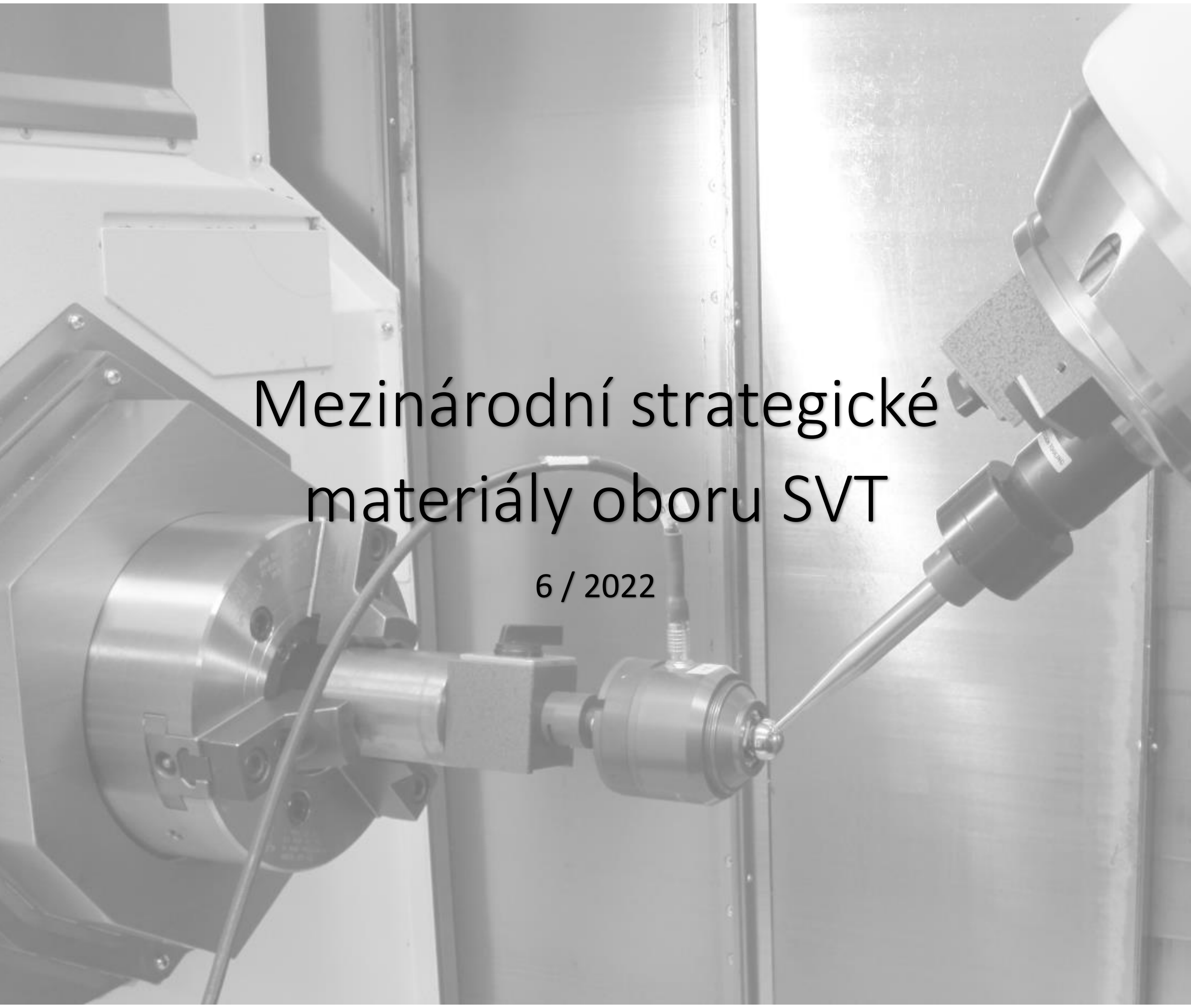

Mezinárodní strategické materiály oboru SVT

6 / 2022

EVROPSKÁ UNIE
Evropský fond pro regionální rozvoj
Operační program Podnikání
a inovace pro konkurenceschopnost

Dokument zpracovaný v rámci projektu

Technologická platforma strojírenská výrobní technika IV

Registrační číslo projektu: CZ.01.1.02/0.0/0.0/17_105/0018877

Obsah

1. Úvod

Citace ze studie proveditelnosti definuje tento dokument: V rámci aktivity PA2 budou shromažďovány podkladové materiály na evropské úrovni (CECIMO, MANUFUTURE, EFFRA, EC, případně další) se zaměřením na strategická, technologická, ekonomická a společenská témata v oboru. Soubor těchto strategických mezinárodních materiálů bude zpracován v souhrnné zprávě "Mezinárodní strategické materiály oboru SVT", která krátce shrne obsah těchto materiálů a bude v příloze obsahovat jejich plné znění. Takto budou zpracovány pro potřeby českých podnikatelských subjektů i výzkumných organizací v oboru SVT.

2. Strategické a podkladové mezinárodní dokumenty

2.1. MANUFUTURE Strategic Research and Innovation Agenda 2030

Strategická agenda výzkumu a inovací (SRIA) popisuje ekosystém výrobního výzkumu a inovací v Evropě a jeho jedinečné vlastnosti. Představuje integrovanou strategii pro propojení základní vědy s aplikovaným výzkumem ve výrobě, která zasahuje do různých fází výzkumu a vývoje. Popisuje nejdůležitější vědecké a technologické výzvy: Přidaná hodnota v systému výroby, Horizontální a vertikální integrace, Cesta k cirkulární ekonomice a Decentralizovaná technická inteligence. V hlavní části uvádí hlavní priority výzkumu v rámci 10 prioritních oblastí výzkumu a inovací pro úspěšnou evropskou výrobu. SRIA je doplněna doplňujícími stavebními bloky pro úspěšnou výrobu: Inovace a podnikání, vzdělávání a školení a odpovídající spolupráce s dalšími iniciativami.

2.2. Progress in International Standardization for AM

Jedná se o prezentaci předsedy komise ISO/TC261 Prof. Dr. Ing. Christian Seidela, který představuje budoucí progres ve standardizaci v oblasti aditivních tehcnologií. Aditivní technologie jako moderní a nová výrobní technika nemá dosud standardizované okrajové podmínky pro proces, materiál i technologii a toto zpracování právě probíhá a je velmi aktuální.

Aktuální výzvy v oblasti standardů AM:

- Rychle rostoucí seznam organizací pracujících/plánujících rozvoj AM standardy Rozsah SDO se vyvíjel
- Vysoké riziko zdvojení úsilí a překrývajícího se obsahu
- Možnost vzniku nesrovnalostí, nebo dokonce protichůdné normy vytvářejí nejednoznačnost a zmatek
- Důležitá je koordinace/spolupráce

Další související zdrojové dokumenty a přílohy: Proposals for the Additive Manufacturing Committee.pdf, Sustainable_additive_manufacturing.pdf

2.3. CECIMO - Guidelines for companies to Taxonomy

Nařízení (EU) 2020/852, známé jako nařízení o taxonomii, zavádí rámec pro usnadnění udržitelných investic. Jeho cílem je vytvořit „zelený seznam“ ekologicky udržitelných ekonomických činností. Taxonomie byla koncipována jako investiční nástroj, který by usnadnil udržitelné investice tím, že pomocí vědeckých kritérií identifikuje a definuje činnosti, které jsou považovány za udržitelné. Použití taxonomie je z velké části dobrovolné, nicméně podle článku 8 nařízení o taxonomii jsou subjekty, na které se v současnosti vztahuje směrnice o nefinančním výkaznictví (NFRD – v současné době v revizi podle návrhu směrnice o Corporate Sustainability Reporting), povinny taxonomii zveřejnit. způsobilost a sladění jejich obchodních aktivit nebo jejich investic v případě finančních institucí. Za účelem upřesnění dalších podrobností a požadavků předložila Komise několik aktů v přenesené pravomoci, jako je akt v přenesené pravomoci podle článku 8, akt v přenesené pravomoci o klimatu a doplňkový akt v přenesené pravomoci, který má být dosud zveřejněn. Platforma pro udržitelné finance navíc předložila návrhy na rozšířenou environmentální taxonomii i sociální taxonomii.

2.4. CECIMO GUIDE TO EU FUNDING OPPORTUNITIES

V současné digitální době představuje politika výzkumu a inovací důležitý nástroj k dosažení konkurenceschopnosti a ekonomické odolnosti Evropy a zajištění její strategické technologické autonomie. V oblastech, jako je výpočetní výkon, je Evropa odhodlána využít domácí technologie a snížit závislosti v oblastech vyspělých technologií, hodnotových a dodavatelských řetězcích, jakož i životně důležitých infrastruktur. Není proto překvapivé, že evropská digitální a technická suverenita je v popředí politických debat EU. Vzhledem k víceletému finančnímu rámci 2021–2027 má Evropa ohromný nástroj k posílení globální konkurenceschopnosti EU, podpoře inovací a umožnění odolné, zelené a digitální ekonomiky. S ohledem na tyto cíle CECIMO informuje o příležitostech otevřených výzev EU podporovaných programy financování EU, které upevní evropskou strategickou autonomii v oblasti inovací na vysoké úrovni.

Brožura poskytuje přehled různých programů financování, jmenovitě: Horizon Europe, Program DigitalEurope, European Innovation Council (EIC) a EIC Accelerator, Evropský institut pro inovace a technologie (EIT) Manufacturing, Erasmus, stejně jako popis kaskádového financování. a její význam pro malé a střední podniky. Kromě toho se brožura soustředí na otevřené výzvy k předkládání návrhů v oblasti digitalizace, kybernetické bezpečnosti, umělé inteligence (AI), robotiky, aditivní výroby (AM), udržitelnosti, dovedností atd. CECIMO představilo tento nový zdroj, takže můžete najít všechny potřebné informace o nejrelevantnějších možnostech financování pro společnosti a organizace v naší síti.

2.5. CECIMO’s Reaction to the Data Act

Evropská komise zveřejnila návrh zákona o datech s cílem zajistit spravedlnost v datové ekonomice a podpořit výměnu dat mezi podniky. Navrhovaný zákon vede ke strategickému přístupu a legislativnímu rámci ve vztazích sdílení dat B2B.

CECIMO se jménem průmyslu obráběcích strojů a souvisejících výrobních technologií zavazuje zvyšovat povědomí o důležitosti sdílení výrobních dat vzhledem k zásadní roli, kterou data hrají při řízení inovací a digitální transformace a vytváření nových služeb a obchodních modelů. CECIMO vítá, a proto podporuje ambiciózní cíle Evropské komise uvolnit nedostatečně využívaná průmyslová data v Evropě ku prospěchu všech.

Evropská komise si klade za cíl vyvinout autonomní a rostoucí datovou ekonomiku, kde by mělo být podporováno a zdokonalováno sdílení údajů na evropské úrovni a zároveň by měly být zaručeny bezpečné a důvěryhodné vztahy v mezipodnikovém přístupu k údajům a sdílení údajů. Konkrétně je cílem vyvinout datovou ekonomiku, kde jsou datové vztahy definovány za podmínek FRAND (spravedlivé, rozumné a nediskriminační). Podporujeme záměry Komise zlepšit evropskou strategii pro údaje a obsah dnešního návrhu zákona o údajích odráží vůli poskytnout evropským společnostem jednoznačný legislativní rámec.

Další související zdrojové dokumenty a přílohy: DATA ACT PROPOSAL-CZ.pdf, Data Act — Factsheet-CZ.pdf

2.6. Why B2B data sharing is important for the manufacturing sector

Chystaný datový zákon si klade za cíl usnadnit přístup k datům a jejich používání ve vztazích B2B a B2G a zároveň přezkoumat pravidla právní ochrany databází. Aby se navíc usnadnilo sdílení údajů v celé EU a mezi odvětvími, cílem návrhu nařízení je posílit mechanismy, které zvyšují dostupnost údajů a posilují důvěru ve zprostředkovatele.

Aby bylo zajištěno, že malé a střední podniky využijí příležitosti pro datovou ekonomiku, CECIMO se domnívá, že následující body reflexe je třeba považovat za zásadní, pokud jde o podporu sdílení dat a podporu využívání datových aplikací v průmyslových závodech.

2.7. CECIMO POSITION PAPER on EU Standardisation Strategy

CECIMO, zastupující průmysl obráběcích strojů a související výrobní technologie, vítá příležitost podělit se o svůj postoj k Evropské komisi. Strategie normalizace vzhledem k dalekosáhlým dopadům, které bude mít na dlouhodobou výkonnost evropského průmyslu a také na celkové fungování jednotného evropského trhu. CECIMO je a vždy bylo velmi proaktivním hráčem v oblasti normalizace, neboť počítá s rozsáhlou sítí národních/evropských sdružení a společností z oblasti výroby, které se pravidelně účastní a formují normalizační aktivity na evropské i mezinárodní úrovni. V tomto ohledu je naše Asociace přímým přispěvatelem k mezinárodním normalizačním aktivitám jak technicky, tak finančně, prostřednictvím naší účasti v mnoha technických komisích v rámci ISO a CEN-CENELEC.

Na základě našich rozsáhlých zkušeností v této oblasti věříme, že současný evropský systém normalizace (ESS) poskytuje dobře vyvážený systém, který bude sloužit evropským zájmům. Současná normalizační struktura se opírá o odborné znalosti široké škály zúčastněných stran, včetně průmyslu, uživatelů trhu, veřejných orgánů a akademické obce. Tím je zaručena vysoká úroveň technické kvality a tržní relevance při zachování inkluzivity a transparentnosti procesu. Ohromující úspěch norem a jejich přijetí na globálním trhu značně těžily z technické kvality a významné legitimity, která je výsledkem výše uvedeného procesu, vzhledem k širokému podílu různých zúčastněných stran na procesech tvorby norem.

Z tohoto důvodu vyjadřujeme obavy ohledně záměru Komise zasahovat do práce a řízení normalizačních orgánů, protože se obáváme, že by to mohlo podkopat důvěru ve stávající systém, který se vyznačuje tržně řízeným partnerstvím veřejného a soukromého sektoru. strategičtější přístup ke stanovování norem, navrhované změny ve správě normalizačních orgánů by neměly narušovat inkluzivní povahu normalizačních procesů, protože by to v konečném důsledku mohlo narušit zájem zúčastněných stran aktivně se účastnit a přispívat k ESS.

I když tedy oceňujeme záměr Komise zavést strategický faktor v rámci dynamiky evropské normalizace, zůstáváme přesvědčeni, že navrhovaná strategie účinně neřeší neefektivitu současného ESS.

Další související zdrojové dokumenty a přílohy: Commission_Report - implementation of the Regulation (EU) No 1025-2012.pdf, Commission_Work_Programme_2022-European standardisation.pdf, EU_Standardization_Strategy_Communication.pdf

2.8. EUROPEAN COMMISSION REPowerEU Plan

Nevyprovokovaná a neoprávněná vojenská agrese Ruska proti Ukrajině masivně narušila světový energetický systém. Způsobila potíže v důsledku vysokých cen energií a zvýšila obavy o energetickou bezpečnost, čímž se dostala do popředí přílišná závislost EU na dovozu plynu, ropy a uhlí z Ruska. Vysoké částky zaplacené za ruská fosilní paliva pomáhají Rusku udržet válku proti Ukrajině.

V březnu 2022 se vedoucí představitelé EU na Evropské radě1 dohodli, že co nejdříve postupně ukončí závislost Evropy na ruském dovozu energie. Na základě sdělení Komise2 vyzvali Komisi, aby urychleně předložila podrobný plán REPowerEU. Na dovoz uhlí a ropy se nyní má vztahovat režim sankcí. Nedávné přerušení dodávek plynu do Bulharska a Polska ukazuje, že je naléhavě nutné řešit nedostatečnou spolehlivost ruských dodávek energie.

REPowerEU je o rychlém snížení naší závislosti na ruských fosilních palivech rychlým posouváním čistého přechodu a spojením sil k dosažení odolnějšího energetického systému a skutečné energetické unie.

Již letos můžeme výrazně snížit naši závislost na ruských fosilních palivech a urychlit energetický přechod. Tento plán REPowerEU, který vychází z balíčku návrhů Fit for 55 a dokončuje opatření pro zabezpečení dodávek a skladování energie, předkládá další soubor opatření:

- šetřit energii;
- diverzifikovat dodávky;
- rychle nahradit fosilní paliva urychlením přechodu Evropy na čistou energii;
- chytře kombinovat investice a reformy.

Další související zdrojové dokumenty a přílohy: REPowerEU-factsheet.pdf

2.9. UPDATE ON THE NEW DUAL-USE REGULATION EU 2021/821

Položky dvojího užití jsou zboží, služby, software a technologie, které lze použít pro civilní i vojenské účely.

Po více než čtyřech letech přijala EU nařízení (EU) 2021/821, kterým se přepracovává nařízení o dvojím použití. Od 9. září 2021 nařízení (EU) 2021/821 (přepracované znění nařízení EU o dvojím užití) nahrazuje stávající nařízení Rady (ES) 428/2009, kterým se stanoví režim Evropské unie (EU) pro kontrolu vývozu, převodu a zprostředkování a tranzit zboží „dvojího užití“.

Přehled klíčových změn oproti předchozímu nařízení (428/2009)

Podle článku 4 nového nařízení EU o dvojím užití zachovává univerzální doložka univerzální kontroly u položek, které nejsou uvedeny v příloze I, pokud by mohly být použity:

A. pokud existuje (podezření) spojení s použitím v programu zbraní hromadného ničení;

B. pro vojenské konečné použití, pokud nakupující země nebo země určení podléhá zbrojnímu embargu;

C. v souvislosti s vojenským zbožím uvedeným na vnitrostátních vojenských seznamech členských států, pokud je vyváženo z EU bez vývozního povolení nebo v rozporu s ním.

Jako samostatná kategorie jsou „položky kybernetického dohledu“ definovány jako položky dvojího užití speciálně navržené tak, aby umožňovaly skryté sledování fyzických osob sledováním, získáváním, shromažďováním nebo analýzou údajů z informačních a telekomunikačních systémů. Podle článku 5 nařízení EU o dvojím použití definuje nové nařízení univerzální kontroly položek kybernetického sledování neuvedených na seznamu, které by mohly být použity v souvislosti s vnitřní represí a/nebo spácháním závažného porušování lidských práv a mezinárodního humanitárního práva.

2.10. Made in Europe The manufacturing partnership in Horizon Europe (2021 – 2027)

Evropská výroba je v centru dvojího ekologického a digitálního přechodu, je hnací silou a podléhá těmto změnám. Výrobní společnosti si zároveň musí udržet technologické vedoucí postavení a zůstat konkurenceschopné. Velikost a složitost souvisejících výzev – jako je integrace umělé inteligence, využití průmyslových dat, transformace na oběhové hospodářství a potřeba agilnosti a schopnosti reagovat – vyžaduje sdružování zdrojů a nový přístup ke spolupráci.

Partnerství Made in Europe bude předním evropským majákem a hybnou silou této změny a spojí přední aktéry z výrobních a příslušných evropských průmyslových ekosystémů, pocházející z akademické sféry, průmyslu, nevládních organizací a veřejného sektoru. Partnerství bude sloužit jako platforma pro národní a regionální iniciativy v oblasti výrobních technologií a požadovaných oborů a technologií, čímž se vytvoří úspory z rozsahu, společné porozumění a sladění cílů a priorit.

Bude rozvíjena strategická spolupráce s klíčovými aktéry na celostátní, regionální a místní úrovni, aby bylo zajištěno naléhavě požadované využití a implementace výsledků výzkumu. Na základě společných odborných znalostí a zdrojů bude partnerství Made in Europe hlasovým motorem pro udržitelnou výrobu v Evropě. Posílí evropské výrobní ekosystémy směrem k celosvětovému vedoucímu postavení v oblasti technologií, směrem k oběhovému průmyslu a flexibilitě. Partnerství přispěje ke konkurenceschopnému, zelenému, digitálnímu, odolnému a na člověka zaměřenému výrobnímu průmyslu v Evropě.

2.11. EIT Strategy 2021 – 2027

Evropský inovační a technologický institut (EIT) je nezávislý orgán EU. Zvyšujeme schopnost Evropy inovovat tím, že podporujeme podnikatelské talenty a podporujeme nové nápady.

Naší vizí „...je stát se přední evropskou iniciativou, která umožní inovátorům a podnikatelům vyvíjet světová řešení společenských výzev a vytvářet růst a kvalifikovaná pracovní místa.“

Naším posláním je:

- Zvýšit konkurenceschopnost Evropy, její udržitelný hospodářský růst a vytváření pracovních míst podporou a posilováním spolupráce mezi předními obchodními, vzdělávacími a výzkumnými organizacemi.
- Podpořte inovace a podnikání v Evropě vytvářením prostředí pro prosperitu kreativních a inovativních myšlenek.

Inovace prostřednictvím integrace

K posílení schopnosti Evropy inovovat je třeba přijmout opatření k překonání roztříštěného evropského inovačního prostředí. Zde přichází na scénu EIT. Máme průkopnickou roli ve zvyšování evropského udržitelného růstu a vytváření pracovních míst posilováním inovační kapacity Evropy. EIT sdružuje přední organizace z oblasti obchodu, vzdělávání a výzkumu, takzvaný ‚trojúhelník znalostí', aby vytvořila dynamická přeshraniční partnerství – EIT Innovation Communities.

Inovační komunity:

- Vyvíjet inovativní produkty a služby;
- Zakládat nové společnosti; a
- Vyškolte novou generaci podnikatelů.

Horizon Europe je klíčovým programem EU pro financování výzkumu a inovací s rozpočtem 95,5 miliardy EUR. Řeší změnu klimatu, pomáhá dosahovat cílů udržitelného rozvoje OSN a posiluje konkurenceschopnost a růst EU.

V rámci pilíře 3 „Inovativní Evropa" přispívá EIT k dosažení čtyř klíčových strategických směrů strategického plánu Horizont Europe:

- posílení udržitelných inovačních ekosystémů v celé Evropě
- podpora rozvoje podnikatelských a inovačních dovedností z hlediska celoživotního učení a podpora podnikatelské transformace univerzit v EU
- přináší na trh nová řešení globálních společenských výzev
- vytváření synergií a přidané hodnoty v rámci Horizon Europe

Právním základem EIT je nařízení o EIT, které stanoví jeho poslání, jeho klíčové úkoly a rámec pro jeho fungování. Strategie, priority, cíle, klíčové akce, činnosti, způsob fungování a očekávané dopady EIT jsou uvedeny ve strategickém inovačním programu EIT 2021–2027.

S rozpočtem 3 miliardy EUR se nová ambiciózní strategie EIT na roky 2021 až 2027 zaměřuje na čtyři hlavní prvky, které odrážejí potřeby evropských inovací a pomohou největšímu evropskému inovačnímu ekosystému prosperovat:

- Posílení dopadu jejích znalostních a inovačních společenství (KIC): Poskytují širokou škálu inovačních a podnikatelských činností v celé Evropě od podnikatelského vzdělávání přes výzkumné projekty zaměřené na inovace až po služby zakládání a urychlení podnikání. Tato podpora bude v příštích letech v celé Evropě dále růst.
- Posílení inovační kapacity vysokoškolského vzdělávání v rámci INICIATIVY EIT HEI – Innovation Capacity Building for Higher Education. Cílem je pomoci institucím vysokoškolského vzdělávání (HEI) učit inovace a podnikání tím, že tyto instituce podpoříme, aby budovaly své kapacity a vyvíjely konkrétní akce ke zvýšení jejich dopadu. Univerzity budou vybaveny správnými nástroji na podporu inovací napříč svými kampusy i mimo ně.
- Posílení regionálního dopadu znalostních a inovačních komunit: EIT posílí svůj inovační ekosystém tím, že zapojí více institucí vysokoškolského vzdělávání, podniků a výzkumných organizací, a to rozvojem regionálních informačních strategií. Výběr kooperačních partnerů a příprava činností Společenství EIT bude inkluzivnější. Znalostní a inovační společenství EIT rovněž rozvinou propojení se strategiemi inteligentní specializace, iniciativou EU na podporu hospodářského růstu a vytváření pracovních míst tím, že umožní každému regionu identifikovat a rozvíjet své vlastní konkurenční výhody.
- Spuštění nových znalostních a inovačních společenství EIT: EIT rovněž rozšíří svůj ekosystém a podporu inovací do nových odvětví vytvořením nových znalostních a inovačních společenství EIT, z nichž jedno působí v oblasti kulturních a kreativních odvětví a průmyslu s výzvou k

předkládání návrhů přicházejících v roce 2021 a druhé v oblasti vody , Mořské a námořní sektory a ekosystémy.

Aktualizované nařízení o EIT, které se zaměřuje na klíčové zásady fungování EIT a jeho znalostních a inovačních společenství, zajišťuje větší právní jasnost vůči Horizontu Evropa a zakotvuje zásadu finanční udržitelnosti znalostních a inovačních společenství EIT. Právní základ EIT také zavádí štíhlý a zjednodušený model financování pro EIT, který má účinněji podporovat dodatečné soukromé a veřejné investice. Konečně posiluje řídící strukturu ETI.

2.12. Proposal for a Regulation of the European Parliament and of the Council on Machinery Products

Revize směrnice o strojních zařízeních - CECIMO, zastupující průmysl obráběcích strojů a související výrobní technologie, vítá příležitost podělit se o svůj postoj k návrhu Evropské komise na nařízení o strojních výrobcích – dále jen „nařízení“. Současná směrnice o strojních zařízeních 2006/42/ES je základní legislativa regulující strojírenský průmysl a podle našeho názoru jde o zdravý právní předpis, jehož revize by se měla vyznačovat spíše kontinuitou než revolučními změnami. V souvislosti s probíhající revizí směrnice o strojních zařízeních jsme se vyjádřili v předchozím stanovisku

naše velká spokojenost s textem, který představoval příklad úspěšné legislativy Evropské unie o harmonizaci, poskytující vysokou úroveň bezpečnosti a zajišťující volný tok zboží v rámci jednotného trhu.

Proto je pro náš sektor důležité, aby budoucí legislativní rámec nadále podporoval harmonizaci v rámci jednotného trhu a vývoj norem na podporu inovací. V tomto ohledu se CECIMO aktivně zapojilo do různých politických diskusí s cílem koordinovat akce a vyměňovat si názory s ostatními evropskými asociacemi na návrh nařízení Komise o strojních zařízeních. V průběhu tohoto procesu jsme v návrhu nařízení identifikovali řadu hlavních hrozeb, které by mohly potenciálně vytvořit značné překážky a vést k dodatečné zátěži a nákladům pro výrobce obráběcích strojů.

2.13. Overview of the European semiconductors strategi

Polovodiče jsou životně důležité součásti jakékoli technologie v digitálním světě a jako takové jsou zásadní pro hladké fungování globální ekonomiky. Vliv digitalizace ve většině sektorů vede k nebývalému růstu poptávky po polovodičích, což způsobuje celosvětový nedostatek čipů, který začal v loňském roce a stále sužuje různá průmyslová odvětví bez výjimky.

V tomto ohledu byl také sektor obráběcích strojů ovlivněn v různých aspektech (např. zákazníci sektoru MT, vývoj nově vznikajících aplikací AI).

CECIMO podporuje cíle Evropské komise snížit závislosti dodavatelského řetězce a rozvíjet strategickou autonomii ve výrobě polovodičů. Aby však bylo dosaženo ohlášených politických cílů, je třeba vzít v úvahu následující:

- Přístup geografické specializace, který byl doposud uplatňován, umožnil zvýšit kvalitu vyráběných čipů a také snížit celkové výdaje na výzkum, inovace a kapitál ve srovnání s modelem, který usiluje o geografickou autonomii. Tento přístup nicméně ukázal zranitelnost a rizika spojená s geopolitickou nestabilitou nebo výjimečnými okolnostmi, jako jsou pandemie nebo seismické události.

- Role Evropy v části hodnotového řetězce věnované výrobě zařízení pro polovodiče je důležitá. Tento aspekt bychom však neměli podceňovat a nadále investovat do tohoto konkrétního výrobního kroku a podporovat investice do nových projektů evropské spolupráce. CECIMO doporučuje podporovat dohazování mezi evropskými společnostmi s cílem vybudovat fungující ekosystém, který zahrnuje mnoho sekundárních dodavatelů, kteří obráběcím strojům poskytují další technologie, jako jsou senzory a lasery.
- Výroba polovodičů může být nákladná a složitá, takže plán EU na rozšíření výrobních míst a závodů je v krátkodobém horizontu náročný. Například továrna na výrobu čipů, super-high-tech výrobní závod, který vyrábí polovodiče, může stát 10 až 15 miliard eur a přibližně dva roky na vybudování a další roky na to, aby byl plně funkční. Z tohoto důvodu CECIMO věří, že pokročilá výroba hraje významnou roli při podpoře výroby polovodičů.
- Dlouhodobého cíle, na který si Komise klade za cíl, nelze dosáhnout, aniž by se věnovala pozornost krátkodobým zmírňujícím opatřením na podporu těch odvětví, která zaznamenala zpomalení výroby během posledních dvou let a která budou pravděpodobně ovlivněna přinejmenším v následujících dvou letech. roční období.
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2.14. Materials 2030 Manifesto

Materiály, zejména pokročilé materiály, jsou páteří a zdrojem prosperity průmyslové společnosti. V kontextu radikálních transformačních změn 21. století budou hrát rozhodující roli právě tyto pokročilé materiály.

V této souvislosti a na základě diskuse u kulatého stolu s Mariyou Gabrielovou, evropskou komisařkou pro inovace, výzkum, kulturu, vzdělávání a mládež, níže podepsaní jednají s co nejširší skupinou zúčastněných stran, aby posílili naši spolupráci a rozšířili používání pokročilých materiálů, a usilovat o následující vizi: Silný ekosystém evropských materiálů pohání zelenou a digitální transformaci a také udržitelnou inkluzivní evropskou společnost prostřednictvím systémové spolupráce vývojářů, následných uživatelů a občanů a všech zúčastněných stran mezi nimi.

Další související zdrojové dokumenty a přílohy: Materials 2030 Roadmap.pdf

2.15. The New Industrial Strategy for the Machine Tool Industry

Dne 10. března 2020 Komise položila základy průmyslové strategie, která by podpořila dvojitý přechod k zelené a digitální ekonomice, čímž by se průmysl EU stal celosvětově konkurenceschopnějším a posílila otevřená strategická autonomie Evropy. Den poté, co byla představena nová průmyslová strategie, Světová zdravotnická organizace prohlásila vypuknutí COVID-19 za globální pandemii.

I když se dopad pandemie v různých ekosystémech a společnostech liší, hlavní problémy, na které krize upozornila, jsou:

- Hranice omezující volný pohyb osob, zboží a služeb
- Přerušení globálních dodavatelských řetězců, a tím ovlivnění dostupnosti základních produktů
- Narušení poptávky

Za účelem řešení těchto problémů aktualizovala Komise dne 5. května svou průmyslovou strategii a navrhla nová opatření, která zohledňují ponaučení z krize a udržují investice. Zaměřuje se především na:

- Posílení odolnosti jednotného trhu,
- Podpora otevřené strategické autonomie Evropy řešením závislostí
- Podpora obchodního případu pro dvojitý přechod

Strategie zdůrazňuje základy průmyslu – inovace, hospodářskou soutěž a silný a dobře fungující jednotný trh – a zároveň posiluje naši globální konkurenceschopnost prostřednictvím otevřených trhů a rovných podmínek.

Společně s národními asociacemi CECIMO studovalo různé akce definované v Nové průmyslové strategii a shrnulo ty, které přímo i nepřímo ovlivňují náš průmysl. CECIMO považuje tyto kroky za důležité a bude se zasazovat o jejich rychlé a efektivní provádění.

Další související zdrojové dokumenty a přílohy: Summary - Revised Commision Strategy.pdf, New Industrial Strategy for Europe.pdf, CECIMO reaction to EU Industrial Strategy.pdf

2.16. Machine tools and the European Green Deal – Status

Pro náš sektor jsou nejdůležitější tyto prvky:

• Mobilizace průmyslu pro čisté a oběhové hospodářství

• Zvýšení ambicí EU v oblasti klimatu pro roky 2030 a 2050

• Ambice nulového znečištění pro prostředí bez toxických látek

• Urychlení přechodu k udržitelné a chytré mobilitě

Každý z výše uvedených prvků bude rozdělen na potenciální příležitost (příležitosti) a/nebo potenciální hrozbu (hrozby) pro náš sektor.

Vzhledem k tomu, že „Mobilizace průmyslu pro čisté a oběhové hospodářství“ představuje nejdůležitější prvek pro náš sektor, bude mít níže samostatnou kapitolu, ve které budou různé dílčí prvky také rozděleny na potenciální příležitosti a/nebo potenciální hrozba(y).

V rámci Evropské zelené dohody přijala Evropská komise v březnu 2020 nový (druhý) akční plán pro oběhové hospodářství (GŘ ENVI).

První akční plán pro oběhové hospodářství (DG GROW) přijala Evropská komise v prosinci 2015 a v březnu 2019 oznámila, že akční plán byl plně proveden (všech 54 opatření bylo splněno nebo se provádí).

Nový akční plán pro oběhové hospodářství představuje soubor vzájemně propojených iniciativ k vytvoření silného a koherentního rámce produktové politiky, který učiní udržitelné produkty, služby a obchodní modely normou a transformuje spotřební vzorce tak, aby nevznikal žádný odpad. Tento rámec výrobkové politiky bude postupně zaváděn, přičemž prioritně budou řešeny klíčové hodnotové řetězce výrobků. Budou zavedena další opatření ke snížení odpadu a zajištění dobře fungujícího vnitřního trhu EU s vysoce kvalitními druhotnými surovinami.

Další související zdrojové dokumenty a přílohy: Green Deal - Zelená dohoda pro Evropu.pdf, Green Deal - Zelená dohoda pro Evropu - Opatreni.pdf, Circular economy action plan EC.pdf

2.17. CECIMO MANUFACTURING RECOVERY PLAN

Společnosti vyrábějící obráběcí stroje v celé Evropě zažívají výrazný pokles úrovně výroby, prodeje, servisu strojů a zaměstnanosti. Úplné oživení zpracovatelského průmyslu je klíčem ke zlepšení technologických schopností evropské ekonomiky a podpoře jejího budoucího růstu. Je životně důležité, aby EU a její členské státy okamžitě začaly definovat plán, jak tomuto odvětví poskytnout podporu, kterou potřebuje, řešit škody na ekonomikách EU a obnovit kapacitu podniků pro investice a zaměstnanost.

S cílem zajistit účinnou reakci EU na koronavirovou krizi, která by připravila cestu ke spravedlivému sociálně-ekonomickému oživení, zveřejnila Evropská komise plán obnovy pro Evropu. CECIMO vítá plán obnovy EU – Evropský okamžik: Opravte a připravte se na novou generaci a věříme, že úplné zotavení průmyslu obráběcích strojů je zásadní pro opravu a oživení evropského jednotného trhu.

CECIMO navrhuje ambiciózní plán obnovy výroby, jehož cílem je obnovit úroveň výroby a investic, zaměstnanost a celkovou podnikatelskou důvěru.

Plán obnovy výroby nastiňuje soubor politických opatření v následujících oblastech:

- Posílení jednotného trhu
- Obchod / Přímé zahraniční investice / Pohyb zboží a pracovníků
- Investiční fondy EU, aby se průmysl vrátil na správnou cestu

2.18. Impact of the EU Green Deal on industrial sector

Hlavním cílem Zelené dohody EU je začlenit průmyslovou politiku EU do ambicí politiky EU v oblasti klimatu. S opatřeními v oblasti klimatu se stále více zachází jako s nedílnou součástí programu zahraniční a obchodní politiky EU. Evropská komise prosazuje pojem „klimatická neutralita“ a nulové emise skleníkových plynů do roku 2050. Zelená dohoda EU proto není jen další iniciativou EK, ale je to velmi ambiciózní plán, který chce spojit ekonomiku, životní prostředí a společnost.

2.19. Advanced Technologies for Industry Product Watch Reports

Product Watch analyzuje nové produkty, které jsou založeny na pokročilých technologiích (AT). Slibné produkty založené na AT lze definovat jako „umožňující produkty pro vývoj zboží a služeb zvyšujících jejich celkovou komerční a společenskou hodnotu, zabudované do jednotlivých částí, které jsou založeny na rozšířené a virtuální realitě, Big Data a Analytics, Blockchain, Cloud, Artificial Inteligence, Internet věcí, Mobilita, Robotika, Zabezpečení, Konektivita, Nanotechnologie, Mikro a nanoelektronika, Průmyslová biotechnologie, Pokročilé materiály a/nebo Fotonika a, ale bez omezení, vyrobené společností Advanced Manufacturing Technologies“.

Další související zdrojové dokumenty a přílohy: Product Watch-Advanced Manufacturing and Robotics for ICT Manufacturing.pdf, Product Watch-Leaflet Advanced Manufacturing and Robotics for ICT Manufacturing.pdf, Product Watch - 3D printing for the machine tool industry.pdf, Product Watch - Leaflet 3D printing for the machine tool industry.pdf, Product Watch - Lightweight Materials.pdf, Product Watch - Leaflet Lightweight Materials.pdf, Product Watch - 3D printing of hybrid components.pdf, Product Watch - Leaflet 3D printing of hybrid components.pdf, Sectoral Watch - Technological trends in the machinery industry.pdf, ATI Methodological Report Indicator framework and data calculations_0-1.pdf, Technology definitions.pdf

3. MANUFUTURE STRATEGIC RESEARCH AND INNOVATION AGENDA SRIA 2030

Strategie Manufuture SRIA 2030 je zaměřena na oblast strojírenství a výroby a jedná se o nejbližší evropskou strategii na nejvyšší úrovni, která je významná pro Strategickou výzkumnou agendu oboru strojírenské výrobní techniky a technologie v ČR. Proto této strategii věnujeme samostatnou kapitolu.

Výroba je páteří evropského hospodářství, přičemž v roce 2014 zaměstnávalo přibližně 2,1 milionu výrobních společností téměř 30 milionů lidí a generovaly přidanou hodnotu ve výši 1 710 miliard EUR. Evropská unie je největším světovým vývozcem průmyslového zboží a je světovým lídrem na trhu vysoce kvalitních produktů. Průmyslové zboží s přebytkem obchodní bilance ve výši 153 miliard EUR v prvním pololetí roku 2016 výrazně přispívá k celkové pozitivní obchodní bilanci Evropské unie. Nejvyšší podíl na evropském exportu mají stroje, dopravní zařízení a chemikálie1.

Výroba je složitý ekosystém zahrnující malé i větší společnosti, který vytváří silnou kapacitu pro poskytování řešení s vysokou přidanou hodnotou prostřednictvím neustálých inovací, a tím vytváření pracovních míst a udržitelného růstu. Výroba umožňuje mnoho služeb s vysokou přidanou hodnotou (například návrh produktu, vývoj softwaru, logistika a další podpůrné služby), což odůvodňuje vytvoření až dvou nepřímých pracovních míst pro každé přímé pracovní místo ve výrobě.

V současnosti společnost prochází zásadní změnou paradigmatu, stejně důležitou jako sociální transformace v první průmyslové revoluci. Tento posun je globálním fenoménem, který ovlivňuje způsob, jakým žijeme, pracujeme a chováme se. Je poháněna bezprecedentním zvýšením rychlosti rozvoje vědy a techniky, rychlým šířením znalostí, novými preferencemi spotřebitelů a globální konkurencí.

K zajištění pracovních míst s vysokou přidanou hodnotou a zajištění regionálního rozvoje a vytváření bohatství si Evropa potřebuje udržet a posílit své postavení ve výrobě, aby podpořila hospodářský růst podporující začlenění.

V této souvislosti, kdy konkurence sílí a stoupá hodnotovým řetězcem a spotřebitelé jsou stále náročnější, bude muset Evropa řešit nové příležitosti a zvýšit své investice do výzkumu a inovací směrem k výrobě, aby byla zajištěna konkurenceschopnost a dlouhodobá termínový úspěch.

Vize ManuFUTURE pro rok 2030 je uvedena v dokumentu „VIZE ManuFUTURE 2030: Konkurenceschopná, udržitelná a odolná evropská výroba“.

Tento dokument podrobně popisuje strategický výzkumný a inovační program navržený Evropskou technologickou platformou ManuFUTURE. Kapitola 1 představuje shrnutí vize a strategie ManuFUTURE pro rok 2030, zatímco kapitola 2 popisuje ekosystém výrobního výzkumu a inovací a jeho jedinečné vlastnosti. Pododdíl 2.3 představuje integrovanou strategii pro propojení základní vědy s aplikovaným výzkumem ve výrobě, která zahrnuje různé fáze výzkumu a vývoje, tj. od základní vědy, základního a aplikovaného výzkumu až po uplatnění na trhu, včetně infrastruktury pro vzdělávání a odbornou přípravu, podnikání a inovace. které jsou nezbytné pro řešení dimenze a složitosti výzkumných výzev ve výrobě. Tento přístup je podrobně uveden v příloze 1.

Kapitola 3 popisuje nejdůležitější vědecké a technologické výzvy, jmenovitě: Přidání hodnoty do systému výroby, Horizontální a vertikální integrace, Cesta k oběhové ekonomice a Decentralizovaná technická inteligence.

Kapitola 4 popisuje prioritní domény výzkumu a inovací, což je první stavební blok navržený společností ManuFUTURE, aby dosáhl své vize v roce 2030. Je představeno deset prioritních domén výzkumu a inovací pro úspěšnou evropskou výrobu: Výrobní technologie a průmyslové vybavení; Digitální transformace; Robotika a flexibilní automatizace; Nanotechnologie a materiály; Biologická transformace; Výroba řízená zákazníkem; Výroba zaměřená na člověka; Návrh a řízení agilních výrobních systémů; oběhové hospodářství; a Nové obchodní modely a logistické sítě.

Kapitoly 5 a 6 představují další stavební kameny úspěšné výroby, a to: Inovace a podnikání a Vzdělávání a školení. Kapitola 7 uvádí příslušnou spolupráci s jinými iniciativami.

Níže uvádíme vyjmuté všechny prioritní strategická témata, která jsou zařazena pod příslušnou výzkumnou a inovační doménu. Vycházíme z kapitoly 4 dokumentu Manufurure SRIA 2030 a vyznačujeme podbarvením témata, která považujeme relevantní pro náš obor SVT v ČR a kterým bychom měli v naší SVA TPSV věnovat také pozornost.

ManuFUTURE Stategic Research and Innovation Agenda 2030
10 Research and Innovation Priority Domains for successful European Manufacturing

Domain	Research and Innovation priority	Topic + type of research activity (F, A, P) *(F) Fundamental Research* *(A) Applied Research and Technological Development* *(P) Pilot implementation and Demonstration*	Description
Manufacturing technology and industrial equipment	Processes and Technologies	ADVANCEMENT IN ADDITIVE MANUFACTURING (AM) (A/P)	The continued industrialisation of additive manufacturing technologies will create evolving needs for technological development, addressing topics such as raw materials standardisation, work piece dimensions, materials and alloys (e.g., aluminium, titanium, copper), working atmospheres, better surface properties, surface integrity and functional testing methodologies, health and safety regulations. The development of new applications will create the need for significant advancement in materials, typically feedstock materials, coupled with an increase in build rate, which will possibly enhance the competitiveness of AM (also for the manufacturing of larger structures with unique features) and enlarge the potential filed of application. Additionally, additive manufacturing needs further developments for process stability, monitoring and control, for the development of competitive and reliable production equipment. Indeed, a key step for the industrial application of AM, in particular for highly demanding applications, is to develop technologies for quality management (all over the product life-cycle), including, but not limited to, process stability and process control. Finally, in order to promote the establishment of an ecosystem, throughout the full value chain, for industrial application of AM technology, it is necessary to ensure the continued development of standards for AM.

ADDED-VALUE ADDITIVE MANUFACTURING FOR LARGE STRUCTURAL COMPONENTS (F/A/P)	New pathways must be developed for AM of structural/functional parts to find its way as an enabler of faster product-to-market approaches. This means creating innovative and unconventional techniques for higher process productivity and lower costs, from the product design office to the factory floor. Focus shall be in: 1) overcoming current metal AM drawbacks, by limiting its application to the production of small parts, and improving its competitiveness as a direct manufacturing technology for medium and large dimension parts, and 2) leveraging the potential of composites AM in order to enable the manipulation of fibre alignments to unparalleled levels. The development of both metal AM and composites AM systems shall include: i) design for AM (DfAM) knowledge, tools, rules, processes, and methodologies, and ii) sensor technology, control methodologies and coupled technology microstructural physics-based models (relation between microstructure aspects and distortions and warpage, fatigue properties and reduced surface roughness) for product topological and topographical optimisation and process simulation.
COMPETITIVE COMPOSITES PROCESSING (A)	Cross-fertilisation platforms among different composite manufacturing technologies, as well as fibres, matrices, modified and hybridised materials shall be developed, fostering their faster adoption and strengthening their role in the supply chain, thus enhancing the overall competitiveness of composite-based processes and products. Increasingly automated processes should be enabled, integrating smart materials, intelligent moulds and process components with sensing and actuation capabilities, as well as robotised material handling and lay-up systems, capable of providing enhanced process and monitoring capabilities, such as heating and temperature management, resin recognition, curing stage, pressure monitoring and defect detection. These shall enable the data collection required for dynamically data-driven end-to-end engineering platforms, integrating simulation based process design, cognitive automation and zero-defect approaches, oriented to the manufacturing of small to large composite parts and its assembly in complex structures. The sustainable use of materials needs to anticipate the end of life impacts ahead, including impact on ecosystems, recycling opportunities, among others, and reject non compliant solutions.
HIGH PRODUCTION RATE OF COMPOSITE STRUCTURES (P)	Composite structures mainly aim for low weight, heavy duty/fatigue, wear and corrosion resistance. The challenge is to achieve economically viable high rates serial manufacturing, while maintaining the primary goals. The need to develop new energy efficient processes for serial production of composite materials is a research and technological development that needs to be addressed.
SURFACE ENGINEERING (A)	A combination of texturizing and surface coatings has the potential to deliver surfaces with several functionalities and features such as hydrophobic, antimicrobial, self-cleaning, durability, noise reduction, friction and aesthetic. The full potential of texturizing and surface technologies (e.g., sol-gel, physical vapour deposition) is yet to be discovered and includes design, surface modification technologies, scale up and process control, and the characterisation and properties of the final system or component, including quality control and non-destructive examination.
MINIATURISATION AND FUNCTIONAL INTEGRATION (A)	Making components smaller and smaller by integrating more functions in surfaces and in concentrated spaces is a cross-cutting enabler for a broad spectrum of applications – ranging from sensors, micromechanical systems, microfluidics, low-energy components, smart surfaces to bio-hybrid components. Products can become smaller, lighter, more robust and more energy efficient. This not only requires new and improved micro and nano manufacturing processes, which are precise, repeatable, fast and easy to be scaled up, but also integration of physical processes with digital technologies.
HYBRID PROCESSES (A/P)	Nowadays, a multitude of conventional and non-conventional manufacturing processes is available, each with its own specific characteristics. Combination and integration of different processes will pave the way for flexible and efficient manufacturing systems. Therefore, approaches, software tools and hardware modules need to be developed towards the selection and combination of different processes in order to create a flexible, reconfigurable system, capable of responding to rapid changes in customer needs. Manufacturing processes are always in evolution: new materials, manufacturing technologies, sensors, the application of digital technologies, innovative process assistance elements (e.g., ultrasonic, cryogenic, etc.), thus opening up unexplored possibilities for hybrid processes. Technologies range from AM-based processes to joining, cold-work, heat treatments, among others, to be combined and integrated in Hybrid systems capable of connecting flexibility with efficiency and cost reduction.

EFFECTIVE PROCESSING OF HYBRID MATERIALS (A/P)	New manufacturing concepts to be explored for the flexible and dynamic production of hybrid and/or functionalised structures shall be developed. It shall integrate manufacturing processes, capable of generating tailored features and geometries but above all the functionalities, often combining materials of mismatching character and local treatments. Current manufacturing solutions are still strongly material, process and/or technology specific and, even if their combination is technological feasible, the related high costs and overall inefficiency preclude any type of hybridisation from high volume fabrication. Advances in KETs can be integrated in established machinery concepts, providing wider processing ranges to enhance material's applicability, and ultimately compatibility and co processing. This includes: i) forming joining hybridisation as well as the dissimilar functionalisation of the individual constituent materials; ii) new hybrid machinery concepts integrating appropriate technologies for flexible, extended or combined materials' processing; iii) new experimental configurations and procedures appropriate for in-line materials /part characterisation considering their specificities regarding non-conventional composition, structure, geometry and/or dimension, as well as off-line testing under loading conditions (static / dynamic, environmental) representative of the new process technologies and expected multi-functionality.
OPTIMISED JOINING FOR NEW MATERIALS, STRUCTURES AND MANUFACTURING PROCESSES (A)T	Traditional joining technologies for new materials have limitations since they are normally "a one case solution", meaning that the technology can only be applied for each multi-material combination or each new material. Such an issue has limited the use of multi-materials and new materials in industry due to the cost involved in adaptation and integration of these technologies in the manufacturing chain. Dissimilar material joining, including joining of composites, multi-phase and coated materials reflect the continuous advancement of the use of multi-material across all sectors: this creates engineering challenges on how to join these materials like metals, ceramics, fabrics, composites, multiphase, coated and polymers. These joints need to operate at versatile environments, to be easy to access and repair and to have a low environmental footprint (either in the materials used for the preparation of the joint or during their life). It is also required that the processes used to join these multi-materials can be easily integrated into the manufacturing chain.
ACTIVE, SMART AND INTELLIGENT PACKAGING (A/P)	Packaging systems used for foods, pharmaceuticals, and several other product types have the potential to extend shelf life, to display information on quality and to improve safety. Intelligent and smart packaging involve the ability to sense and measure the attributes of the product having active functions beyond the passive containment and protection of the product. This information can trigger active functions, thus making the package an active IOT device in the product/factory life cycle.
RESILIENT PROCESSES (A/P)	Manufacturing processes have been constantly evolving and improving in terms of accuracy, reliability and robustness. However, the majority of manufacturing industries rely on establishing appropriate process parameters through extensive experimentation and trial-and-error, using specific, usually strictly controlled materials. When any of these need to be changed, manufacturing systems are slow to respond, thus reducing flexibility. Therefore, there is a need for new methods and tools, enabling self-learning and self adaptive manufacturing processes, driven by simulation/digital twins as well as historical data, adapting the process to variable feedstock quality, reducing or even eliminating setup/changeover time and defective parts.
ZERO-DEFECT STRATEGIES FOR SMALL-BATCH MANUFACTURING (F/A)	New methods and tools to increase the potential of zero-defect strategies for the manufacturing of small-batches in a multi-stage manufacturing need to be developed. Strategies for the application of self-adaptive solutions, such as Machine Learning and Artificial Intelligence, are needed in order to hinder the propagation of errors. New methods and tools for profile monitoring of functional data and geometrical product features are needed to minimise the defect of the chain and to facilitate the implementation of zero defect manufacturing (ZDM) strategies. The results of this research are relevant and applicable in many industrial sectors and companies, namely those dealing with small batch manufacturing. Additionally, dynamic machine control systems together with geometric feature monitoring can prompt the adaptation of process plans based on the degradation state of the shop floor resources.

		SYSTEMIC BIO-INSPIRED MANUFACTURING PLATFORMS (F/A/P)	Truly systemic manufacturing platforms shall be enabled by developing novel bio-inspired manufacturing concepts, which shall leverage the current implementation of advanced cyber-physical systems (integrating hybrid twins, cognitive automation, Artificial Intelligence, among other state-of the-art techniques) to unprecedented resilient production environments, introducing a new manufacturing paradigm. The hypothesis is that, by mimicking self sustainable living processes with corresponding functionalities, such platforms would simultaneously present optimum operational performance and extreme autonomy to react/ adapt to any change in the production conditions. Such a step change in the design of manufacturing systems and processes requires however intricate interdisciplinarity between a series of research fields from areas as distinct as Biology/Life sciences and Engineering, to develop efficient and added-value biomimetic manufacturing solutions, also pushing for new approaches/models in the different KETs and engineering processes.
Digital Transformation	QUALITY in production systems	CLOUD-BASED AND EDGE-BASED CYBER-PHYSICAL SYSTEMS FOR EFFICIENT IN-LINE ROOT-CAUSE ANALYSIS IN THE MANUFACTURING OF COMPLEX HIGH ADDED-VALUE PRODUCTS (A)	Learning and diagnostic methods for the efficient identification and assessment of non-conformance root-causes in complex products (multi-material, 3D-printed, highly customised product, …) will leverage the huge amount of data generated by cyber physical production systems (CPPS), both at cloud (data at rest) and edge levels (data in motion), towards efficient zero-defect manufacturing. The research will need to address and demonstrate integrated intelligent platforms, exploiting machine learning, Artificial Intelligence and real-time feedback and control, leading to novel data-driven insights, and enabling data sharing between different stakeholders. The key objective is also to reduce the delay in feeding back of quality information to design and engineering, when compared to the existing solutions, and to minimise costs. Block chain / Distributed Ledger solutions have the potential to support a new form of the decentralised data collection and sharing with a consensus of replicated and synchronised data, geographically spread across multiple stakeholders.
		MACHINE / DEEP LEARNING FOR AUTONOMOUS QUALITY IN THE SMART FACTORY (F)	Machine / Deep learning has become one of the primary drivers and approaches within AI in industry. However, remains a complex field that needs a scientific consolidation, actual implementation and validation. In factory environments, there is still the need to assess if Deep Learning or other Machine Learning techniques (including Ensemble learning) will enable the creation of models, which can support quality-related tasks, such as anomaly detection, fault detection and classification, product quality control, virtual sensors deployment, and machine behaviour forecast.
		SMART SENSORS SYSTEMS FOR IMPROVING QUALITY AND USE OF RESOURCES (A)	Smart sensors based on vision systems, laser scanners, X-ray, among, offer the possibility to deliver an enhanced digital image of the actual product, to identify defects and to monitor compliance (e.g. relevant for automation in the food processing sector). "Marrying" the signals with simulation models and linking different data sources (through AI-based approaches) will offer a digital representation of product and processes reliable and constantly updated. Smart sensors coupled metrology systems for intelligent inline measurement can also be enablers for Product/Process Manufacturing Fingerprinting.
	DYNAMIC and FLEXIBILE production systems	DIGITAL AND SMART MANUFACTURING PLATFORMS FOR MASS CUSTOMISED PRODUCTS (P)T	Digitalisation enables the manufacture of customised and smart products (with embedded software, sensors, connectivity and AI). However, manufacturing systems for these kind of products (i.e. systems comprising 3D printers, robots, electronics, powering and connectivity) are often operating in isolation and (in most cases) are not connected over digital platforms. Pilot platforms could demonstrate the successful implementation (and promotion) of the integration of digitalisation and manufacturing technologies.
		DIGITAL PROCESS PIPELINES (A)	When designing a new product, companies are often unaware of the challenges related to the actual manufacturing process, and, more broadly, to the whole life c cycle of the product. Typically, the feedback from production or customers results in revising certain aspects of the design after a relatively long period of time. Seamless data exchange and processing are required in order to facilitate connection between design, manufacturing and recycling phases, thus increasing the knowledge content and its exploitation.

NEW DESIGN AND ENGINEERING TOOLS AND DEVELOPMENT METHODS (A/P)	In order to increase productivity and address sustainability, European companies will have to excel even more in problem-solving capacities and in the supply of innovative reliable solutions. Operational excellence in production is increasingly coupled with the excellence in the orchestration of innovation in a multi-stakeholder, interdisciplinary environment. Therefore, there is a strong need to enhance the engineering and design capabilities and efficiency of European innovators – engineers, designers, material scientist, entrepreneurs (also promoting on-demand engineering and knowledge sharing services). This will not only increase competitiveness, but it will also contribute for reducing the skills and knowledge gap and easing the shortage of engineers and data scientists. This should happen through a multidisciplinary approach, shaping the next generation of knowledge-based engineering, and system engineering tools, improving the understanding of system behaviour, modelling and simulation, delivering and integrating easy-to-use solutions and more efficient testing and validation methods, also taking into account automated, creative design systems (e.g., generative design technology to quickly produce high-performance design alternatives). Advances and increased capabilities in this area are also a precondition for enhanced customer-involvement in the development and design of personalised solutions.
CYBER PHYSICAL SYSTEMS OF SYSTEMS FOR DYNAMIC PRODUCTION AND LOGISTICS (A)	New Artificial Intelligence methods, architectures and tools are needed to enable cyber physical systems to promptly adapt process plans, parameters and production based both on the needs of the value chain and on the detected quality of the parts under processing. The objective is to dynamically adapt to the market needs while, at the same time, minimising the propagation of defects during the production processes. As data needs to be shared at a production-network level, security and privacy play a relevant role and must be addressed. It is also expected the integration of manufacturing data into business decision, through advanced prescriptive analytics, to make a parametric analysis of business KPIs and estimate error/risk or predictions of this KPIs. New methods and approaches for self optimisation of manufacturing networks also include the extraction of knowledge from the historical process data (big data sets consisting of process parameters and outputs/ responses) and development of process model (process digital twin) using AI techniques.
INTEGRATING NEUROCOGNITIVE PROCESSES WITH AI IN FACTORIESAND VALUE NETWORKS (F/A)	Innovative companies are witnessing the beginning of a massive shift towards neurocognitive manufacturing, which studies and combines humans' cognitive capabilities with the sensing capabilities of machines, computational models, intelligent assets and Artificial Intelligence. These systems will be able to largely collect, transfer and analyse various forms of data, processes, and workflows within the manufacturing to make smart decisions in real-time, optimising the operations and enhancing the workforce. Additionally, existing manufacturing management systems that are mainly driven by human action, like TPM or FMECA, need data processing analytics to address new data-human interaction challenges, such as weak feedback loops and lack of sharing and detection of good and bad practices. However, the use of AI in real processes will have to meet the highest standards concerning safety, reliability, quality and precision. Furthermore, AI in industry requires the capability to work with rather small data sets, which needs to be integrated using context knowledge and transfer learning. Research for AI in industry must be geared towards concrete applications in business and industry, based on context-dependent acquisition, selection and assurance of data quality and secure connectivity. These questions must be addressed in a cross border, multi-disciplinary and application-oriented research areas.
DIGITAL TOOLS IN MANUFACTURING (A)	Virtualisation of local and distributed production systems and development of decision support systems, based on simulation models and optimisation tools adherent to reality and constantly synchronised, for the design and operation of production systems are of cornerstone importance. This includes the development and implementation of methodologies and tools both edge-based and cloud based. Simulation, optimisation and forecasting, must be oriented towards the design and operation phases of flexible and high-performance production systems. The outcomes of those tools, empowered by interoperability through Asset Administration Shells, can positively affect the manufacturing processes also by the technology development of augmented and virtual reality at the shop floor. The creation of a hybrid manufacturing simulation models (e.g., model of a machine, cell, line, site), containing analytical and data-based models, will allow for tools oriented towards different scenarios to include maintenance and production optimisation based on hierarchies of mixed data and analytic models at different levels.

		KNOWLEDGE AND DATA FUSION FOR MANUFACTURING (A)	Current plants can generate a significant amount of data streams. Big data refer to multiple streams of complex high-resolution, high-speed data (signals from different sensors, images, video in the visible and infrared ranges). All this information is often stored but not properly managed. Novel approaches to combine different levels of information coming from experts, measurement, digital-twins/simulations; big data streams inline and in-site should be developed. These novel approaches should not just provide a sequential use of these different sources of information but define novel approaches to fuse, combine and calibrate all the information to better drive the manufacturing processes and systems towards enhanced flexibility and responsiveness. Additionally, transparency is needed to get meaningful insights from data in a production system: shop floors can be considered as extremely complex systems where small variations or disturbances can create a huge effect. Superb decision-making support, increased awareness, efficient use of resources, prompt reaction to unpredicted events and reduced defect rates should be the final targets.
	DIGITAL-REAL CONVERGENCE in productionsystems end ecosystem	DIGITAL TWIN OF FLEXIBLE MANUFACTURING PROCESSES (A)	Understanding and modelling the manufacturing processes is crucial in order to further enhance the productivity of each single process steps as well as the whole process chains. In order to fully exploit the potentials of such understanding, sophisticated models of existing processes (ranging from flexible materials behaviour and proprieties, to complex processes such as additive manufacturing or EDM) need to be combined with data from product design, process planning and actual field data. Methods for a better understanding of product manufacturing, structure, and performance, will lead to digital twins that better mimic and simulate complex processes. Consequently, future Digital twins could be the “single source of truth” at any moment in time, and the reliable foundation on which control and management systems make operational and tactical decisions (also thanks to trustworthy short-term predictions about the performance of the system).Complex Digital twins bring together and synchronise data from different sources (also from unstructured sources where data can be gathered, for example, from artificial vision) and require many experts to collaborate, designing new reference models and consolidating them, to make possible complex combination of data and derive meaningful conclusions. Every resource in a flexible automation production framework, is accompanied by its digital twin, that ‘owns’ and manages the ownership of the resource, becoming the single access point to the resource (thus making the digital twin to be online, embedded, highly available, upgradable while remaining operational). Digital platforms that will combine and compare data from different sites is a necessity for effective decision-making.
		MULTI-LEVEL SIMULATION SYSTEMS (A)	Modelling and simulation tools are key in optimising manufacturing processes. However, such tools and approaches are often tailored to a specific process and scale, and have limited connection and interaction with other tools. In order to simulate a complete system though, process/machine models at various levels are required, from micro to macroscopic (multiscale and multiphysics). Models need to form building blocks of a larger “simulation system”, feeding input from one to the other in a closed loop iterative manner, allowing a complete simulation of a production system. Additionally, modelling and simulation tools meant to support new production processes and systems are needed, beginning from the specification of requirements. There is also a need for modelling and characterisation of advanced materials and their manufacturing technology, in particular for (multifunctional &structural) materials and (nano)surfaces.
		AUGMENTED END-TO-END VIRTUAL MANUFACTURING SYSTEMS (A)	After several key steps have been achieved in the development of advanced Virtual Prototyping and Virtual Manufacturing solutions, a complete and mature end-to-end virtual manufacturing system – based on deep linkage between 3D models simulations,0D/1D system modelling and real-time process control and optimisation bridging design and production – is still missing in the industrial manufacturing sector. Now, also introducing Artificial Intelligence, further advances are needed for gathering dynamic data driven multi-field modelling and simulation of manufacturing processes, multiscale and multi-variate modelling of operational performance of highly demanding and complex structures (for virtual testing of products, tools and machines), efficient design optimisation techniques, data knowledge/extraction at a simulation level, interlinked with novel control systems, advanced sensors and non-destructive testing/inspection (NDT/NDI) systems with cognitive capabilities capable of reacting to unpredictable situations, to plan their further actions, and to learn and gain experience from previous manufacturing processes, i.e. to autonomously increase the system operation range.

DIGITAL SERVITISATION (A)	Building successful business innovations based on data and services call for a visionary approach to future markets. This requires manufacturing companies to combine deep domain expertise with a thorough understanding of related digital technologies and value for customers. Increased availability of data coming from the product usage phase allows targeting individual customers' needs, by providing personalised services and by expanding their range in both B2B and B2C markets. This requires innovations at both technological level and business model level. On the one hand, research is needed to integrate data sources in smart products, to manage secure data flows of sensible data and to extract from them the relevant business features thanks to AI (thus creating advanced digital images of product/processes). On the other hand, new business models capable of capitalising such innovation are essential for making them stick in the digitally driven markets of tomorrow.
DIGITAL MARKETPLACE FOR EXCHANGE OF QUALIFIED RESOURCES IN DYNAMIC VALUE NETWORKS (A/P)	Digitalisation of assets and resources is the main driver that disrupts the traditional static supply chain to dynamic value networks that are arranged on demand to couple the needs of buyers with the providers of manufacturing capacity. In the last years, the manufacturing domain has witnessed a global challenge for selection of the dominant production services marketplace. If Europe is to succeed in this race, it needs to exploit its own platform enabled responsible marketplace that makes the manufacturing capacity available, as well as other virtual and physical assets, closer to the production demand in order to achieve their smart matching, even in non-obvious situations, by leveraging on machine learning techniques. Actual exploitation of existing marketplace and digitalisation of assets and resources are the main driver of this paradigm shift, which disrupts the traditional static supply chain model and establishes dynamic value networks that are arranged on demand to couple the needs of buyers with the availability of sellers of manufacturing capacity. The possibility to include block chain technology as a mean to provide smart contracts, to enable identification of assets and to support traceability of exchanges and intellectual contributions (for instance in idea-generation processes) occurring along value creation shall be considered to increase the value for the customer
NEXT GENERATION INDUSTRIAL DATA MANAGEMENT (A/P)	The digital transformation of industrial/manufacturing companies will create data in quantity and quality never seen before, fostering an enormous potential for their businesses. These companies are now becoming conscious of this reality but lack skills and resources to deploy a continuous strategic process of data management and governance. Nevertheless, only a very small percentage of industrial data is currently used in a way that makes sense or adds value. Several approaches to assess maturity and define digital transformation roadmaps are today proposed both in research and practice, yet none of them addresses explicitly and in detail the data strategy and governance required to explore the full potential of this movement. There is a need to develop a systematic approach to support industrial/manufacturing companies to deploy a strategic data management process, especially in this context. An effective and strategic data management process will provide companies with data awareness and data maturity, enabling an effective data-driven approach to their decision-making.
CYBERSECURITY AND CONNECTIVITY (P/A)	It is clear that connecting the internet to the shop floor has the potential of bringing substantial advantages. The question is how to tackle the cybersecurity and connectivity issues in a heterogeneous real life environment without blocking the production or cause dangerous situations. New methods, architectures and algorithms need to be developed considering the unique requirements of the Internet of Things adopted in manufacturing. Scattered approaches need to be unified and standardised in order to accelerate their implementation in the industrial environment. Providing solutions to reliable, fast and secure connectivity, enabling decentralised and remote control, are of top priority. Research in this field will affect all the manufacturing areas where IoT is implemented and secure data exchange and/or remote access is required. Additionally, real-life production systems area mix of new and older equipment and technologies, often bought from different technology providers, dealing with different communication protocols. It is clear that bringing the internet to the shop floor has the potential of bringing substantial advantages. Then the question of how to tackle the security issue in such a heterogeneous real-life environment without blocking the production arises.

		THE INTERNET OF WEARABLE THINGS IN MANUFACTURING (P)	Never before has computing been small enough to be worn on the body, leading to the creation of unobtrusive technologies that are revolutionising manufacturing (e.g., voice based hands-free devices, capability extenders, etc.). Wearable technologies boost the convergence between the physical and digital world and enable more seamless workflows, meaning greater productivity. This new paradigm is empowered by advancements in microelectronics, ICT, big data and cloud computing, supporting employees to be more productive, easily report mechanical problems, service disruptions and other potential issues at the shop floor level, and, simultaneously, enriching the digital representation of factories with worker-related data. Research is needed to consider human factors and social aspects related to factory work when new technologies are introduced to enhance work productivity.
Robotics and flexibleautomation	Robotics	TASK-BASED PROGRAMMING OF ROBOTS (F/A/P)	If robots are to become more flexibly applicable for manipulation tasks, new software templates need to be developed for robots to learn, by demonstration, how to execute complex manipulation skills. These skills must be easily reconfigurable and quickly switchable within a family of similar tasks. The robot should guarantee the safety of the human operators it is interacting with, thereby taking into account events happening in its environment. This requires a wealth of actors and sensors to make the robot 'soft' and aware of its environment. Full autonomy of the robot is still utopic. The human must supervise the robot's actions,intervene and correct when necessary. Therefore, the human is not eliminated but relieved from repetitive or heavy work. He may eventually supervise several robots.The application of this methodology in several application domains (car assembly,electronics assembly, warehousing, equipment manufacturing) requires investing informalising the domainspecific knowledge such that the software templates already contain the domain knowledge. This way, the task demonstration by the operator canbe limited to the variability in time and space in which the templates are to be used; the intention of the templates must be pre-programmed.
		INTRINSICALLY SAFE ROBOTS (A)	Robots that are to work in the vicinity of humans have to behave safely and dependably. This means that collisions must be avoided by suitable spatial proximity sensors. If collisions occur they must be physically harmless, which requires the robot arm to becovered with a soft skin, which at the same time acts as a distributed touch sensor, just like in the human skin. The joints should be soft as well, thus exhibiting a low mechanical impedance. All these sensor inputs should be incorporated into the control software for the robot to generate safe trajectories. Aspects of cognitive and perceived safety are equally important to consider. Systems can be perfectly safe, if the user does not trust them, there is a problem (cf. airplanes).
		MOBILE MANIPULATORS FOR LOGISTICS (A, P)	Mobile manipulators are a promising technology for factory environments designed for the human use, due to the combination of mobility and dexterity. New high speed and high precision localisation and navigation control algorithms will allow mobile robots to replace traditional conveyors, with clear advantages in terms of layout flexibility. The current use of mobile robots as rolling conveyors is limited to the current precision of the localisation systems and, therefore, operations made on these rolling conveyors can only be executed by human operators. The use of industrial robots, or other automation equipment on parts transported by rolling conveyors, require a new generation of control algorithms to enhancethe overall precision of the rolling conveyors. Light, but strong, safe and energy-efficientrobots, eventually with innovative configurations, are needed to be mounted on mobile platforms. The present generation of cobots lacks these features.
		MULTI-ROBOT SYSTEMS - ROBOT SWARMS (A/P)	Fleets (swarms) of robots will increasingly become operational. Examples of this are fleets of intelligent AGVs in warehouses, swarms of drones for package delivery or reconnaissance missions, fleets of intelligent wheelchairs in retirement homes or hospitals, robot submarines for underwater repair, exploration and ocean floor exploitation. Distributed algorithms are to be developed to coordinate the behaviour of the swarm. The behaviour of swarms of social insects is a logical source of inspiration for controlling robots warms in manufacturing or other settings. Suchlike algorithms allow for easy scalability, reconfigurability and lead to resilient/robust systems. There is a need for centralised/decentralised control, enabling the fleet to work under task and environmental constraints, exhibiting multi-agent learning and self-repair surfaces by 'graceful control of degradation'.

FLYING, FLOATING OR DIVING ROBOTS FOR MANUFACTURING (A/P)	Drones are recent additions to the robotics world. They have distinct advantages over the classical configurations: they can move over large distances without requiring complex ground infrastructure, such as rails or a flat floor and they do not occupy permanent floor space. These features make them interesting for a variety of manufacturing-related tasks, such as logistic tasks (transportation and manipulating of goods over short or long distances). Assembly tasks with drones are imaginable and potentially interesting because an assembly system with drones occupies very little floor space. Building assembly drones requires considerable research to guarantee high positioning accuracy needed to assemble parts with low tolerances. This requires the development of novel sensor systems working accurately over large spaces and position control algorithms. The technologies developed for drones can be extended to include manufacturing-related activities on or under water, such as repair of drilling rigs, erection of offshore wind turbines.
ROBOT MACHINE TOOL (A/P)	The use of robots as machine tools has been a dream for a long time. They are already in use for operations in which there is no contact between the robot end effector and the environment, such as for 3D printing, and where high positioning accuracy suffices. Using a robot as a machine tool, where cutting forces occur between the tool held by the robotand the work piece, requires robots with high stiffness. The passive mechanical structure of the robot cannot guarantee the high stiffness of a machine tool. Active stiffness control through the robot drive motors is required, and more importantly, direct end point position measurement is indispensable. High challenges lie ahead to achieve this. Besides the material removal processes, typical other manufacturing processes that can use robots as machine tools are: surface finishing processes using compliant tooling (e.g., abrasive belt grinding) or other end-of-arm tooling as potential, considering accurate material removal models, deburring of castings; 3D-printing, laser cutting, laser melting deposition, etc.
SHARED AUTONOMY IN MANUFACTURING – COBOTS-COOPERATIVE MANIPULATION (F/A/P)	Cooperation between human and robot requires the sharing of the autonomy between both actors. This can be physically, for example, when the human takes the robot by the hand to guide it to a certain position to correct the pre-programmed end position. This can alsobe by the control computer correcting a wrong trajectory executed by the human operator. Applications where shared control can be useful are cobots, free ranging AGVs, (haptic) joystick controlled wheelchairs and other assistive devices. Software development is needed to merge the autonomy of the interacting actors (intention estimation, trajectory generation).
ROBOT SKILL ACQUISITION (F/A/ P)	Making robots more autonomous requires a training phase during which the skill has tobe transferred from the human operator to the robot. This requires a data capture during the human execution phase and the subsequent translation of this data set into a robot program that allows the acquired skill to be executed by the robot. Taking a spray painting robot by the hand and manually execute the painting job and subsequently play back the captured robot coordinate data stream is a straightforward case. Acquiring a robot casting deburring skill is a much more complicated task as it requires considerable research effort, involving AI techniques such as neural networks, Kalman filtering, etc., to transform the mechanical impedance (forces, positions) of the human arm into the impedance of the robot holding the deburring tool.
AUGMENTING THE HUMAN (A/P)	Robots can augment the human capabilities in different ways: by increasing the load carrying capabilities of humans (power multipliers, iron nurses', exoskeletons, assistive devices (rehabilitation robots), by reducing the cognitive load (wearables) and by simplifying and enhancing the communication with robots (cobots, assistive devices). Extensive research and development is needed in many aspects: hardware, software, shared autonomy in order to obtain usable products that can benefit human kind.
HANDLING SOFT AND LIMP MATERIALS (A/P)	Handling soft and limp materials is relatively easy for humans but is a real challenge for robots. These handling tasks occur frequently in manufacturing industries (e.g., furniture,clothing, shoe industries), as well as in non-manufacturing areas, such as agriculture (fruit harvesting), health care (handling bedridden patients, making up beds, rehabilitation), etc. Many pending problems in robotics (suitable sensors, grippers, smart intuitive programming and machine design) need a solution to achieve progress in this important but difficult area.

		ROBOTS IN CONSTRUCTION (A/P)	The inroads of robots and other flexible automation into the manufacture of homes, building and other civil engineering structures has remained limited so far. Automating building construction is closely related to the developments in modular building technology. Building cranes have to be turned into large robots by introducing more accurate positioning through sway compensation control schemes and shared autonomy algorithms. 3D printing of complete building is on its way but needs developments in the hardware, in the deposited materials and in the automatic deposition software. Autonomous road and railroad construction also offers high automation potential.
	Flexible automation	REFERENCE ARCHITECTURES FOR FLEXIBLE MANUFACTURING SYSTEMS (F/A)	New reference architectures are required to combine the advantages of hierarchically structured (predictable) performance with those of hierarchical systems (flexibility, robustness). Holonic or multiagent manufacturing system architectures have shown much potential. They are based on a structurally, rather than functionally-oriented reference architecture of the system and on astrict separation of concerns. Such architectures make the system easily scalable, extendable,and robust against disturbances. A real-time digital twin, emulating the system and its dynamics,as single source of truth at any time allows short-term predictions of the system behaviour. More research is needed to adapt the reference architectures to more application domains. The interaction with existing planning systems is to be further explored. In multi-plant configurations and when subcontractors and Original Equipment Manufacturer (OEM) companies are involved,trust considerations (in humans and infrastructure) can be incorporated to make resource allocation more reliable. Another open issue is how to incorporate planners or schedulers, which provide valuable information in a hierarchical setting when they are available, into the more heterarchically-oriented holonic execution system to give expert advice.The reference architecture allows to smoothly incorporate the human as a system resource. The description of the human holon in the digital twin of the system will require the help of sociologists and psychologists. The availability of a reference architecture along the lines explained here solves in a generic way a vast set of problems associated with flexible automation in different disciplines different from or adjacent to manufacturing. Examples of this are logistics, inland navigation transport, health care, open air engineering, railway operations, smart grids, e-health, smart homes, etc.
		AUTONOMIC ROBOTS AND FLEXIBLE MANUFACTURING SYSTEMS (A)	Autonomic systems are different from autonomous systems. An autonomous system can stand on its own and tackle unexpected events independently during the execution of a task. An autonomic system is a system that keeps it self in optimal condition, regardless ofthe task it has to execute. When something wrong happens it degrades gracefully. Very much like a human who keeps his/her body temperature constant and keeps breathing unconsciously. In medical terms it is called 'homeostasis'. A robot or a manufacturing system has to keep running as well as possible under all circumstances. When one degree of freedom fails, it still can execute a reduced set of motions. A machine tool that overheats or works at high ambient temperatures can still produce parts at a reduced accuracy. An autonomic machine keeps its accuracy intact under temperature disturbances. Suitable sensors should be developed or selected and software should be developed to compute the remaining capabilities of the system based on the sensor readings. Condition monitoring and prognostics is a field in full expansion. There is a need for the development of suitable sensors for a range of variables to be measured. Big data analytics should extract relevant features out of the captured data clouds. Storage ofthe huge amounts of raw data increasingly poses serious problems. Not the data itself is important but rather the extracted useful information. Artificial neural networks may helpfor data reduction. Learning algorithms can make the system smarter by learning from paste xperiences.
		TRUST, SOCIALLY ACCEPTED BEHAVIOUR AND CYBER SECURITY ISSUES IN FLEXIBLE AUTOMATION – BLOCK CHAIN TECHNOLOGY (A)	The increasing involvement of humans in flexible automation systems, particularly in multiplant manufacturing systems make it necessary to include trust considerations into the manufacturing execution systems and in the digital twins that emulate these systems.The flexible manufacturing execution systems must be laid out in such a way that their 'decisions' remain socially acceptable.Similarly, cybersecurity has to be ascertained, particularly in multi-plant manufacturing systems and in the virtual companies emerging in the increasingly global economy. In this respect, the advent of blockchain technology should be carefully scrutinised as an eventual candidate to guarantee absolute cybersecurity of the data used in the manufacturing execution systems.

		RECONFIGURABLE MANUFACTURING SYSTEMS (A)	Flexibility of the manufacturing system can also reside in the system hardware by reconfiguring the system components. It is however much more difficult to realise than with softwarere configurability. Modularity is the key issue here. Research is needed to define the modules and most importantly their mechanical and control interfaces to allow easy reconfigurability.The importance of this issue is becoming higher by the recent emergence and success of the hybrid-manufacturing concept by which several manufacturing processes are combined intothe one machine. Besides the hardware and control components, other modules that should be considered to be integrated are product visualisation modules and inspection systems. This is particularly important when a real-time digital twin is to be the ‘single source of truth at any instant of time.
Nano-technologies and materials	Nano-technologies and materials	MULTI-FUNCTIONAL MULTI-MATERIAL SYSTEMS (F/A)	New design and processing approaches guided by Artificial Intelligence and other computational methodologies to ensure the competent deployment of functionalised multi-material components, by considering the overall efficiency (technical, environmental, economic) of each integrated material component, including its disassembly and individua lrecovery and re-use, in the sense of Circular Economy. This shall be supported by the codevelopment of innovative high fidelity computational multi-scale material modelling andsimulation techniques, materials design optimisation methods, for example., machine-learning and generic algorithms, and advanced experimental characterisation test setups. The use of multifunctional materials should be promoted as enablers for such systems as well as the design for hierarchical systems and locally functionalised and/or reinforced materials, as ameans to achieve highly optimised nano-enabled systems.
		NANOMATERIALS FOR ADVANCED AND HIGH-PERFORMANCE COMPOSITE MATERIALS (A/P)	New nanomaterials are required to provide new functionalities to conventionally used polymer, metal and ceramic-based composite materials, and to improve their suitability for conventional manufacturing processes (minimising the effort in terms of process adaptationsand potential negative effects in other performance properties). In addition, such nanomaterials must be industrially available in large amounts and at affordable prices to ensure European non-dependence on nanotechnologies for composite materials. The nanomaterial production processes must be robust, cost effective, easily scalable and with low environmental impact; and the use of raw materials (either natural or recycled) widely available in Europe is also imperative. Development of tailor-made nanomaterials, oriented for enhanced compatibility intargeted materials and applications should also be an important focus. Tailoring includes their availability in physical formats that will ease their introduction into the final applications (e.g. inthe form of masterbatch, fibres, 3D structures, films, coatings). Support of introduction of such nanomaterials into semi-products is something that also should be targeted from research to industrial scale.
		NOVEL RAW-MATERIALS AVAILABILITY FOR COMPOSITE MATERIALS (A/P)	Further gains in composite materials and related structures are highly dependent on the availability of raw materials that are used for their manufacturing. A wide range of performance properties and processing characteristics would be possible through the use of different polymer matrices, fibres, and additives, including nanomaterials. In addition, these rawmaterials also need to be provided in suitable formats, such as pre-impregnated materials, reinforcement fabrics, commingled yarns, liquid resins, polymer films, or master batches, tomake possible their use for composite materials manufacturing. This includes combinations of new polymer/fibres combination in prepreg materials, hybrid fibres systems and the introduction of new and improved polymer (thermosets and thermoplastics) and fibre-based materials. Such developments are critical building blocks for future multifunctional and high performance lightweight composite materials.
		SMART, HYBRID AND MULTIPLE MATERIALS (A/P)	Design, modelling and manufacturing processes of multi-metallic, plastic-metal or composite-metal components and high-performance materials. Structures and components with integrated functions and tailored material properties and location-specific properties. Enhanced, faster joining capability with a range of materials.
		LIGHTWEIGHT STRUCTURES BASED ON ADVANCED AND MULTIFUNCTIONAL MATERIALS (P)	Development of nano-enabled multifunctional lightweight structures (composites as polymermatrix and metal composites, aerogels, coatings, surfaces, adhesives and/or any otherpolymeric materials) through the industrial production of nanoscale structures in unprocessed form, intermediate products with nanoscale features and nano-enabled products to foster innovation in key industrial sectors and support the development and market uptake of KETs.

SMART MATERIALS AND FUNCTIONAL PRINTING (F/A/P)	Design, modelling and manufacturing processes integrating smartness to parts. Structures and components with integrated functions (functional printing) and selective deposition or texturing. Another specific technical-related issue that needs to be addressed is the development of connectors (flexible, robust, etc.) that are also needed. In addition, other general issues must also be addressed, such as recyclability, repairability and standarisation. In terms of the materials: The development of novel materials for fully printed devices (e.g. for sensing or electronic functionalities) are needed, together with the optimisation of conventional processes for those materials. The challenge of printing directly on a3-dimensional part and on any substrate (e.g. composite, metal, or other plastics) beyond what is currently possible (i.e. PET, PC, PMMA or PU in plastics, glass and some ceramics). A wider range of technologies and innovations is needed to achieve the objective.
ADDITIVE MANUFACTURING WITH NANOPARTICLES (A/P)	Design and fabrication of components/tools through the use of nano-reinforced alloys, concrete or polymers, especially designed and prepared as feedstock material to improve the part properties (mechanical strength, toughness, hardness, or wear resistance, etc.). Thermal conductivity of plastics and composites has been seen as a disadvantage in the replacement of traditional metals in some applications. Nanomaterials can be enablers of this property in plastics and composites. They also open the possibility to tailor the thermal conductivity value, thermal management and pathways. Focusing on this propertyis important for future smart materials based on the combination of nanomaterials with plastics and composites.
NANOFABRICATION TECHNIQUES TO CONTROL SURFACE PROPERTIES (F/A/P)	Nanofabrication can be used to nanopattern different substrates to implement functionalities on the surface of injected/thermoformed parts or others. Based on the control of thesurface roughness, several functionalities related to surface energies (icephobicity, antifog,etc..) or to light interaction (anti-reflecting, structural colours, etc..) can be tuned; these and other functionalities (e.g. aesthetics-related) should be exploited for new product development using texturing at different scales (femto, pico, nano, micro texturing andother nano fabrication techniques).
NEW NON-NOBLE-METAL BASED CATALYSTS (A/P)	A high number of industrial processes are based on reactions, such as hydrogenations, hydrogenolysis and oxidations, based on highly expensive and scarce supported noble metal catalysts. In addition to this, many energy conversion and storage technologies (such as fuel cells, rechargeable metal-air batteries, unitised regenerative cells, and water electrolysers) use electrocatalysts based on noble metals (e.g., Pt, Ru, Ir). To head towards sustainability, catalysts based on cheap and abundant nonnoble metals able to provide the same or similar performance are needed.
MATERIALS DESIGN AND PRODUCTION FOR FUNCTIONALITY, DURABILITY AND ENERGY EFFICIENCY DURING USE BUT CONSIDERING THE REUSE AND RECYCLING PHASE (A)	Prediction of the lifetime, modelling and scale up of the production of new materials and nanomaterials, considering composition, microstructure, production process and finishing, functionality and performance during use in order to increase lifetime. It is really important to assess both durability and energy efficiency during the use. For that, tribology is an important tool for reproducing, in a laboratory, the working conditions of the application to address in the design phase of the component, the right material that might reduce the energy consumption and to increase its lifecycle. These materials should be integrated in products (whenever possible) allowing traceability in order to facilitate or simplify recycling or reuse. In addition, the design and manufacture of engineered components depend to a large extent on the availability of materials property and processing data qualified for use in the industry sector involved. However, material specifications from suppliers often providefor a range in compositions, microstructures and as-supplied properties, which means that designs then allow for the poorest performance in the range. This has led to overdesigned products with excessively conservative allowances for known component failure modes. There is a need to tighten up materials data management, and the models used for its interpretation, so that better engineered and cost-effective products can be delivered without leading to unacceptable risks of failure in service and product insurance implications. An efficient methodology for addressing these issues is the production of open access material databases so that all in the value chain are fully aware of the data, and that newly derived data is provided at the highest quality.
MATERIALS, COATINGS AND FLUIDS RESISTANT TO HIGH TEMPERATURE MANUFACTURING SYSTEMS (P)	Manufacturing systems (e.g., high-pressure injection moulds, hot stamping) have a limited lifetime due to the hard working conditions. New materials and surface treatments have to be developed to resist higher temperature, oxidation and thus increasing the durability and reducing manufacturing cost (OPEX) in industry. Modelling and characterisation technique sneed to be combined in order to reduce the experimental work, reproducing the critical failure mechanism at the laboratory to implement in the industry.

		NEW MATERIALS FOR JOINING (A)	Joining of speciality materials with enhanced properties; Low electrical resistivity and low thermal conductivity joints; High performance Joining of non-metallics; Micro and Nano Joining. Joining dissimilar materials is challenging especially when trying to minimise the use of adhesives to facilitate recycling. Galvanic coupling of dissimilar materials and corrosion resistance of joint and welding is an important issue that are still seriously limiting the system lifecycle.
		NANOCELLULOSE-BASED FUNCTIONAL MATERIALS AND PRODUCTS FOR MULTI-SECTORIAL APPLICATIONS (A/P)	Research and development is required on the scale-up of production of functionalised cellulose nanofibers and nanocrystals, which are natural nanomaterials that can be easily obtained from renewable resources (e.g., trees, annual plants, paper, cardboar, etc). At the same time as addressing the pilot-scale manufacturing of the functionalised nanomaterial itself, the potential of these bio-based and biodegradable nanomaterials must also be demonstrated by developing novel nanocellulose-based functional materials and products,with wide-ranging applications, including food packaging, environmental remediation filters and sponges, thermal insulation materials or materials for skin treatments to name a few. It is foreseen that the superior properties of these bio-based materials will displace in many applications existing materials, which are currently widely used despite their negative environmental impact and inferior properties.
		ADVANCED LARGE-SCALE MULTI-FUNCTIONAL COATINGS FOR STEEL AND OTHER METALLIC SUBSTRATES (A)	Research on the design, formulation and application of novel large-scale multi-functional coatings that enhance the durability of steel and other metallic material-based products is urgently required, particularly for those products that are large and exposed to extreme environmental conditions. Unless these coatings are proven for products with large dimensions, the targeted applications, i.e. offshore, will not be impacted. This research will also address the need for multi-functional coatings in a variety of different industrial sectors. For this, an evaluation of the different technologies available (including Thermal Spray, Sol-Gel, Electrodeposition, Advanced paint systems, PVD, CVD, ALD, etc.) should be performed initially depending on the end user requirements and on the different properties or functions that are sought in each case. The main aim of this project will be to identify the best solution to the problem of corrosion-resistant coatings for steel, which can be used in extreme conditions such as in off-shore applications, with dramatically improved lifetimes with respect to current products and eventually offering added functionalities on request (e.g., self-cleaning, anti-icing, anti-fouling, etc.). The new coatings and production processes shall be environmentally friendly, not hazardous and safe in the workplace and shall eventually replace toxic and hazardous substances currently in use. Additionally, they should work in combination with monitoring systems that provide, in time, online information about the material and component degradations due to corrosion,bio-fouling, fatigue, icing and erosion.
		INDUSTRIAL MANUFACTURING OF ADVANCED MATERIALS (P)	The introduction of new nano-enabled advanced materials in industrial production lines is needed to secure their wider market uptake. In many established sectors, the introduction of new materials and innovation has to deal with a huge factor scale that is often difficult to overcome. As an example, the urgent technical needs related to metal forming (metalworking processes) for materials like new super alloys, Metal Matrix composites, light alloys and nanocomposites and in particular the manufacturing of semi-finished products (bars, tubes, wires, plates, etc) lack the availability of midscale plants. This gives no possibility for SMEs to access production facilities that are able to provide this kind of processes at the scale needed for small series production, thus blocking the introduction of these advanced materials into advanced products.
Biological transformation	Biological transformation	BIO-INSPIRED STRUCTURES, MECHANISMS AND PRINCIPLES OF THE BIO-INTELLIGENT MANUFACTURING SYSTEMS (F/A)	Decentralised, autonomous cell-based, highly networked manufacturing systems and value networks will be highly adaptable and resilient. They have a high potential for self-optimisation, high efficiency and transparency.
		BIOSENSORS (F/A)	Biosensors are composed of a biological sensing element (enzyme, antibody, DNA, receptor or complete cell) in direct contact with a physical sensor (transducer). Few examples exist, like a highly sensitive “electronic nose” for gas sensing. A systematic evaluation will reveal many more application areas and bio-sensing principles, to be demonstrated in application-specific implementations.

		BIOACTUATORS (F)	Nowadays, research is exploiting many physical and material effects to realise smart actuators. However, all of them are still far from the efficiency and energy density of physiological and biological actuators. One of the consequences can be to use artificially grown biological actuators in a life sustaining microenvironment. Further optimisation may allow to reduce the biostructures and along with it the life-sustaining system to the necessary minimum.
		ADDITIVE MANUFACTURING OF BIO-INTELLIGENT MATERIALS (A)	3D printing of bio-active materials and even biological cells have been demonstrated in basic research. The development towards highly reliable and efficient additive manufacturing will also reveal further application scenarios and printing materials.
		ENZYMATIC PROCESSES (F/A)	Enzymatic processes are currently used in cleaning and in food manufacturing, as bioleaching is also used in the extraction of metals from their ores using living organisms. In the future, the extraction of raw materials from waste will be much more important and enzymatic processes promise efficient solutions. Further developments may lead to other material transformations, even very localised and/or as manufacturing processes, e.g., in microelectronics, micro-systems and polymer electronics.
		MICRO-BIOREACTORS (F)	Material transformation, as it is widely used today in large bioreactors, could be developed to be used in smaller and even micro-bioreactors as manufacturing processes for local generation and dissolution of materials. Stimulated photoemission and photoswitching of the genome, as it is used today in biological research, could be used to monitor and control the processes.
		SMART BIO-MANUFACTURING DEVICES (F)	The results of the research topics mentioned above, combined with synthetic biology, bioelectrochemistry, and artificial intelligence could allow the development of self optimising biomanufacturing devices for local manufacturing of consumer goods.
		BIOCOATING AND BIOINOCULANTS (F,A)	Exploit the potential of different biotech-based solutions to offer protection of products across different sectorial activities, such as protection from microbial degradation and/or affording them with antimicrobial properties
		BIOPACKAGING (F/A)	Exploit the potential of different bio-based solutions for packaging applications, including the use of new biomaterials, technologies for bioencapsulation, among others, which could offer suitable and sustainable approaches for manufacturing processes.
		ECOLOGY-BASED MANUFACTURING (F)	Re-thinking manufacturing units based on nature based principles of ecology that could offer integrated and sustainable perspectives to industries.
		BIOREFINERIES (F/A)	Integrated solutions of biorefineries for sectorial clusters to extend the use and applications of products and co-products across the value chains and to produce new materials and products.
Customer– driven manufacturing	Smart design	GENERATIVE DESIGN FOR PERSONALISED PRODUCTION (A/P)	An important asset to bring mass customisation and personalised manufacturing closer to sustainable production paradigms is the development of design platforms. These tools should be targeted to properly collect and address customers' requirements towards optimised conception and design of individual and specific products. To this aim, newsmart CAD/CAM solutions have to be developed to provide the ground for implementation of computational and generative design within the boundary conditions set by the technology. Co-design activities, where industry experts can have the opportunity to involve customers as contributors in the creation of products, should be further developed. Novel design solutions should provide more satisfied customers, increase the product quality (embedding biometric and personal data) and establish a better product-consumer relation due to the interactive process. This latter aspect can result in customer interaction in stores, centres/corners for personalised manufacturing, bringing new game-changing services, which include final users in the product conception and design.
		FACTORIES OF THE FUTURE MANUFACTURING THE PRODUCTS OF THE FUTURE: COLLABORATIVE PLATFORMS FOR VALUE CREATION (A/P)	More products that incorporate digital technologies are becoming more than a bundle of functionalities. The products of the future will become platforms for value creation for both the customer and the product provider. Co-operation between man and machine needs to be considered based on artificial intelligence and data driven approaches. More agile offerings centred on customers' needs and preferences are expected from this research priority line. New technologies that enable to capture customer opinion and feedback throughout the product's life cycle are important. Research on this field will affect thevalue-adding proposition of current and new solutions while providing the customers with more complete and fulfilling results.
		SOCIAL MEDIA IN MANUFACTURING (A)	New models and approaches considering customer involvement through social networks need to be considered. Extracting social media data and integrating them in manufacturing is important, providing data throughout the product's lifecycle. Product platforms that connect social media data with production and supply chain control need to be explored. Research in this field will affect product design, production and supply control and is expected to affect customer's involvement in manufacturing.

	DESIGN FOR ADDITIVE MANUFACTURING (A)	Design for Additive Manufacturing means taking into account the advantages and restrictions of different AM processes during the design phase of a product. There is a great need for development, and perhaps even more for the spread of knowledge on design for AM. New methodologies are needed for design of parts and design an entire product family instead of a single product for production by AM, or the production of an AM enabled process chain.
Customised processes	PERSONALISED MANUFACTURING (F/A/P)	Thanks to the Industry 4.0 paradigm shift (distributed sensing and big-data data gathering), customisation can finally move from the product to the process stage. Personalised manufacturing means being able to handle each resource (tool copy, material flow, roughpart and machine) considering its specific history and current state. Due to increasingly costeffective sensing, novel digital models should be designed and developed to follow each resource consumption trajectory in order to guide specific actions (process parameters, substitution and maintenance policies) and promptly react to unpredicted events.
	NOVEL SOLUTIONS FOR EFFICIENT MASS CUSTOMISATION VIA AM (F/A)	Additive Manufacturing is in principle able to achieve “complexity for free”, thus paving the way to a new generation of personalised production (biomedical, dental, aerospacesectors). However, many gaps need to be filled to let AM act as an efficient and viable solution for mass customisation: the excessive cost of design, when it is attributed to one single copy of the product; finishing of complex surfaces or elimination/reduction of supports; excessive time to produce a defect free product. This action focuses on the research needed to achieve efficient mass-customisation via AM.
	MASS PERSONALISATION (A/P)	Adaptive production models and the development of technologies to implement mass personalisation need to be accelerated. New ways (including new business models) to exploit modern networks to capture the customer requirements and include them in a product design need to be examined and combined with global manufacturing networks.This field is interconnected with all the levels of manufacturing and, thus any, research connected to it.
	MASS CUSTOMISATION OF COMPOSITE STRUCTURES (A/F)	The great challenge is to provide appropriate procedures, design solutions and manufacturing processes to achieve mass customisation of composites. Composite structures mainly aim to low weight, heavy duty low fatigue, and resistant to wear and corrosion. The challenge is to achieve manufacturing with high output rates together with competitive costs. The need to develop new composite materials and energy efficient processes is a research and technology goal to be addressed.
	NEW RAPID TOOLING TECHNOLOGIES (A)	Conventional forming and machining processes need to quickly adapt to the frequent design changes required by the customers. Conventional manufacturing processes for metal or ceramic tools are too expensive to meet the ever-increasing requirements of short product lifecycles and mass customisation. New tooling design concepts, new materials, surface treatments and new manufacturing processes, which need to be rapid, cost efficient and robust, must be developed.
Data-augmented customisation	PROCESS QUALIFICATION VIA I4.0 FOR MASS CUSTOMISATION (F/A)	New technologies as AM allow in principle mass customisation, given their specific capability of producing complex shapes without the need of expensive tools and moulds. Unfortunately, a strong barrier to mass customisation in highly regulated sectors (aerospace, biomedical implants) is represented by process and product qualification standards, which tend to freeze the process conditions and limit the number of product variants. Thanks to the impressive amounts of sensing and in-line data availability, novel approaches to digital qualification should be based on process signature rather than on product testing. This paradigm shift in qualification will have a significant impact on highly regulated sectors such as aerospace and biomedical, in which the product personalisation is particularly interesting for the development of new businesses.
	TRANSFER LEARNING AND SCALING-UP FOR ZERO-DEFECT CUSTOMISATION (F/A)	When small lot or one-of-a-kind/personalised production is considered, an important barrier consists in time and resources wasted in the trial-and-error experimental campaign that has to be carried out to realise defect free products. Transfer learning should beaimed at defining approaches and tools to “translate” the knowledge and the experience acquired on a given machine, material and product geometry to other machines, materials and product geometries. Similarly, novel solutions for scaling-up results obtained at the laboratory level should be developed in order to reduce industrialisation time. Information provided by IoT quality feedbacks from similar products/machines/laboratories should be used if possible as a reference.
	ZERO-DEFECT IN PERSONALISED PRODUCTION (F)	New methods and tools for monitoring and controlling quality in one-of-a-kind or small lots scenarios need to be developed. In fact, typical approaches for quality monitoring, control and optimisation assume large-scale production. New solutions and approaches for zerodefect manufacturing of personalised products have to be developed.

		I4.0 FOR CUSTOMISED MANUFACTURING SYSTEMS (A/P)	Self-adjusting plug and produce devices that are able to ensure rapid response to highfrequency customer changes are becoming a fundamental pillar in the new manufacturing paradigm. Real time planning and control of reconfigured manufacturing systems is a barrier that needs to be overcome to allow fully resource utilization, rapid customer response and high efficiency. New digital models, algorithms, and self-adaptive, autonomous and perfectly coupled technologies must be developed to enable customer drivenmanufacturing in modern factories.
Human-centred manufacturing	Understand	ADVANCED BEHAVIOURAL AND COGNITIVE MODELS FOR HUMANS IN MANUFACTURING (F/A)	This research will address the development, validation and testing of new advanced models for the humans in the manufacturing environment. These models will address two main directions: the first one is the modelling of the human workers' behaviour aimed at analysing and understanding the actions they are executing in order to predict and prevent risks. The second one is related to the modelling of cognitive processes in the decision making and learning. Adaptations in the organisation of work enable technological innovations to be successfully implemented and to reach "full potential" . Approaches and methodologies coming from different disciplines have to be taken into consideration, i.e., human science, artificial intelligence, psychology, etc.
		BEHAVIOURAL AND COGNITIVE HUMAN-MACHINE SYSTEMS (A/P)	This research will address the development of neurocognitive approaches for manufacturing modelling, developing and testing human-machine interaction paradigm fusing human and artificial sensing and operating capabilities. This research will take advantage of cognitive science, interaction models and technologies, mathematical models, computational models, artificial intelligence, sensors and actuators. These systems will be able to largely collect and analyse various forms of data, processes, workflows within the manufacturing to make real-time smart decisions in collaboration with the humans, allowing a smooth and safe human-machine interaction.
		ANALYTICS FOR DATA-HUMAN INTERACTION (A/P)	Data processing analytics for new data-human interaction challenges of existing manufacturing management systems that are mainly driven by human interaction like Total Preventive Maintenance (TPM) or Failure mode, effects and criticality analysis (FMECA). It is expected that analytics will enhance such systems, avoid weak feedback loops and evolve to RT update including the sharing and detection of good and bad practices.
		SKILLS AND KNOW-HOW MANAGEMENT (F/A/P)	Manufacturing skills and know-how is tightly linked to the role of the human workers and the preservation and continuous improvement of them is constantly at risk, both when looking at the present market demand and also in the future. It is required not only to requalify the current generation of workers (but at the same time preserving their knowhow in existing manufacturing processes) but also to develop systemic mechanisms to boost the attractiveness of the youngest generation and make them ready to act in manufacturing environments. Acceptance and adoption of new technologies by workers interms of new skills/capabilities, attitudes, implications for cooperation in (work) teams and adaptive performance.
		NEW LEGAL FRAMEWORKS FOR HUMAN WORKERS	The use of advanced technologies (e.g., sensors, cameras, digital assistants, etc.) is creating new challenges for jurisprudence and its practical application. From a legal perspective, new types of contracts, the sharing of data, errors in collaborative production process, new work environments, new skills and roles for the workers, a value of the work provided by humans that is more difficult to recognise and assess, all these play a key role in the definition of the legal framework for workers in Europe.
		KNOWLEDGE MANAGEMENT AND SHARING (F/A/P)	The sharing and codifying of knowledge in factories requires the development of models that represent knowledge and the capability to make them available and usable. This is relevant for aspects linked to the knowledge of the production or design process among the various employees working in different corporate functions. In order to exploit fully the non-structured knowledge within factories, it is necessary to develop multidisciplinary research that has references in the ICT, machine learning and in the interaction designsectors, in which various skills in the area – such as psychology and engineering – must converge in models supporting knowledge management.
	Protect	NEW MATERIALS AND NEW TECHNOLOGIES FOR SAFETY IN THE WORKPLACE (F/A)	New materials and new technologies for safety in the workplace based on interaction between the operator and the working environment, in where he is called to operate, can be developed to improve the quality of work and to ease its conditions. Moreover, this priority requires the study and development of new materials, with high mechanical and thermal energy absorption, products (sensors, work clothes) and tools for safety in the workplace.

		BIOSENSORS AND MATERIAL FOR HUMANS IN MANUFACTURING (F/A)	Biosensors for health monitoring and early disease detection. Sensorised smart, aesthetic and comfortable materials and surfaces are needed to protect physically and cognitively human workers from demanding complex manufacturing environments.
		WORKPLACE DESIGN FOR HEALTH AND SAFETY (F/A/P)	The design of workplaces embedding new interaction technologies, advanced machinery and digital tools entails the need of assessing health and safety aspects beyond the current practice, regulations and standards. In the case of the complex technologies and human machine systems risk factors that are difficult to discover, have to be evaluated, both duringthe design of the equipment and in an operational context.
		DESIGN OF NEW EQUIPMENT, INTERFACES, PERSONAL PROTECTION DEVICES (F/A/P)	New equipment, interfaces and devices such as smart devices, virtual, mixed or augmented reality, or intelligent assistants requires new methodologies to assess their safety with respect to different classes of workers. This will require fundamental concepts of ergonomics relating to the human-machine interaction to be updated with respects to new equipment to be used. This will require design concepts that are centred on human beings, assessment analyses for different classes of products and workers, as well as specific standard and regulations.
	Support	TRAINING ENVIRONMENTS (F,A)	Existing learning environments do not fit the needs of future manufacturing work places. The workers on the shop floor need to be trained with contextualised learning technologies(e.g., augmented and virtual reality). Specific information on problem solving and modelling of the industrial context need to be combined in order to strengthen the ICT knowledge ofthe workers. These new technologies will support the implementation of a smart learning environment that enables future workers in smart decision-making and smart production processes. Education and training anticipates and meets the skill requirements of advanced manufacturers, while remaining broadly consistent with long-term projections of labour demand.
		ACTION-BASED LEARNING FOR HIGH ADDED-VALUE MANUFACTURING SKILLS (A/P)	Application of the concept of teaching factories for the development of associated training and skills in added-value manufacturing, thus providing employees with cross disciplinary skills, preparing them to integrate new technologies and giving them the ability to combine knowledge. The aim is to design and plan “hands-on” trainings, in which employees can directly experiment the technologies, in order to ensure an immediate return and applicability in their factories.
		HUMAN-CENTRIC DATA AND INFORMATION MODELS AND TOOLS (A)	Current shop floor information management models and tools are based on principles of decades ago and are not adequate to the demands of complex socio-technological environments. Information technology evolution has made possible to develop and use hybrid digital informational content combining multimedia content with augmented reality and 3D modelling and visualisation. Immersive environments can also be explored to provide human worker a more efficient interaction with data and information in the shop floor. Moreover, these new approaches are the basis for effective knowledge management, training and learning.
	Empower	AUGMENTED HUMANS - UNOBTRUSIVE ASSISTING TECHNOLOGIES FOR WORKPLACE SUPPORT (F/A)	Even though today’s smart assistive technological devices are still clumsy and heavy, in the next years, development in soft advanced materials, artificial intelligence, and mechatronics will lead to the creation of natural-to-use and smart skin-tight suits. Such lightweight and flexible devices will enable people with specific impairments to perform tasks they could not accomplish before, by providing outrageous feats of strength (heavy lifting, mobility support) and capabilities to physically interact with the manufacturing surroundings in a shared workspace.
		INTUITIVE DIGITAL TOOLS FOR EMPOWERED OPERATORS (A)	This research aims to develop new intuitive digital interfaces that assist operators in different types of manufacturing operations. The tools should significantly facilitate the achievement of quality performance targets and the normal execution of the tasks. Wearable and multimode interaction technologies will boost the convergence between the physical and digital world and enable more seamless workflow, translating in to a greater productivity. The results of this research priority are relevant and applicable in many industrial sectors and companies.
		NEW PERFORMANCE MANAGEMENT SYSTEMS FOR HUMAN-CENTRED MANUFACTURING ORGANISATION (A)	Decisions on the division of work between human, workers and production technologies have been based so far on productivity/economic criteria. We need to develop performance models that enable a new paradigm in manufacturing, in which the performance measurement is aligned with the complexity of the world. Performance measurement should be multicriteria, including criteria in social, environmental and economic sustainability. In particular, more comprehensive human and social performance criteria should be developed to be weighted with economic criteria. These new performance management systems will be the cornerstone to (re)design factories and manufacturing networks.

		HUMAN-MACHINE PROCESS AND SYSTEM DESIGN (A/P)	The increasing degree of interaction between workers and automatic machine requires new methodologies supporting the design of production systems as well as the flexible assignment of tasks. Even if the functions of humans and machines will remain separated, assignment decisions are requested to be flexible and dynamic grounding on the skills of the worker, the characteristics of the products, for example, personalisation, the specific status of the system or the worker (overloading, end of a shift, etc.).
		HUMAN-CENTRIC WORK ORGANISATION AND PLANNING (A/P)	Advanced methodologies and tools for flexible and reconfigured work organisation considering the status of the resources and the processes, ergonomic aspects and associated risks, age-appropriate assignments, qualifications and skills of the workers as well as their training, in a way that is integrated with the overall plant organisation and planning.
Agile manufacturing systems design and management	Agile manufacturing systems design and management	GLOBAL MANUFACTURING NETWORKS AND DYNAMIC SUPPLIER NETWORK CONFIGURATION AND MANAGEMENT (A)	Considering globalisation, complexity of supplier networks today and their variability, establishment of supplier networks configuration and management through the adoption of information technologies and enabling network-wide connectivity for coordinating complex interdependencies is required. To exchange data with common tools is mandatory at a worldwide level. Research on this field will be highly usable in integrating new technologies in existing Configuration and Management network systems, including the management of supply chains under uncertainty.
		DECISION MAKING TOOLS FOR FLEXIBLE ASSEMBLY LINES RECONFIGURATION (A/P)	New methods to control autonomous production units enabling the reconfiguration of the shop floor for smaller series. Should enable the introduction of flexible production resources such as autonomous mobile manipulators, capable of repositioning themselves on the line and allow the exchange of both parts and grippers between robots. New decision-making methods should support the generation of safe and efficient reconfiguration plans.
		ADAPTIVE AND AUTONOMOUS PRODUCTION CONTROL (A)	With more production data available, adaptive control is the next step. New approaches in production monitoring interfaces, including human-in-the-loop, are important so that operators may contribute. Data-driven algorithms that enable autonomous control will improve decision support. In-process sensors for machine diagnostics support decision making both in quality control, availability and in maintenance planning. Unified real-time platforms that will gather data from different sources need to be developed. Research in this field will affect both production sites and networks.
		MANUFACTURING SYSTEMS COGNITIVE DIGITAL TWINS (A)	New approaches connecting production system-related data to digital twin systems able to support decision-making are required. There is a need to develop platforms that will combine and compare data from different sites for effective decision-making. Algorithms that will be able to make complex data combinations and that will derive meaningful conclusions are a main challenge. The result of this research will improve the utilization of resources at a production level, and will need a high level of digital continuity.
		NOVEL CONTROL AND SENSES BASED AUTONOMOUS ROBOTIC SYSTEMS (A/P)	Sensor-based reconfiguration of flexible robotic cells integrating multiple sensors such asvision, tactile, RFID, presence sensors are needed to adjust the operation to part types and dimensional variations and to assume complete autonomous robotic systems. Machine learning, dynamic modelling, identification and analysis of robotic systems will be used to simulate their individual components and to predict their kinematic and dynamic behaviour under variable operating conditions. Hybridisation of basic components contributes to guarantee the safe and smooth cooperation with operators and a regulatory and normative development.
		INDUSTRIAL ROBOTICS AND DEXTEROUS MANIPULATION TECHNOLOGIES (A/P)	Cooperating robots, investigating approaches to control autonomous and mobile robotic production units can change tasks and position in the shop floor to enable random production flow. Dual arm robotics mimicking the human motion during production. Dexterous and innovative handling and processing devices.

		HYBRID PRODUCTION SYSTEMS (A/P)	Wearable or smart devices to augment operators' abilities in cooperation with robot systems, enabling the future manufacturing agile organisation. Augmented reality applications for human operators superimposing information while enhancing the operator safety and acceptance. The ability to interact and to collaborate with human operators will be critica lfor production flexibility while maintaining cost effectiveness.
		ARTIFICIAL INTELLIGENCE (AI) ENABLED ROBOTIC SYSTEMS FOR MANUFACTURING (A/P)	Autonomous manufacturing systems enabled by the incorporation of AI methods for decision-making at the planning and execution stage. Robotic systems will achieve local autonomy, relying on data from their sensors and also from the Industrial Internet. They will also contribute to a collective perception, sharing these data with all other production resources.
		LEARNING PROCESSING MACHINES FOR VARIABLE RAW MATERIALS (A)	Learning processing machines should enable smart adjustment to differences in dimension, variety, location on multiproduct processing lines (different types of raw materials), recording and saving the former optimal adjustments, analysis of Big data to optimise adjustments.
		TRACEABILITY AND CONNECTIVITY TO HARMONISE INTEGRATED SUPPLY CHAINS (A/P)	On-time delivery and optimisation of raw material delivery, with processing capacities, traceability optimised inventory level route management systems, to harmonise the whole processing lines (efficiency and quality), monitoring the compliance with the requirements throughout the whole supply chain. Analysis of data for the identification of weak points, quality hazard levels and related alarm signals.
		QUALITY PLANNING METHODS TO ANTICIPATE THE DETECTION OF NON-CONFORMANCE QUALITY DURING SYSTEM DESIGN (A)	New quality planning methods that anticipate quality issues during the system design stage, by capturing the effect of inter-stage correlations, of fixturing and of non-ideal part variations. The objective is to significantly reduce the likelihood of defects and to minimise costs. The results of this research are relevant and applicable in many industrial sectors and companies.
		DYNAMIC CONTROL OF PRODUCTION QUALITY TARGETS (A)	New methods and tools for dynamic control of production quality target performance during the system lifecycle. The objective is to minimise ramp-up times among system reconfigurations. The results of this research are relevant and applicable in many industrial sectors and companies.
		ARTIFICIAL INTELLIGENCE AT THE SHOP FLOOR (A)	Introduction of the equipment and production lines that integrate the self-monitoring, selfassessment, self-learning and self-adjusting concepts with artificial intelligence technologies for production systems at the shop floor level.
		IMPLEMENTATION OF ADDITIVE AS PART OF A HYBRID PROCESS (F/A/P)	Optimisation of intelligent process chains requires an increased degree of integration ofthe different processes in the production chain. The requirements for such an optimised integrated process chain depend on the requirements of the specific applications of the products. Integrated hybrid manufacturing solutions can include: ▷ Combination of several operations in one single machine, ▷ Development of a standardised generic interface between different machines/production units ▷ Versatile configuration to form an integrated hybrid-manufacturing cell or hybrid manufacturing process chain. In order to achieve a machine neutral generic solution with high degree of flexibility, a wide involvement of different stakeholders throughout research and industry is needed.
Circular economy	Materials and energy (recovery, recycle,	SECONDARY MATERIAL MANAGEMENT (F/A)	Recycled materials are aimed at providing a reduced environmental footprint, although their characteristics, chemical composition and behaviour, could be affected by uncertainty due to the complexity of the separation, collection and recycling processes. Secondary materials have to provide sufficient quality for industry and re-users, as well as safety of toxic residues. New approaches, methodologies and technologies must be addressed to support the qualification, quality control, handling, tracking of recycled materials.
		RESILIENT APPROACHES FOR RAW MATERIALS (F/A)	The expected availability of critical materials cannot be guaranteed in the future. For this reason, new technologies must be investigated for sustainable mining as well as for the replacement, using different materials. During mining, challenges are related to equipment, and their respective materials, with higher strength and corrosion resistance to enable operations at higher depths and extreme environments.
		MATERIAL RESOURCE EFFICIENCY (F/A/P)	In the future, bioeconomy is important to reduce the amount of materials used, including raw materials and intermediate products, under the paradigm of "doing more or the same with less". Research is required for more efficient manufacturing systems with a lower environmental impact. In this context, new technologies must be explored for sustainable exploitation, use of raw materials and improve sustainability of the supply chains.

	NEW SUSTAINABLE MATERIALS, PROCESSES AND BIO-PRODUCTS (A)	The introduction of new sustainable raw materials resulting from other industrial processes and the adaptation of industrial processes and equipment allows them to carry out an intelligent management of materials and waste, enabling their future valuation elsewhere in the value chain. In this context, further research is required to promote industrial symbiosis, consisting in the physical exchanges of materials, energy, water and by-products between industrial facilities, in a way that the waste/by product of one facility is used as a resourceby another. Promote the production and use of bio-based products, in alternative to synthetic and nonrenewable products. Research needs to rethink the product and process design in order to use biological feedstocks. Also, it requires more sustainable and efficient supply chains, capable of making a better use of the raw materials.
	ENERGY-EFFICIENT APPROACHES IN MANUFACTURING (A/P)	Development of manufacturing systems (lines, cells, etc.) and tailored industrial control processes aimed at intelligent management of energy use, efficiency, energy balance and integration of multiple production processes. Manufacturing systems and energy supply systems should be adapted to use energy from renewable sources.
	INDUSTRIAL SYMBIOSIS AND ECO-EFFICIENCY OF PRODUCTION PROCESSES (F/A)	Significant technical and methodological breakthroughs and coordinated R&D effort are still required to bring the environmental footprint of the manufacturing industry to a radically deep minimum, ideally at a symbiotic level. Advanced technologies and procedures should be developed and properly combined to provide for: ▷ minimum inefficiencies of the production systems ▷ improved efficiency of the industrial processes, designed to maximise the preservation of natural resources ▷ integration of renewable energy sources in the industrial manufacturing processes ▷ balanced flows of resources and integration of waste streams as input materials ▷ valorisation of waste ▷ rational thermal energy consumption ▷ recovery of waste heat/cold, thermal energy storage ▷ energy management
Design, Refurbish and Remanufacture	PRODUCT AND PROCESS DESIGN FOR MATERIAL REUSE AND RECYCLING (A/P)	The design of a product and the associated process is a fundamental phase to ensure longer lifespan and to define many of the future reuse and recycling options. With this aim in view, new approaches for the design of processes and products (metal, plastics,composites and multi-material) have to be developed in order to provide an easy reuse and recycle of the materials and extend the product lifecycle. The following aspects have to be taken into account: ▷ design for repair and disassembly ▷ products can be easily repaired and upgraded for a long-term use ▷ recycling options for the product, with regulations and recycling guidelines ▷ energy and resource footprint of the products and the associated manufacturing processes ▷ energy and resource footprint of the manufacturing system
	PROCESS MODELLING AND CONTROL IN DEMANUFACTURING AND REMANUFACTURING (F/A)	The research aims at increasing the knowledge about demanufacturing and remanufacturing process modelling and about cyber-physical systems for process control in circular economy businesses.The research will develop new knowledge based on an extensive study of the existing research on systems, methods and tools for process modelling and control in the recovery,reuse, and upgrade of functions and materials from industrial waste and post-consumer products.
	ADDITIVE-SUBTRACTIVE PROCESSES AND SURFACE TREATMENTS FOR IN-LINE PRODUCT REPAIR AND REMANUFACTURING (A/P)	New methods and tools to enable combined additive-subtractive processes and surface treatments for in-line product repair and remanufacturing. The objective is to significantly increase resource efficiency and to reduce costs. The results of this research are relevant and applicable in many industrial sectors and companies, namely those dealing with alarge product portfolio or customisation.
	VARIANT PRODUCTION TECHNOLOGIES FOR MANUFACTURING/ REMANUFACTURING SYSTEMS (A/F)	The need to cope with production systems playing different role in the manufacturing/remanufacturing process chain and the use of alternative technologies must be considered for the production of a given part/product. In this perspective, additive or subtractive processes as well as different technologies within these classes will be interchangeable to cope with the fraction of products to manufacture and remanufacture, the dimension of the lots, etc. Besides process characterisation, assessment and management approaches, the role standards and regulations must also be addressed.

		MANUFACTURING SYSTEMS FOR THE RE-USE OF SECONDARY RAW MATERIALS (A/P)	Secondary raw materials are an important source but entails the need of manufacturing processes and systems to be tolerant in terms of some characteristics, e.g., chemical behaviour, mechanical behaviour, chemical composition, purity, among others. The aim of the research is to design manufacturing systems and processes capable of managing material-related uncertainty through robust design or robust control of the process and system parameters. The impact is to reduce waste and costs and to significantly increase resource efficiency. The results of this research are relevant and applicable in many industrial sectors and companies, particularly those dealing with the manufacturing oftextiles, electrical and electronic equipment, furniture, vehicles, and buildings and building components.
		DIGITALISING AND AUTOMATING DE- AND REMANUFACTURING PROCESSES AND SYSTEMS (A/P)	This research will develop, implement and evaluate highly digitalised, automated and optimised de-manufacturing and remanufacturing technologies that enable the recovery of value, functions and materials of scrapped defective parts and of end of life products. The objective is to unlock the potential of remanufacturing and make it a viable proposition for many more companies, thus helping to expand the remanufacturing industry and to spread the benefits of remanufacturing across Europe.
		NEW TECHNOLOGIES FOR REMANUFACTURING, REFURBISHMENT AND RECYCLING OF PRODUCTS AND COMPONENTS (F/A/P)	This research priority stems from the need to design high-performance processes, machines and robots for the remanufacturing, refurbishment and recycling of products and components. The research will focus on new concepts and technologies as well as cross-fertilisation from other sectors and/or applications. Process-monitoring solutions are relevant to developed adaptive systems that are able to cope with the intrinsic uncertainty of the products to process. The activities can range from the development of advanced physical models to small and large-scale prototypes and pilot plants.
		MONITORING OF THE ENERGY FOOTPRINT OF THE PRODUCTS (A/P)	The energy impact of the products is influenced by numerous factors, some of which grounds on the design and engineering phase and have an impact on the production process and technologies and the way they are used. The capability of recovering highenergy materials (e.g. aluminium or semi-conductors) has a significant impact on the overall balance from the energy point of view and therefore requires new methods for the recycling of these materials. The research will address the development of Cyber Physical Systems (CPSs) capable of gathering and centralising data on energy consumption in general (production of raw materials, production cycle, distribution logistics, conditions of use, disposal and recycle), considering the specific characteristics of the context (monitoring the boundary conditions that may have an impact (e.g., climate, type of use, maintenance, etc.) and characterising of the products in terms of their energy footprint.
		TECHNOLOGIES AND TOOLS FOR INTELLIGENT REMANUFACTURING AND RECYCLING SYSTEMS (F/A/P)	The development of technologies, methods and tools to support remanufacturing and recycling systems for products and the recovery of critical materials is essential in the high-tech product manufacturing industry in Europe. The main aim of this research is the development of an integrated and interoperable platform to efficiently design, operate and control advanced remanufacturing and recycling systems for the recovery of components with high added value, such as electronic and mechatronic components of automotive and aeronautical applications. A multilevel approach should be pursued including both the process level and the system level as well as the possibility to be reconfigured throughout its life cycle to match the requirements of the products and processes. The platform should also be integrated with field data acquisition tools for a continuous improvement of the technologies and the systems.
		INNOVATIVE SOLUTIONS FOR SUSTAINABLE AND FLEXIBLE PRODUCT PACKAGING (A/P)	Reducing the environmental footprint of the packaging material is a key aspect of the circular economy. New packaging solutions are necessary for helping to reduce the amount of waste, increase the products shelf life and process efficiency, while providing valuable traceability information for the consumer. Research in this field should focus on new packaging materials and technologies, packaging design as well as adapting the product design, manufacturing process and logistics to cope with the new packaging solutions.
	Maintenance and Reuse	ORGANISATIONAL AND BUSINESS RELATED MODELS FOR MAINTENANCE AND REUSE AND IN A CIRCULAR ECONOMY SCHEME (F/A)	Business models for the “Circular Economy”, based on innovative technologies for the management of the end of life of products and materials within close-loop supply chains. The collection of products at the end of their life has to be considered as well as the associated generation of waste, to maximise their residual value through maintenance, reuse, remanufacturing and recycling. With these approaches, the recovered systems,products, components and materials will re-enter the production cycle. New business models also have to address new architectures for the relationships in the supply chain, aggregation of skills and technologies to improve efficiency, distribution of value among the various actors, aiming at encouraging to close the loop within the supply chain and promoting the new paradigms of the sharing economy.

		LIFECYCLE MANAGEMENT TECHNOLOGIES AND APPROACHES FOR PRODUCT MAINTENANCE AND REUSE (A/P)	Models and techniques for the economic, environmental and social performances of product services, production processes and systems based on Life Cycle Assessment(LCA), Life Cycle Costing (LCC) and Social Lifecycle Assessment (S-LCA). These models must embrace the entire lifecycle of the products (from design to production and end oflife) to manage the network of actors involved and the associated risks. Supply sustainability metrics have to be addressed to support the decisions for the different product's lifecycle phases and may be used both at the corporate and public policy level, including changesto consumer behaviour from privileging more sustainable products. The collaboration between private companies and public authorities have to be investigated to improve and optimise the production, maintenance, reuse as well as remanufacturing and recycling flows. The enrichment of LCA and LCC systems based on data shared by different companies must also be considered as well as the use big-data approaches to make these systems more reliable. The social impact of the related job creation in Europeshould also be evaluated. These technologies and approaches are aimed at improving the traceability of the products and components in working conditions and their actual status to estimate the expected "remaining useful life"" (RUL). These calculations should be supported by accelerated tests, simulating the work conditions of the materials in relevant use environments. The knowledge and tools will also support the analysis and identification of viable "second lives" of a product or component (re-use/remanufacture or recycling).
New business models and logistics networks	New business models and logistics networks	INDUSTRIAL PRODUCT-SERVICE SYSTEMS (IPSS) (P/F)	In order to improve competitiveness and sustainability, industries shift their business models, by providing Industrial Product-Service Systems (PPS) increasing the added value of their products. There is a need to develop new approaches that will enable new and existing products to be upgraded to PSS. Developing solutions adaptable to customers'requirements is a major challenge. The results are applicable in many industrial sectors, with the main purpose of increasing their competitiveness and profit. Furthermore, there is a need for paradigm shift of industrial companies. In other words, research should build roadmaps for digital knowledge of intensive product-service-systems. The roadmap would explore whether smartness is added to physical products or physical products are part of digital solutions. Digital platforms and data-driven business models are crucial elements for these novel product-service systems within Industry 4.0.
		INNOVATIVE PRODUCT DESIGN AND MANUFACTURING BASED ON THE FRUGAL CONCEPTS, (FUNCTIONAL – ROBUST – USER FRIENDLY – GROWING – AFFORDABLE – LOCAL) SUPPORTED BY ADVANCED ICT PLATFORMS (P)	Modern manufacturing companies are heading towards a new era of frugal innovation. Frugal innovation introduces a new business model, in which low cost and high customer value solutions should be designed and provided taking into consideration the regional customer's requirements. Mobile applications and advanced ICT tools that will support manufacturing companies to capture the needs and preferences of the customers and markets need to be developed.
		DEVELOPMENT OF SUSTAINABLE BUSINESS MODELS FOR INDUSTRY 4.0 TECHNOLOGIES (A)	In order to achieve a systematic change in pursuit of sustainable I4.0 manufacturing, astrategic long-term perspective (looking for new techs) and a concrete implementation of the knowledge acquired in practical sustainable business models are needed. Given the opportunities brought forward by the fourth industrial revolution and the challenges that current modes of production and consumption place on nature and society, it is necessary to pursue a new way of conducting business. It is indeed a challenge transforming business models into I4.0 empowered sustainable business models and creating pathways for sustainable technology development. Indeed, no application is viable without identification and assessment of the value for customers, producers and society in general created by the new application of technology and the corresponding production systems.
		MANUFACTURING STRATEGIES AND BUSINESS MODELS FOR CIRCULAR ECONOMY (F/A/P)	New manufacturing strategies and business models for circular economy will be implemented, tested and validated in relevant manufacturing environments. Research should also study how to implement and monitor sustainable Closed-loop supplychains that include the returns processes in order to capture additional value and further integrating all supply chain activities. Moreover, the interaction within international supply and production networks will be taken into consideration.

		BUSINESS MODELS FOR DISTRIBUTED (DE-CENTRALISED) PRODUCTION AND PRODUCTION AS SERVICE, AIMING AT COMMERCIAL AVAILABILITY OF PILOT LINES AND SPECIFIC MACHINERY (A)	Distributed production of different components of a product followed by an efficient assembly provide opportunities to meet consumers' expectations in terms of product diversity and personalisation in an efficient way. Novel business models are necessary to engage and involve SMEs in the production of large businesses. Suppliers not only provide raw materials and finished products but also transportation, energy, packaging, design, and recycling services. This include telemaintenance, rapid repair at breakdowns, upgrading existing machinery with new sensors, controls, replacement of specific parts of the processing lines. In different industries, including food, high variability and seasonality allow network operators to benefit from sharing, specific equipment between different companies and geographical locations.
		AN OPPORTUNISTIC MODEL FOR INTEGRATED MAINTENANCE, QUALITY AND INVENTORY CONTROL (A/P)	The research will aim at increasing the knowledge on dynamic and opportunistic maintenance models, which integrate maintenance, quality and inventory control decisions, to mitigate the impact of maintenance actions on the target service level. Here, datadriven business approaches could provide new opportunities for integrated maintenance, when maintenance planning is done, using market data to schedule maintenance breaks. Adaptive lifecycle management aim at developing methods and tools for business-driven upkeep, maintenance and renewal, and re-use of production assets.
		FLEXIBLE PLATFORMS FOR BUSINESS PROCESS MANAGEMENT (A/P)	Business models and logics are largely based on the business process management that is realised using dedicated platforms. The existing solutions for business process management platforms have major shortcomings: (i) aren't flexible nor efficient enough to provide a response (composite service/process) in a near real time; (ii) difficulty in composing a new service using existing services that come from different applications / vendors; (iii) high cost; not affordable for a vast majority of SMEs. The research and technological development should address the above-mentioned limitations, including an improved service-oriented architecture (SOA), to provide an efficient and flexible environment to compose services/processes from heterogeneous applications in a near real time, and to enable plug and-play process/service capability. These platforms should be prepared to be offered as a service (Platform as a service – PaaS). The results should be relevant for various industrial sectors and companies, especially for manufacturing SMEs that strive towards business process agility in the sharing and the outcome economy. In addition to the platform's technical solution, there is a need to explore cooperative boundary resources, i.e. operation models and practices enabling connected platforms and information flow (smart contracts, blockchain technologies, APIs, cyber security).
		END-TO-END BUSINESS PROCESS AND BUSINESS MODEL OPTIMISATION (A/P)	New methods and approaches for the modelling of (i) business processes sequence at the enterprise level, and (ii) business model (for example. end-to-end dynamic business process) at the enterprise network level, using digital twins, AI, machine learning techniques (e.g.,deep neural networks). Based on the above, new methods and approaches for optimising end-to-end business process behaviour and sequence using AI optimisation techniques (e.g., swarm-based algorithms) in terms of an improved match-making, simplified business model and logic ("the shortest path" approach), etc. There is a need for research to address the above-mentioned tasks, followed by the pilot implementation and demonstration on the enterprise network level. The results are relevant for several industrial sectors and manufacturing companies that strive towards a business process agility in the sharing and the outcome economy.

4. Přílohy

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