholder requirements

Chapter 3 – Identity and professional development
The chapter does not consist of separate sections, but is one coherent story on your professional development during the entire master program. You should mainly include media that shows various moments of your development. More detailed guidelines for each section can be found in the table below:

Chapter section	Identity and professional development
Related learning outcome	Personal & Professional Identity - Graduation Level
Guidelines for the content of this section	Use audiovisual media (eg. infographics and a documentary) to show your professional development during the master, including the goals and success criteria you set for yourself and the way in which you worked towards these. Visualise your professional development by showing several products created throughout the master, in which you express your learning process at that moment. Make sure to include various experiences that helped you to explore your personal and professional identity, both as an individual and as a team player.
Mandatory evidence (appendices)	• Two Infographics containing the competences and learning needs regarding the tasks and responsibilities within the digital technology integration process, together with a reflection. • Documentary showing personal and professional development (identity, talent, limitations, criteria for success) during this year's learning process. • Analysis of the (professional) situation and the roles one has in these situations. • A learning agreement and a mid- and end term evaluation of the learning agreement. • A mid- and end term reflection on one's own learning and behaviour, related to their (professional) environment.
Optional evidence (appendices)	• Feedback from colleagues, teachers and students. • Multimedia in which development is shown, such as pictures, texts, vlogs, podcast, blog, etc. • A description of the own environment and how the student participates in this environment (as a team member, a loner, a ...) • Multiple tests that pinpoints the students' specific learning needs for the competencies needed to be a professional that adds value to his environment. • Photo collage that shows your team membership from multiple social, economic, political and cultural perspectives. • An in-depth reflection on the development of your personal identity • An in-depth reflection on the development of your professional identity, using the seven phases of the Self-Directed Professional.

Grading criteria for chapter 3
Identity and professional development
Criteria are used to assess the learning outcome Personal and Professional Identity - Graduation Level
✓ The student has taken responsibility, and has shown commitment, to various tasks and responsibilities within the digital technology process. ✓ The student has shown enough information in the two infographics to show his/her personal learning process. ✓ The student uses at least ten different learning experiences in the documentary and uses these to explain his/her learning process. ✓ The photo collage shows at least 30 photographs in which images are connected through their social, economic, political and cultural meaning. ✓ The student critically analyses his/her situation using multiple point of views (economic, cultural, historical, ideological, …). ✓ The student uses multiply tests to objectively analyse the way he participates in his (professional) environment, related to the roles (s)he has fulfilled in the graduation project. ✓ The student drafts his own learning agreement that includes the conditions, actions, content, evaluation criteria and evidence of accomplishment. ✓ The student reflects at least mid- and end term his learning and behaviour, related to his own learning agreement, and reflects on the evidence of accomplishment as well. ✓ The student shows that the results of his learning and behaviour is validates by peers and for his profession relevant others.

Appendix B: Assessment form Graduation Report

Student name: _____
Student number: _____
Date: _____

Name first examiner: _____
Name second examiner: _____

Formal requirements
Not meeting the formal requirements will result in a fail grade.

- ☐ All references to sources are in APA-style
- ☐ The readability and consistency of the text is not hindered by a severe amount of language and grammatical errors
- ☐ The student used hyperlinks to directly link to the evidence/appendices in the text of the relevant section
- ☐ The chapters do not exceed the maximum amount of words (chapter 1: 4000, chapter 2: 6000, chapter 3: 1500)
- ☐ The report includes a table of evidence/appendices, including the name, type, date and creator(s) of each evidence

Chapter 1

Section on design process		**Section on research process**	
Assessed learning outcome: Design-based Working		Assessed learning outcome: Practice-based Research	
Knock-out Criteria: ☐ The content of the section matches the guidelines ☐ All mandatory appendices are included ☐ The student refers or links to the appropriate appendices, when relevant		*Knock-out Criteria:* ☐ The content of the section matches the guidelines ☐ All mandatory appendices are included ☐ The student refers or links to the appropriate appendices, when relevant	
Criteria concerning content and quality (based on the learning outcome & indicators): ☐ The student used a design-based working approach. ☐ The student explained his/her individual design process in regard to their digital technology solution. ☐ The student used clear visualisations to illustrate the design process. ☐ The student conducted at least two creative multi-disciplinary sessions and explained how these contributed to the digital technology solution. ☐ The student made at least one lo-fi and one hi-fi prototype and explained how these contributed to the digital technology solution. ☐ The student justified at least two iterations during their design process based on the outcomes of the user tests with users and other relevant stakeholders.		*Criteria concerning content and quality (based on the learning outcome & indicators):* ☐ The student conducted and described at least three small-scaled practice-based research studies, of which at least 2 are user tests. ☐ The student formulated research questions relevant to the process of digital technology integration. ☐ The student selected and explained appropriate (qualitative or quantitative) practice-based research (or user testing) methods to answer the research question. ☐ The student made an informed decision about the set-up of the studies considering research ethics. ☐ The student autonomously conducted the research in accordance with the research design. ☐ The student analysed and interpreted the data of the research studies. ☐ The student reported and explained the research results. ☐ The student reflected critically on the validity and reliability of the conducted research and the relevant literature. ☐ The student explained the value of the research output for the digital technology solution and the involved stakeholders and how these research studies and outcomes have strengthened the digital technology integration.	
Grading scale: If the knock-out criteria are not met: grade = 4.0 In order to get a pass grade (> 5.5), at least 5 out of the 6 content criteria should be met. The exact grade is determined on basis of the quality of the students' work in relation to the learning outcome.	*Grade for learning outcome Design Based working:*	**Grading scale:** If the knock-out criteria are not met: grade = 4.0 In order to get a pass grade (> 5.5), at least 7 out of the 9 content criteria should be met. The exact grade is determined on basis of the quality of the students' work in relation to the learning outcome.	*Grade for learning outcome Practice-based Research:*
Justification of the grade:		*Justification of the grade:*	

Chapter 2

Grading criteria for chapter 2					
Section on technical design justification		**Section on business plan justification**		**Section on engineered system justification**	
Assessed learning outcome: Design-based Working				Assessed learning outcome: Practice-based Research	
Knock-out Criteria: ☐ The content of the section matches the guidelines ☐ All mandatory appendices are included ☐ The student refers or links to the appropriate appendices, when relevant		*Knock-out Criteria:* ☐ The content of the section matches the guidelines ☐ All mandatory appendices are included ☐ The student refers or links to the appropriate appendices, when relevant		*Knock-out Criteria:* ☐ The content of the section matches the guidelines ☐ All mandatory appendices are included ☐ The student refers or links to the appropriate appendices, when relevant	
Criteria concerning content and quality (based on the learning outcome & indicators): ☐ The student has successfully used structured, unstructured and/or real-time data in the solution. ☐ The student has successfully used at least one digital technology (such as Data, AI and IoT) in the solution. ☐ The student demonstrates the ability to develop and evaluate products, processes, systems, methods, or technical solutions ☐ In the Technology Impact Assessment, the student takes into account circumstances and needs, as well as society's goals in terms of ethical, social, and ecological sustainable development.		*Criteria concerning content and quality (based on the learning outcome & indicators):* ☐ The student shows a sound value proposition of his final product which fits with the designed business model and relevant ecosystem in which the final product will be used ☐ The student performs partially quantified analyses with proven methodologies to support the choices made for the business case ☐ The student uses feedback from at least three different experts to validate the choices made for the business case ☐ The student demonstrates that relevant stakeholders were actively involved in the design of the business case and implementation plan ☐ The implementation / scale-up plan is realistic, well-argued and accepted by the relevant stakeholders		*Criteria concerning content and quality (based on the learning outcome & indicators):* ☐ The student thoroughly explains the design of the engineered system and the involved subsystems ☐ The student provides a sound argumentation for each of the high end user requirements ☐ The student explains the interaction of different parts of the system (digital solutions, analog circuits, mechanical parts, etc..) and its impact on the overall performances of the final product. ☐ The student translated the system requirements from a wide range of influence factors, taking into account the 4 P's (product, price, place and promotion) ☐ The student conducted various tests to determine whether the relevant subsystems of the engineered system match the system requirements. The tests are valid and the results are sufficiently reliable ☐ The student explains how (s)he validated whether the engineered system meets the high end user requirements	
Grading scale: If the knock-out criteria are not met: grade = 4.0 In order to get a pass grade (> 5.5), at least 5 out of the 6 content criteria should be met. The exact grade is determined on basis of the quality of the students' work in relation to the learning outcome.	*Grade for learning outcome Digital Technologies:*	**Grading scale:** If the knock-out criteria are not met: grade = 4.0 In order to get a pass grade (> 5.5), at least 5 out of the 6 content criteria should be met. The exact grade is determined on basis of the quality of the students' work in relation to the learning outcome.	*Grade for learning outcome Social Entrepreneurship:*	**Grading scale:** If the knock-out criteria are not met: grade = 4.0 In order to get a pass grade (> 5.5), at least 5 out of the 6 content criteria should be met. The exact grade is determined on basis of the quality of the students' work in relation to the learning outcome.	*Grade for learning outcome System Engineering:*
Justification of the grade:		*Justification of the grade:*		*Justification of the grade:*	

Section on identity and professional development
Assessed learning outcome: personal & professional identity
Knock-out Criteria: ☐ The content of the section matches the guidelines ☐ All mandatory appendices are included ☐ The student refers or links to the appropriate appendices, when relevant
Criteria concerning content and quality (based on the learning outcome & indicators): ☐ *The student has taken responsibility, and has shown commitment, to various tasks and responsibilities within the digital technology process.* ☐ *The student has shown enough information in the two infographics to show his/her personal learning process.* ☐ *The student uses at least ten different learning experiences in the documentary and uses these to explain his/her learning process.* ☐ *The student critically analyses his/her situation using multiple point of views (economic, cultural, historical, ideological, …).* ☐ *The student uses multiply tests to objectively analyse the way he participates in his (professional) environment, related to the roles (s)he has fulfilled in the graduation project.* ☐ *The student drafts his own learning agreement that includes the conditions, actions, content, evaluation criteria and evidence of accomplishment.* ☐ *The student reflects at least mid- and end term his learning and behaviour, related to his own learning agreement, and reflects on the evidence of accomplishment as well.* ☐ *The student shows that the results of his learning and behaviour is validated by peers and for his profession relevant others.*

Grading scale: If the knock-out criteria are not met: grade = 4.0 In order to get a pass grade (> 5.5), at least 5 out of the 6 content criteria should be met. The exact grade is determined on basis of the quality of the students' work in relation to the learning outcome.	*Grade for learning outcome Personal & Professional Identity:*
Justification of the grade:	

Learning outcome	**Grade**
Design-based Working	
Practice-based Research	
Digital Technologies	
System Engineering	
Personal & Professional Identity	
Final Report Grade: *Average of the 6 grades above*	

First examiner:

Signature:

Second examiner:

Signature:

Appendix C: Assessment form Graduation Presentation & Interview

Formal Requirements (knock-out criteria)
- ☐ Total length is 15 – 20 minutes
- ☐ All the required topics are covered (process, results, professional development and transfer to other contexts)
- ☐ The presentation is suitable for the desired professional context of the student

	Insufficient	Sufficient	Good
Design and Research Process (20%)	The student did not clearly present the design and research processes conducted during the graduation project and/or could not correctly answer several critical questions related to the graduation-level learning outcomes design-based working and practice-based research.	The student clearly presented the design and research processes conducted during the graduation project and was able to correctly answer most critical questions related to the graduation-level learning outcomes design-based working and practice-based research.	The performance of the student matches the description of 'sufficient', and moreover: When presenting and/or when answering questions, the student is able to connect the perspectives or specific elements of both learning outcomes, showing understanding of the interdependence of practice-based research and design-based working.
	1,0 2,0 3,0 4,0 5,0	5,5 6,0 6,5 7,0 7,5	8,0 8,5 9,0 9,5 10,0
Results (Products) (30%)	The student did not clearly present the three types of products/results created during the graduation project (digital technology solution, the business elements and the engineered system) and/or the student could not correctly answer several critical questions related to the graduation level learning outcomes digital technologies, social entrepreneurship and systems engineering.	The student clearly presented the three types of products/results created during the graduation project (digital technology solution, the business elements and the engineered system) and the student was able to correctly answer most critical questions related to the graduation level learning outcomes digital technologies, social entrepreneurship and systems engineering.	The performance of the student matches the description of 'sufficient', and moreover: When presenting and/or when answering questions, the student is able to connect the perspectives or specific elements of the three learning outcomes, showing understanding of the relationship between digital technologies, social entrepreneurship and systems engineering in the final solution.
	1,0 2,0 3,0 4,0 5,0	5,5 6,0 6,5 7,0 7,5	8,0 8,5 9,0 9,5 10,0
Professional Development (10%)	The student did not clearly present his/her professional development and professional identity and/or could not correctly answer several critical questions related to the graduation level learning outcome professional and personal identity.	The student clearly presented his/her professional development and professional identity and was able to correctly answer most critical questions related to the graduation level learning outcome professional and personal identity.	The performance of the student matches the description of 'sufficient', and moreover: Both in the style and delivery of the presentation, and while answering the questions, the student confidently and consistently shows his/her developed professional identity (e.g. in attitude, behaviour, language and posture)
	1,0 2,0 3,0 4,0 5,0	5,5 6,0 6,5 7,0 7,5	8,0 8,5 9,0 9,5 10,0
Transfer to other contexts (40%)	The student does not present ideas, and/or adequately answer explorative questions, about possibilities of transferring (parts of) the designed digital technologies solution or lessons learned in the innovation process, to comparable problems or innovation-opportunities in other (international) contexts. The student is not able to generalise the graduation project beyond the scope of the context in which it was conducted.	The student both present ideas and answers explorative questions about possibilities of transferring (parts of) the designed digital technologies solution or lessons learned in the innovation process, to comparable problems or innovation-opportunities in other (international) contexts. The student uses convincing arguments to support these possibilities.	The performance of the student matches the description of 'sufficient', and moreover: The student either comes up with a wide range of innovative possibilities, on a more abstract level, or discusses two or three specific possibilities in much detail and from various perspectives.
	1,0 2,0 3,0 4,0 5,0	5,5 6,0 6,5 7,0 7,5	8,0 8,5 9,0 9,5 10,0

Result Graduation Presentation & Interview

Student name: _____
Student number: _____
Date: _____

Design and Research Process	Results (Products)	Professional Development	Transfer to other contexts
Weight 20%	**Weight 30%**	**Weight 10%**	**Weight 40%**
Calculated final result:			

Feedback by examiners:

First Examiner	Second Examiner	Student
Name:	**Name:**	**Name:**
Signature:	**Signature:**	**Signature:**

Comments by external advisor (if applicable):

pulsed®

Fontys | fontyspulsed.com