AceForm4.0 Overview
Status and Learnings for Validation
Project Overview

Horizon 2020 Coordination and Support Action (CSA) project Oct 2016 - Oct 2018

Objectives

- Establish a European Formulation Interest Group (EU-FIG)
- Identify **common technical and industrial challenges** for the **European Formulated Products Industries**
- Establish a **common vision and roadmap**
- Arrange **knowledge exchange activities** and facilitate **new initiatives** along the value chain

Key project outputs

- Influence the **content of future EU calls**
- EU-FIG community with >500 organizations
- > 10 new collaborative cross-sectorial initiatives

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www.formulation-network.eu
Objective 1: Establish a European Formulation Interest Group

Objective 2: Identified Common Scientific and Industrial Challenges

Objective 3: Establish a Common Vision, Roadmap for 2025 and Associated Implementation Plan

Objective 4: Through Knowledge Exchange Activities Facilitate Creation of New Cross-Sector Value Chains Initiatives

Objective 5: Establish a Business Plan for Continuity
Objective 1: Establish a European Formulation Interest Group
- 100+ members (of 500)

Objective 2: Identify Common Scientific and Industrial Challenges
- 24 Interviews
- 106 surveys

Objective 3: Establish a Common Vision, Roadmap for 2025 and Associated Implementation Plan
- Reports (draft)
- Analysis of 5 SRAs

Objective 4: Through Knowledge Exchange Activities Facilitate Creation of New Cross-Sector Value Chains Initiatives
- 2 x Workshops (of 6)
- Draft value chain mapping structure

Objective 5: Establish a Business Plan for Continuity

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Progress against Objectives
Phase 2 - validation

**Objective 1**
Establish a European Formulation Interest Group
- Newsletter (2 of 5)
- 130+ members (of 500)

**Objective 2**
Identified Common Scientific and Industrial Challenges
- Through Knowledge Exchange Activities
- Facilitate Creation of New Cross-Sector Value Chains Initiatives
- 5 x Workshops (of 6)
- Value chain maps x 6

**Objective 3**
Establish a Common Vision, Roadmap for 2025 and Associated Implementation Plan
- Open / survey
- Interviews 20+
- Validation Events
- WP4 workshops
- 3 x webinars
- Launch event

**Objective 4**
Establish a Business Plan for Continuity
- Develop plan

**Objective 5**
Establish a European Formulation Interest Group
- Final validated Reports
- Completed (Green)

Priorities for engagement
Key targets for engagement to enable a balanced and robust output are:
- Agro Tech & Plant Protection sector
- Contract Research Orgs, Consultants, Manf. contractors, Equipment and instrumentation suppliers, Governmental bodies or agencies and non-governmental organisations
- Organisations in southern and east European countries.
- Champions of novel sustainability focussed business models (academics, SMEs, NGOs).

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Learnings for Validation
The EU Formulating Industries
Context and Scope

<table>
<thead>
<tr>
<th>Sector grouping</th>
<th>Subsector</th>
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<tbody>
<tr>
<td>1. Home,Industrial &amp; Personal Care</td>
<td>Personal care – cosmetics, cleaning, well-being, perfumes</td>
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<td>Home care – cleaning, laundry, hygiene</td>
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<td>Industrial and institutional cleaning</td>
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<td>2. Pharma &amp; Health Care</td>
<td>Pharmaceuticals – small molecule, biologics</td>
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<td>Healthcare – hygiene, skincare, pain relief, nutrition</td>
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<td>Medical Devices, Diagnostics, Imaging</td>
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<td>3. Agro Technologies &amp; Plant Protection</td>
<td>Crop Protection</td>
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<td>Agrichemicals</td>
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<td>Seed treatments</td>
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<td>4. Coatings and Surfaces</td>
<td>Paints</td>
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<td>Inks and dyes</td>
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<td></td>
<td>Lubricants</td>
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<td></td>
<td>Adhesives</td>
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<td>Speciality chemicals</td>
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<td>5. Food &amp; Drink</td>
<td>Food – confectionary, processed foods, sauces, animal feed</td>
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<td>Drink – alcohol, soft drinks, coffee</td>
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<td>6. Advanced materials</td>
<td>Composites, polymers, ceramics</td>
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<td></td>
<td>Catalysts</td>
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<td>Paper and packaging industry</td>
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<td>Additive manufacturing</td>
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- AceForm analysis focuses across 6 main sectors; selected based on:
  i) Potential for economic and societal impact (sector size, EU footprint, potential for growth)
  ii) Potential for cross sector collaborations and synergies (ingredient/materials base; current capabilities; collaboration culture).
- This approach does not preclude engagement and applicability of AceForm outputs to other sectors
Cross-sector trends / drivers

• **New Product and Process Development**
  • Faster Product lifecycles and product obsolescence
  • Radical effects and high performance
  • Faster time-to-market
  • Customisable and personalised products

• **Manufacturing and Supply Chain Performance**
  • Operating and maintenance costs of plants
  • Rejuvenating legacy assets to maintain and/or improve competitiveness.
  • End-to-end productivity of supply chains
  • Responsiveness of supply chains
  • New revenue generating business models (e.g. shift to service)

• **Sustainability and the Circular Economy**
  • Resource efficiency and the reuse across the whole supply chains
  • Renewable and/or bio-degradable ingredients
  • Rising awareness of human impact on the environment (ocean, air and land)
  • Rise of internet-empowered consumer
Europe will lead the global path in the innovation and commercialisation of new sustainable formulated products that deliver radical effects and high-performance to downstream industries, end-users and consumers whilst optimising resource and energy efficiency and minimising adverse impacts on biodiversity and the environment.
The EU Formulating Industries
Market Growth Opportunities

- AceForm highlights and prioritises public intervention on complex opportunities; intractable by current value chains
- Action 1: Make recommendations for CR&D calls themes; highlighting potential for formulation (Fund)

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<td>• Product differentiation through personalisation</td>
<td>• Personalised medicines</td>
<td>• Preventative care models</td>
<td>• Managing increasing variability in regional ingredient supply</td>
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<td>• Products for ageing population</td>
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| Digitalisation and Technology | | | | | | |
| • E-commerce driving reformulation to support novel Direct-to-Consumer models | • Formulation for emerging therapies | • Automated smart farm concept | • Real time performance monitoring (service model) | • IoT enables modelling of supply chain environment for enhanced product design | | • Reformulation for Additive Manf. |
| | • Formulation for close-loop digital health model | | | | | • Energy storage materials |
| | | | | | | • Materials for IoT |

| Environment and circular economy | • Drive for sustainable products; enabling resource efficiency. | • Biofeedstocks | • Water scarcity | • Various regs/legs for removal of harmful ingredients | • End of life / recycle / recover | • Reformulate to reduce CO2 impact | • Lightweighting |
| • Resistance | | | • End of life / recycle / recover | | | • Zero waste (product) | • End-of-life / recycling for composites |
| • Resistance | | | | | | | • Zero plastic waste |

Note: Examples given above are illustrative of fuller analysis available in full draft report.

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Value Chain & Cycle Collaboration – Systems-based Solutions for Complex Challenges

1. **Finding new Partners** – beyond ‘business as usual’ networks
2. **Modelling Value Chains and Cycles** – protecting IP and future role

Circular Economy – Unlocking Value through Systems-based Sustainable Solutions

3. **Understanding the Relevance** - for all formulated products
4. **Enabling Disruptive Companies and Business Models**
5. **Modelling the Impact** – Environmental, Societal, Commercial

Industry 4.0 – The toolkit for Future Formulation

6. **Understanding what it is and the Implications**
7. **An enabler for Radical Product and Process Design**
8. **Universal Industrial Challenges** - Integration, Data Sharing and Digital skills gap
9. **Formulation Specific Technical Challenges**
10. **Knowing where to start?** – Digital Formulation Capability Benchmarking and Roadmapping
A key recommendation from AceForm is to prioritise and enable collaborations that extend reach along and across value chains.

The big 21st century challenges/opportunities demand better sharing of:
- Technical expertise, data and insights
  - Much of which extends beyond formulation
    - E.g. chemical production, devices, packaging, env. remediation, process eng.
- Specification/Customer understanding
  - Including extend reach beyond tradition routes consumers / consumer groups
- Constraints
  - E.g. cost base, supply base, regulations (sometimes conflicting across sectors)

Action 2: Improve Formulation outreach (Inform, Connect)
- Grow EU stakeholder value chain maps; reaching beyond ‘business as usual’ partner networks
- Develop resources to do better job of selling value of formulation.
• A further recommendation is to prioritise and enable collaborations that extend to value cycle thinking

Note: sustainability isn’t always the primary driver for value cycle collaboration e.g. other drivers - security of supply, quality.

• Action 3: Promote prioritisation of CR&D calls where extended value chain / cycle collaboration can be demonstrated (Fund)

• Action 4: Promote access to, and coordination of central resources for modelling value chains/cycles (Connect, Access)

circular economy challenges (green) and technological challenges (blue)
Looking beyond the current “take, make and dispose” extractive industrial model, the circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimising negative impacts as well as energy consumption. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural and social capital.
Circular Economy (CE) and Formulation Understanding the relevance

- CE is a significant opportunity for economic and societal impact across Formulating Industries
- General awareness across Formulating Industries is good; but issues around understanding
  - Generally not enough big picture thinking – typically tackling sustainability from operational silos.
  - Consumables – unclear that CE can be applied, assumed not as product ‘in-use’ life-span is short
  - Difference between formulations that have potential to be:
    - intrinsically circular (e.g. motor lubricant); or a CE enabler (e.g. packaging ink that enables recycling)

25. Are you familiar with the term "Circular Economy" within your organization?
   - Yes: 24%
   - No: 9%
   - Do not know: 9%
   - No Answer: 67%

27. Does your organisation have a defined strategy for addressing one or several aspects related to Circular Economy?
   - Yes, we do have a Circular Economy strategy: 25%
   - Yes, we have a strategy that covers some of the aspects: 14%
   - No, we do not have a common strategy at all: 34%
   - Do not know: 27%
   - No Answer: 0%

Action 5: Improve awareness of formulation related CE case studies (Inform)
Action 6: Promote and explore innovative ways to stimulate investment in disruptive CE businesses (Fund)
Circular Economy (CE) and Formulation
Modelling the impact

- Formulating Industries, particularly SMEs, are limited in their ability to exploit CE opportunities as there is poor access to (or at least awareness of) relevant collaborative tools for modelling impact.
  - Environmental impact – Full Life-Cycle Analysis; Quantitative; Complex systems
  - Societal impact – see donut economics thinking (schematic below)
  - Modelling value chains/cycle – to model impact in future disruptive value chain/cycle
  - Modelling Business models – e.g. shift to service model; how to re-configure business

Action 7: De-risk shift to CE by improving access to relevant collaborative tools to model impact (Access)
AceForm Definition

Industry 4.0 is the integration of various digitalisation technologies (existing and emerging) to enable advanced capabilities to connect, model and automate design, manufacturing and supply chains systems. => delivering products, processes and services faster, more efficiently and more flexibly.
AceForm consultation highlights a generally poor understanding of Industry 4.0 across Formulating Industries.
Elements are being applied in silos; so missing the bigger picture opportunities.

Action 8 – Improve awareness of resources and networks that promote the value of Industry 4.0 (Inform, Connect)
Industry 4.0 and Formulation
An enabler for Radical Product and Process Design

- **Industry 4.0 can unlock a more collaborative, dynamic approach to product and process design**
  - Breaking barriers between lab, factory and field
  - Enabling new Value Chains/Cycles and Circular Economy collaborative opportunities

- **i4.0 enables step-change learning from data (modelled, experimental, in-use)**
  - across many locations, companies, environments and points in time
- **i4.0 enables flexibility to adapt design and production protocols to evolving technical and market learnings.**
- **Return on investment in radical toolkit is high**
  - as products require re-formulation on regular cycles and are highly variable.

- **Action 9 – Influence CR&D calls to prioritise deployment of i4.0 technologies for radical Product and Process Design (Fund)**
- **Action 10 - Influence wider Industry4.0/digitalisation calls; maximising relevance to formulating industries (Fund)**

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e.g. Resource Efficient Formulations for the Smart Farm
e.g. Digital Preventative Healthcare
e.g. Tailored Engine Oil; mobility as a Service

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Industry 4.0 Challenges

**Universal Industrial Challenges**

- **Data-sharing** - A step-change is required for greater access and sharing of data currently segmented across a risk adverse supply chain.

- **Integration** - many digital systems, many functional business needs, many legacy capital assets

- **Digital skills** – retraining for tools of the future

**Formulation Specific Technical Challenges**

- **Digital Twins** - are not easily created for Formulations; performance/failure mechanisms are not well understood (rooted in subtle nano/micro phenomena; often product specific) and so i4.0 may create more data and levers, but without any underpinning insights as to how/when to use them.

  - **Formulations are inherently unstable.** ‘Good’ is only a point in time. As such, stability / performance / quality assessments over can be unreliable over short periods of time.

  - **Standards** for describing formulations or structuring data don’t exist. This limits the ability to apply novel data approaches and codify knowledge.

  - **Target properties** - are generally difficult to reduce to a discrete measure/physical attribute; as such it will continue to be difficult to make a meaningful quality measurement.

**Action 11 – Raise awareness and build on projects already seeking to resolve these issues (Inform, Connect)**
Knowing where to start?
Digital Formulation Capability Benchmarking & Roadmapping

- By benchmarking and roadmapping respective digital formulation capability journeys
- Companies can better i) identify a practical first small step ii) identify collaborations & ii) map long-term value
- In turn, public bodies can better inform investment in greater-good public infrastructure
- AceForm proposes that capability journeys should be mapped over 5, 10 and 15 years

Against Four themes

1. **Quantification** – all aspects of the formulation life-cycle should be reduced to numbers or numerical models.

2. **Connection** – data should be generated through all stages of the formulation life-cycle and captured centrally. Associated integrated control capabilities should also be in place.

3. **Embed multiscale modelling** – truly predictive design capability will only be realised by bridging material/structure-property relationship models across time/length-scales and across the formulation life-cycle.

4. **Embed intelligence** – systems should be developed to codify ‘expert’ human intelligence so as to automate routine decision making and artificial intelligence to enable better resolution (advanced empiricism) of intractable design problems.

Across six stage of Formulation life-cycle

1. **Ingredients**
2. **Mixture** (often viewed at the formulation)
3. **Process** – including recovery/recycle
4. **Delivery** - Storage/transportation/device e.g. pack, lorry, shelf, injection, spray
5. **Application** e.g. wetting, delivery, heat transfer
6. **Subject** e.g. skin, leaf, engine

Action 13 – Influence CR&D calls to value impact of co-development of advanced underpinning formulation capability (Fund)
Action 14 – Analyse capability roadmaps to identify infrastructure gaps to be supported through public investment (Fund, Access)
## Recommendations
### Summary of Actions

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<tr>
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<th>Action</th>
<th>Intervention (Inform; Connect, Access, Fund)</th>
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<td>A</td>
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<td>5</td>
<td>Improve awareness of formulation related Circular Economy case studies</td>
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<td>Promote and explore innovative ways to stimulate investment in disruptive Circular Economy businesses</td>
<td>F</td>
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<td>De-risk shift to Circular Economy by improving access to relevant collaborative tools to model impact</td>
<td>A</td>
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<td>C</td>
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<td>Influence CR&amp;D calls to prioritise deployment of i4.0 technologies for radical Product and Process Design</td>
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<td>Raise awareness and build on projects already seeking to resolve these issues</td>
<td>C</td>
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<td>12</td>
<td>Develop and deploy toolkit to roadmap and benchmark digital formulation capability</td>
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<td>13</td>
<td>Influence CR&amp;D calls to value impact of co-development of advanced underpinning formulation capability</td>
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Europe will lead the global path in the innovation and commercialisation of new sustainable formulated products that deliver radical effects and high-performance to downstream industries, end-users and consumers whilst optimising resource and energy efficiency and minimising adverse impacts on biodiversity and the environment.

Success Indicators

- Formulation is valued as a key contributor to **EU economic growth, job creation, sustainability and well-being.**
- Formulating Industries has **a step-change in extending reach and partnering across value chains and value cycles.**
- Formulating industries embraces, adapts and identifies new ways to create value through the Circular Economy.
- Formulating industries lead in exploiting **Industry 4.0 to enable Radical Formulated Product and Process Design**
- All formulating companies have a roadmap and active action plan to **advance underpinning digital formulation capabilities**
- Public and private **uplift in R&D and innovation investment**; driven by evidence of value creation.
- **SMEs with high growth potential** have **enhanced access to advanced capabilities** via open-access facilities.
- **Cross sector and value chain collaborations** function with minimal friction and are common place for leading innovative companies.
The EU Formulation Interest Group
Validating and actioning AceForm outputs

Your benefits:

- Receive **AceForm4.0 newsletter** (ca. every two months)
- Get **exclusive access** to deliverables, presentations, partner search engine and further information in the **restricted members area**
- Influence on **future call topics** in the area
- Gaining understanding on the implications of the potential of **Circular Economy** and **Industry 4.0** trends for formulated products
- Receive **information on events** in connection to formulation European conferences
- Get access to a **network of important players** in the formulation
- **Connect** to experts across industrial sectors
- Opportunities in connection to initiatives **along the value chain**

**Register and connect here:** [formulation-network.eu/members](formulation-network.eu/members)