

“How Will Europe Win At 450mm?”

**Malcolm Penn, Chairman & CEO
Future Horizons, Semicon Europa 2013**

FutureHorizons

The Global Semiconductor Industry Analysts



Future Horizons – Industry Analyst

- ◆ 1989 – Company Founded (1st Apr)
 - ◆ Worldwide Nano-Microelectronics Industry Focus
 - ◆ European & Russia/CIS Semiconductor Industry Specialisation
 - ◆ Cover Full Spectrum – From Research To End Markets
 - ◆ Market Research, Industry Analysis & Training
 - ◆ Custom Consulting & Marketing Studies
 - ◆ Due Diligence & IP/Product Positioning
 - ◆ Business Development Opportunities & 1-2-1 Contacts
- Off-The-Shelf Research Reports & Industry Intelligence/Analysis
 - Bespoke Research Assignments - From Proof Of Concept To Full Market Development
 - Due Diligence Analysis - From Seed Funding Through IPO
 - Competitive Benchmarking & Positioning - From the Basic IC Design & Technology Up
 - Unique Combination Of Chip Design Know-How With Market & Business Insight

Global Organisation, Headquartered In Sevenoaks, Kent, UK
Regional Offices In The UK & Russia
Affiliates In Europe, India, Israel, Japan, Russia & USA

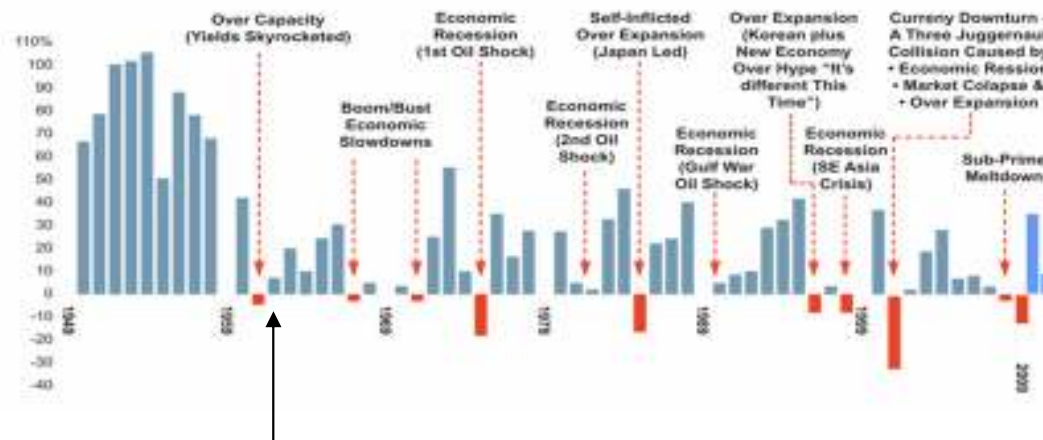


Research Philosophy (Experience & Common Sense)

History May Not Repeat Itself ... But It Does Rhyme A Lot (Mark Twain)

"Plus ça change ... plus c'est la même chose" *(The More Things Change ... The More They Stay The Same)*

- ◆ Analyse The Industry Fundamentals – Ignore Them At Your Peril
- ◆ When A Trend Is Clear It's Already Too Late – Feint Heart Never Wins
- ◆ Customers & Markets Shift Dramatically – It's A 10-Year Divorce Cycle
- ◆ Create Your Own Destruction – If You Don't Your Competitors Will
- ◆ Hype Springs Eternal – NEVER Believe Your Own PR Or Management Spin
- ◆ Long-Term Visibility Is Good – Near-Term Poor (6-9 Months At Best)
- ◆ Plus Commitment – If You Don't Believe It Can Be Done It Won't Be Done



My Industry Experience Started Here ...

How Europe WILL Win At 450mm

Meet The Goals Of 10/100/20



**Commission VP Neelie Kroes
Has Laid Down The Marching
Orders To Industry ...**

**The 20% Production Share Goal
Requires 450mm High-Volume
Production In Europe**

THANK YOU Ms Kroes

From Humble Beginnings Great 10-100:20 Visions Are Born



EEMI450 Initiative



- ◆ **The European 450mm Equipment & Materials Initiative Was Founded As An Independent Entity**
 - **Still Open To All European Companies With An Interest In 450mm Technology**
 - **In 2009 It Submitted A Project To ENIAC Confusingly Also Entitled EEMI450.**
 - **This Successfully Concluded In 2012**
 - **The Initiative Remains Active Though With The Latest Meeting This Thursday Here At SEMICON Europa**
- ◆ **The EEMI450 Initiative & Other Discussions Got The European Commission Really Interested In 450mm**



Another Key Event Was The FH SC Workshop



- ◆ **Workshop Held In Brussels HQ On 23 April 2009**
- ◆ **Hosted By Dirk Beernaert (DG INFO) – SMART Project Sponsor**
- ◆ **Attended By 45 Participants Representing 6 Different DGs**
- ◆ **Round Table Q&A On Strategic Importance Of Manufacturing**
- ◆ **Strongly Resisted By EECA/ESIA**
(Midnight Phone Calls Demanding Several Slides Be Excluded!)

EU SMART 2010/62 Project

◆ This Led To The Establishment Of The EU SMART 2010/62 Project

- Commission Brief: Benefits & Measures To Set Up 450mm Semiconductor Prototyping & To Keep Semiconductor Manufacturing In Europe - The Role of Public Authorities & Programmes

◆ Future Horizons & Decision Joint Research Project

- Awarded Dec 2010, Started Jan 2011
- Questionnaire Plus Extensive “Off The Record” Interviews With Key Industry Players In Europe, The US, Japan, Korea & Taiwan
- Draft Report Completed Nov 2011; Final Report Submitted Feb 2012 With Only Minor Changes

◆ Publically Released Jun 2012

- Downloadable From FH Or The EU's Web Site

◆ Although 450mm Focussed The Report Looked At All Relevant Aspects Of Future IC Manufacturing

- 450mm, ‘More Moore’, ‘More Than Moore’, 300mm & Below

◆ The SMART Report Has Helped Future Horizons Become THE World-Leading Analyst On 450mm (Technology, Design, Manufacturing & Business Aspects)

- Regular Meetings With Intel, TSMC, Samsung & Other Asian Entities & Key Firms
- Work Package Leader Of Several FP7 EU Programmes



Our Take On The SMART 2010/62 Outcome ...

“450mm Should Be Europe’s Microelectronics ‘Man On The Moon’ Goal”



On May 25, 1961 JFK Summoned A Joint Session Of Congress & Asked America To Commit Itself To The Goal, Before The Decade Was Out, Of Landing A Man On The Moon & Returning Him Safely To Earth ...

“We Choose To Go To The Moon & Do The Other Things Not Because They Are Easy, But Because They Are Hard, Because That Goal Will Serve To Organize & Measure The Best Of Our Energies & Skills, Because That Challenge Is One That We Are Willing To Accept, One We Are Unwilling To Postpone, & One Which We Intend to Win.”

Just Over 8 Years Later, On Jul 20, 1969, Neil Armstrong Stepped On To The Surface Of The Moon ... & Came Home Again Safely To Earth



EU Commission Bold & Holistic Vision

On May 23, Europe Got Its ‘Man On The Moon’ Goal!

"I want to double our chip production to around 20% of global production. I want Europe to produce more chips in Europe than the United States produces domestically. It's a realistic goal if we channel our investments properly"

- ◆ **The Strategy Will Focus On Three Complementary Lines:**
 - Making Chips Cheaper (Transitioning To 450mm-sized Silicon Wafers)
 - Making Chips Faster ("More Moore") And
 - Making Chips Smarter ("More Than Moore")
- ◆ **This Seven-Year Partnership Is Designed To Cover The Whole Value & Innovation Chain In The Electronics Sector, Including Funding Large-Scale Innovation Projects, Under The EU's Horizon 2020 Research Programme**

European “Airbus Of Chips” aka The “10/100/20 Strategy”
€10b EU Co-Funded Projects / €100b Industry Investment
20% Global Manufacturing Share

Source: Press Conference on launch of European strategy for micro- and nanoelectronic components and systems /Brussels - 23 May 2013



Championed By VP Neelie Kroes (Digital Agenda)



“I am NOT a politician ... I’m Dutch; I tell it bluntly”

If our electronics sector is not competitive, then every other sector suffers, and our entire manufacturing base is at risk. If we don't take this opportunity, if we don't connect our strongholds, then others will leapfrog us. We need this public investment - we need it to be rapid, strategic and coordinated. I will expect great things from the industry; they will have to build on this investment to take the sector to new heights. They will have to find ways to repeat the success of Airbus, but this time in the chip sector, and with its own unique business model

“Let’s just do it; let’s go for this goal and let’s do it”

Source: Press Conference on launch of European strategy for micro- and nanoelectronic components and systems /Brussels - 23 May 2013

Reins Now Handed Over To The ELG*

- ◆ **Official Kick-Off Meeting Next Week (Oct 16)**
- ◆ **Report Back With Implementation Plan By Dec 31**

Recap Of The ELG's Marching Orders

“Strategy Will Focus On 3 Complementary Lines”

- Making Chips Cheaper (Transitioning To 450mm-sized Silicon Wafers)
- Making Chips Faster (“More Moore”)
- Making Chips Smarter (“More Than Moore”)

“Let’s just do it; let’s go for this goal and let’s do it”

For Europe’s & Our Children’s Sake ... Let’s All Hope & Pray The ELG Is Up For The Challenge

*** European Leader’s Group**

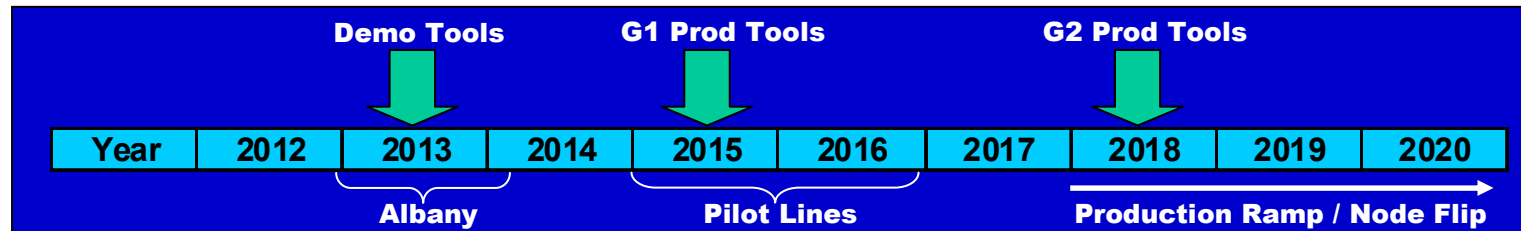


450mm Update



450mm Transition

◆ No 'Substantive' Changes To Our Dec 2011 EU 450mm Report



◆ Industry Is Ambivalent

- Intel, Samsung & TSMC Still Say "YES" (*Sort Of*)
- GF, Toshiba, SK-Hynix & Micron Say "MAYBE" (*But Hope Not*)
- Equipment Industry Says "Who's Paying?" (*We're Not*)

◆ Europe Too Is Divided Right Down The Middle ...

- Research Labs, E&M Firms & Commission Say "YES" (*Europe Needs*)
- Infineon, NXP & STM All Say "Nein, Nee & Non/No" (*We Don't Want It*)

450mm Is A Bifurcating Systemic Disruption

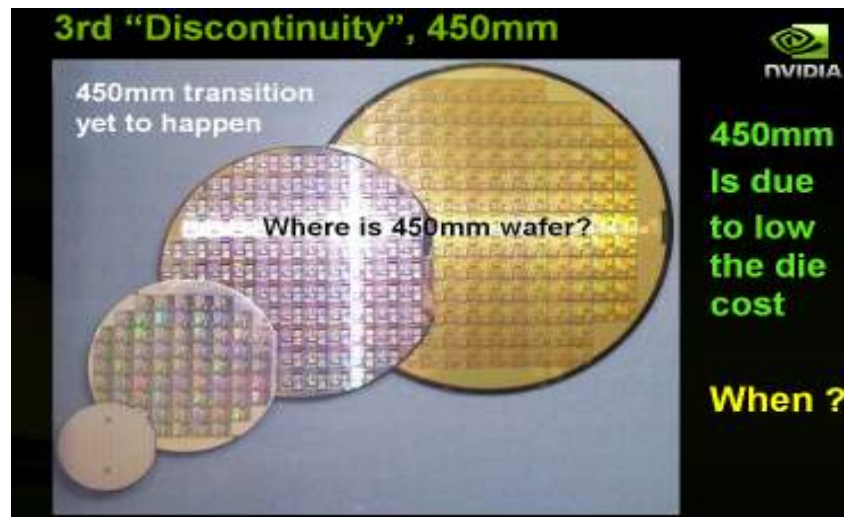
- ◆ **450mm Rollout Will Impact ALL Existing Fabs**
(No Matter What The Exact Roll-Out Dates Achieved Are)
- ◆ **450mm Cost Structure Will Annihilate Anyone 300mm-Based**
(Whatever The Product, Worse Still For 200mm & 150mm-Based Production)
- ◆ **300mm Fabs Will Migrate To ‘More Than Moore’ Products**
(As With TI & Infineon With 300mm Analog ... & Yes, Analog Scales)
- ◆ **200mm Fabs (Already ‘Land-Locked’ At 90nm) Will Struggle**
 - That makes Them Obsolescent & Vulnerable To Market Cannibalisation
 - Few Can Be Upgraded To 300mm
 - Increasing Competition & Ever-Shrinking TAM Means Inevitable Closure Or Possibly Switched To Making LEDs
- ◆ **Post-CMOS Structures Will Be 450mm Silicon Wafer-Based**
(Whatever Their Precise Nature: Silicon, III-V, SiC, Graphene Or Other)
- ◆ **450mm Can Pave The Way For An Industry Eco-System Rethink**
 - AKA Airbus Industries (viz a viz FH “Broken Industry Model” Warning)
 - Key FH EU450 Report & Discussions Recommendation
 - Vertical & Horizontal Collaboration (Europe’s Key Global Strength)



The Market Is “Wishing & Waiting”

Most Importantly The Customers Are Saying “Hurry Up!”

- Intel ... *“We Should Have Introduced 450mm In 2011”*
- John Chen, nVIDIA (IEF2013)



- Wally Rhines, Mentor Graphics (IEF2013)
“Too Little, Too Late?”

SMART 2010/62 Key Conclusions Recap - 1

1. “450mm Processing Will Happen”

- Intel Has Remained The Most Enthusiastic About 450mm With Ground Broken On Their First 450mm-Ready Module
- TSMC Were At First The Most ‘Gung-ho’ Until The Equipment Suppliers Reined In Their Ambitions With Some Realistic Delivery Timescales
- Samsung Have Accepted It Is A ‘Must-Do’
- In the US The G450C Initiative & In Europe The IMEC Pilot Line Are Ensuring Every Issue Is Being Covered Before Roll-Outs Begin.
- All New Fab Shell Constructions Are 450mm Ready

2. “Cost Of A Volume 450mm Fab Will Exceed US\$10b”

- Requirement To Build One 450mm Fab (at US\$10b) vs 2½ 300mm Fabs (at US\$5b Each) Makes This Cost Somewhat More Palatable!
- Final Cost Will Depend Largely On The Price & Throughput Of The Litho, Be They EUV or Immersion
- Litho Cost May Also Be The Determining Factor On Whether Or Not 450mm Conversion Can Deliver Its Part Of The Die Cost Reduction Goal



SMART 2010/62 Key Conclusions Recap - 2

3. “Demand For The Output From Advanced Fabs Will Rise”

Current 10-11% IC Unit Growth (8-10% IC Capacity Growth) Can Be Expected To Continue In The Long Term. Of Course If The Higher Levels Of The Electronics Industry Fails To Think Of New Applications For Semiconductors Then The Whole Value Pyramid Comes Crashing Down.”

◆ Since Then The Near-Term Reality Has Been Mixed

- PC Sales Are Down Considerably, Partly The Economy & Partly Structural
- Mobile Phone Sales Are Still Very Healthy Though Some Stock Exchange Overhyping Is Coming Home to Roost
- Mobile Computing Sales Have Exceeded Most Expectations
- However Other Mobile Devices From Cameras to Sat-Navs Have Suffered Corresponding Declines
- Television Sales Are Levelling off. 3D Was Not the “Next Big Thing”
- Jury Still Out on Next-gen Games Consoles

◆ Longer-Term Prognosis Clearer, The Future Remains Transistorized

- Presenters At Our IEF Forum in Dublin Last Week Showed Numerous New Applications That Will Require Ever More Transistors (In Addition To The Obvious Medical, Energy & Automotive Areas)
- Don’t Hold Your Breath Though For ‘Wrist Watches & Wearables!’



Just A Few “Trillion Transistor” Applications



BRAIN-DERIVED COMPUTING

- Consistent concept for a non-von Neumann, non-Turing computer architecture
- Accessible to available technologies (CMOS) and attractive application for future component technologies (nanoelectronics)
- Key features : Universality, scalability, fault tolerance, power efficiency, speed, learning
- Accelerated operation : Only known approach to bridge all timescales relevant for circuit dynamics



SUMMARY AND OBSERVATIONS ON FUTURE DIRECTIONS ON TOUCH AND BEYOND TOUCH.

- *Think Beyond Touch* - important to consider touch augmented with other sensor technologies
- *Camera/Imaging Sensors* - emerging as universal building blocks for future user interfaces including touch and beyond touch
- *Unbreakable, Ubiquitous, Sensor-Rich* - flexible printable electronics in some scenarios
- *Ultra-fast low-latency and 3D capture* - challenges computational and communication limits

Microsoft Research

A New Revolution: Into the Wild



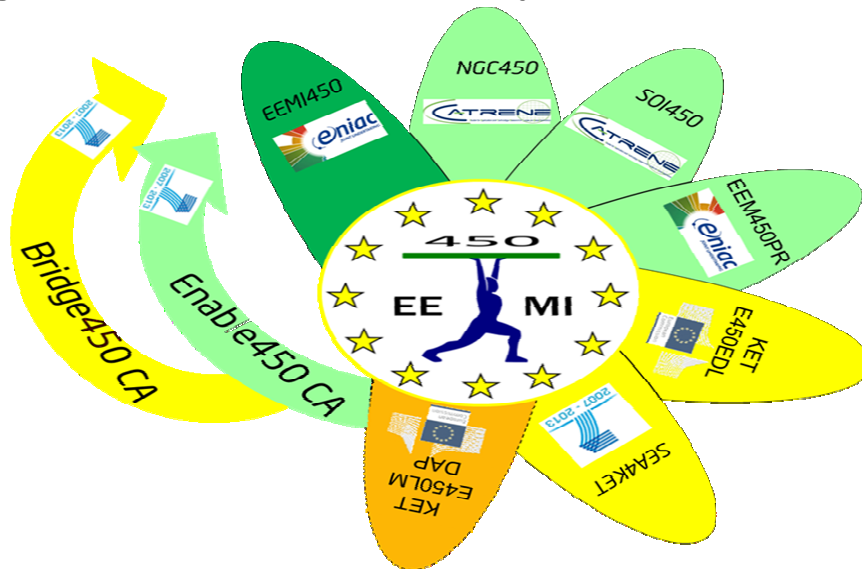
University of Edinburgh



SMART 2010/62 Key Conclusions Recap - 3

4. “The 450mm Introduction Will Be Better Managed Than 300mm”

- ◆ Generally This Still Appears To Be True
- ◆ SEMI Is Doing A Good Job Keeping Standards In Line
- ◆ G450C Has An Unfortunate Habit Of Springing Things On The Rest Of The Industry (e.g. Their Sudden Support For Notchless Wafers)
- ◆ IMEC 450mm Pilot Line Approved Soon After SMART Report Publication
- ◆ Several New 450mm E&M Projects Have Been Funded To Help Support This, Ensuring Europe Will Be A Key 450mm Technology Contributor



SMART 2010/62 Key Conclusions Recap - 4

5. “Intel Expected To Build 3 450mm Fabs As Soon As Viable”

- ◆ This Is Still Believed To Be The Plan. Work Has Already Begun On The First 450mm Module At DX1 In Oregon

6. “TSMC Committed To Fab 12 450mm Upgrade As Soon As Possible”

- ◆ This Is Still The Plan But No Construction Has Begun Yet

7. “Samsung Not Made Any Statements But Unlikely To Be Left Behind”

- ◆ Nothing New Has Been Announced

8. “GlobalFoundries Will Follow Soon After”

- ◆ Thoughts Of A Fab In Abu Dhabi Seems To Have Quietly Faded Away
- ◆ We Assume One Of The Three 450mm Fabs To Be Supported By New York State At The Marcy Nanocentre Will Be For Them, Though We Have No Idea Who The Other Two Will Be. Samsung? TSMC? IBM?
- ◆ If True, This May Make An Upgrade Of Dresden This Decade Less Likely

9. “These Four Companies Represent 70% Of Current SC CapEx”

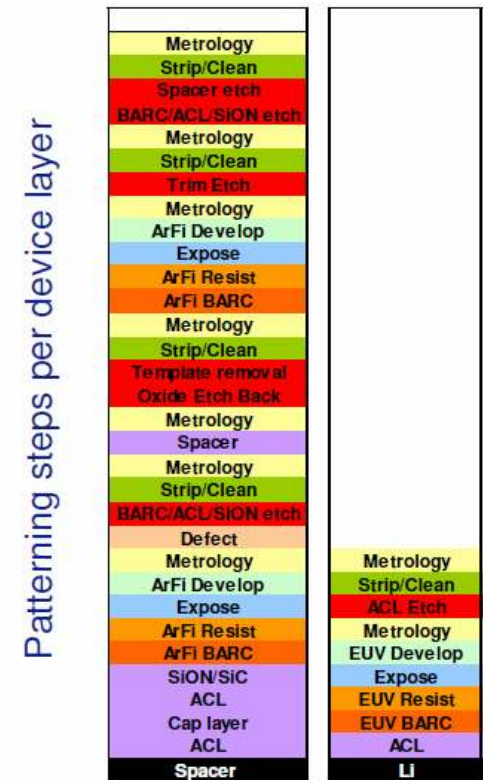
- ◆ On Current Trends, This Will likely be 80% Plus By 2020



SMART 2010/62 Key Conclusions Recap - 5

10. “450mm Wafers Will Lead To A 28% Die Cost Saving Independent Of Other Issues”

- ◆ “Driving This Is The Fact Lithographic Costs Will Continue To Drop. Without This Moore’s Law Would Have Ended Decades Ago. In Recent Years The Actual Cost Of Lithography Has Grown Significantly, Not On A Per Exposure Basis But Due To The Extra Steps Incurred By Double Patterning, EUV Will Return Us To A More Sensible Number Of Process Steps”
- ◆ Predicted Cost Saving Remains The Most Controversial Point, Impossible To Prove Until We Get There
- ◆ EUV Will Surely Appear In Due Course But Until Then We Will Just Have To Grin & Bear The Double/Quadruple Patterning Costs (Whether 300mm Or 450mm Wafers)
- ◆ EUV Delays May Make It Uneconomic To Launch EUV Production Machines With 300mm Tables



Current European 450mm Status

- ◆ **Major Direct Support Announced By Belgium & Dutch PAs For IMEC & ASML**
- ◆ **ASML Will Be The Key Litho Equipment Provider Be It EUV Or Not!**
 - However Should Alternate New Lithographic Solutions Be Required They Are Likely To Come From Europe As Well.
 - Despite Intel Buying Part of ASML, They Are Also Supporting Nikon As Well ... You Can Never Take Anything For Granted In This Business!
- ◆ **IMEC Is THE Key Worldwide Provider Of R&D For Processing, Materials & Transistor Structures**
 - Various REAL 10nm & 7nm Transistors Already In Development
 - 450mm Pilot Line Will Be The First To Truly Process Wafers End To End
 - The Intel Pilot Line Will Supplant It Soon After & Be Much Larger ... Europe Needs A Higher-Volume Follow Through
 - Possible Bi-furcation In Industry Transistor Standards At Some Point As Intel's Choice May Not Be Right For The Mainstream Foundries
 - By Then Memories Will Be Unrecognisably Different



European Success Stories

- ◆ **Unlike Fabrication, Europe Is The World Leader In Semiconductor Processing Equipment**
 - ASML Is The Obvious Star Performer.
 - ASMI, RECIF, Edwards, M&E & Many Others Also World Class
- ◆ **Meanwhile Imec Is The World Leader At Semiconductor Process Development With Only STM And IBM Not In Its CMOS Initiative**
- ◆ **Europe Also Has A Host Of Skills In Fab Design Currently Drawn Upon By New Fabs Under Construction Worldwide**
- ◆ **Finally Of Course Europe Is The World Leader In Semiconductor Cell Library & Circuit IP**
- ◆ **Europe Can Supply EVERYTHING A Semiconductor 450mm Wafer Fab Needs ... So Why NOT Build It In Europe ???**
- ◆ **We Have Found Many PAs Now Want To Support New Fabs But Europe Must Sell Itself Better Again As In The 80s/90s**



New Initiative – “Bridge450”

- ◆ **Hopefully Many Of You Are Aware Of & Members Of The EEMI450 Initiative (If You Aren't Then Please See Bas Van Nooten To Join)**
- ◆ **The Enable450 Project Tends To Focus More On The Needs Of The Larger E&M Companies & It Was Felt Another Project Could Assist The SMEs. The Commission Agreed & A New FP7 Funded Project Called Bridge450 Was Born**
- ◆ **This Project Will Involve High Level Visits To Asia & The US To Highlight European Abilities In 450mm Semiconductor Manufacture**
- ◆ **These Are Not Sales Visits As Such But Aim To Discover What Opportunities These Companies Might Have When Building Their New Fabs & To Open The Doors At These Companies To European SMEs Who Might Otherwise Fail To Be Considered**
- ◆ **The Concept Has Already Been Mentioned To Our C-Level Contacts At TSMC, Samsung & SK-Hynix With Positive Approval**



Bridge450 Participation

- ◆ **If You Are Interested In Participating, Please Talk To Bas Van Nooten Or Mike Bryant**
- ◆ **We Will Need From You A One Slide ‘Elevator Pitch’, A Couple Of Supplementary Slides For The Presentations To Address Likely Questions & An Introductory Document In Electronic Form That We Can Leave With The Companies Visited**
- ◆ **The Document Must Include Full Contact Details For Your CEO; Asian Culture Relies On Top Level Introductions First Before The Real Work Begins**
- ◆ **To Start This Process Off, Neelie Kroes Will Be Visiting Taiwan Shortly After Morris Chang Pointed Out To Future Horizons That The European Commission Had Never Even Visited TSMC!!**



What Next For Europe

- ◆ **There Can Be No Doubt Europe Is At A Nano-Microelectronics Crossroads, Affecting Current & Beyond CMOS Generations**
- ◆ **For Semiconductor Processing 10/100/20 Is The 'Last Chance Saloon' ... If It Fails Then Europe Will Be Lost Forever As A Leading Edge Node Semiconductor Producer**
- ◆ **We Cannot Allow Vested Self-interest Or Self-Defeatism To Deflect Europe Away From The Ambitious Goals Set By This Initiative**
- ◆ **Fortunately Research & E&M Is Coming From A Position Of Strength**
 - However Some European Companies Are Not Fully Engaged With G450C At Albany So Could Find Themselves Locked Out Of The First Round Of 450mm US Fab Construction
 - We Don't Expect This To Be Such An Issue In Asia
 - We Would Trust That New European Fabs Receiving Public Support Would Have A Large European Sourced Content



Europe MUST Fund New 450mm Fabs

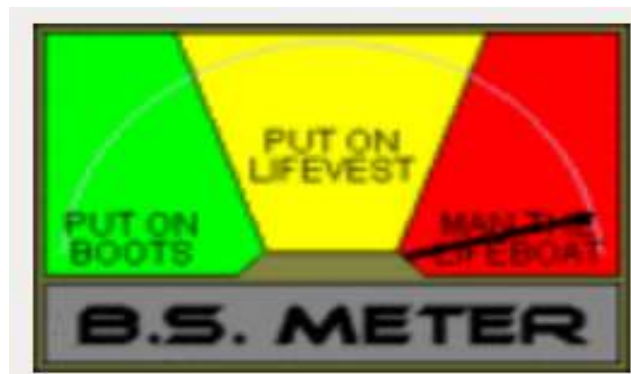
- ◆ There Is No Doubt Europe Is At A Strategic Technology Crossroads
- ◆ It Is Vital That Our Strengths In R&D & E&M Are Used To Make Europe An Attractive Location For New Fab Construction
- ◆ New York State Is Providing Funding For Up To Three 450mm Fabs To Be Built There. Intel Will Also Build Two Additional 450mm Fabs In Oregon & Arizona
- ◆ The Ambitious Goals Of 10/100/20 Will Lay The Framework For Europe To Match These Investments AND Take A Lead In More than Moore As Well
- ◆ Arguments Like ‘Goals vs Targets’; ‘FD-SOI vs Fin-FET’; ‘200-300mm’s All Europe Needs’ Are Pure Distraction & Filibustering
- ◆ Europe Used To Take Opportunities For World Leadership Such As GSM and VDSL With Both Hands But Nowadays We Just Set Up Committees! For 450mm, Stop Procrastinating JUST DO IT !!!!

“Ask not what Europe can do for your company, ask what your company can do for Europe”



Time Too For Node Honesty

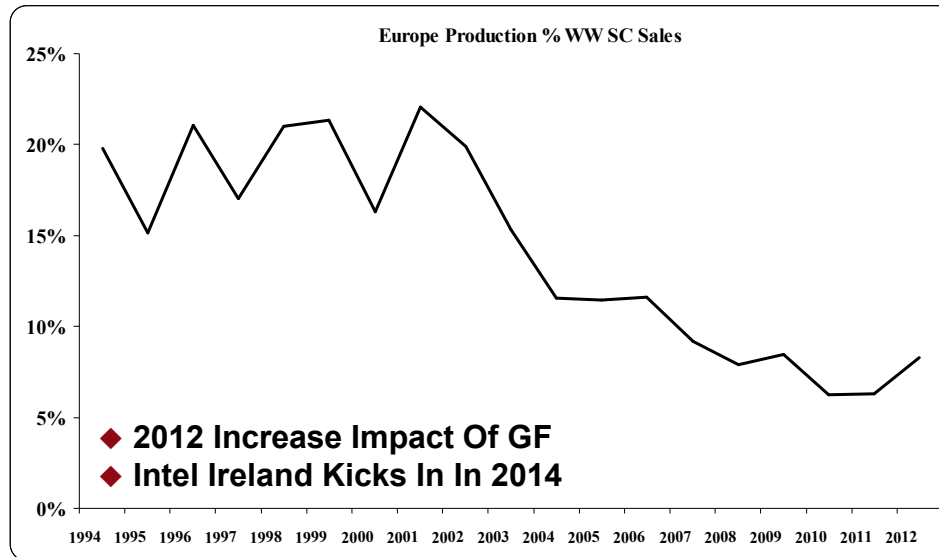
The Current Spin & Hype Is Out Of Control



Based On SRAM Size & Other Information We Have Seen In Our Consulting Work, In Our View The “14nm” Nodes From Each Manufacturer Should Be Called:

- ◆ Intel – 16nm or 17nm
- ◆ Samsung – 18nm
- ◆ TSMC & GF – 20nm
- ◆ STM – 21nm

Our Message To The ELG



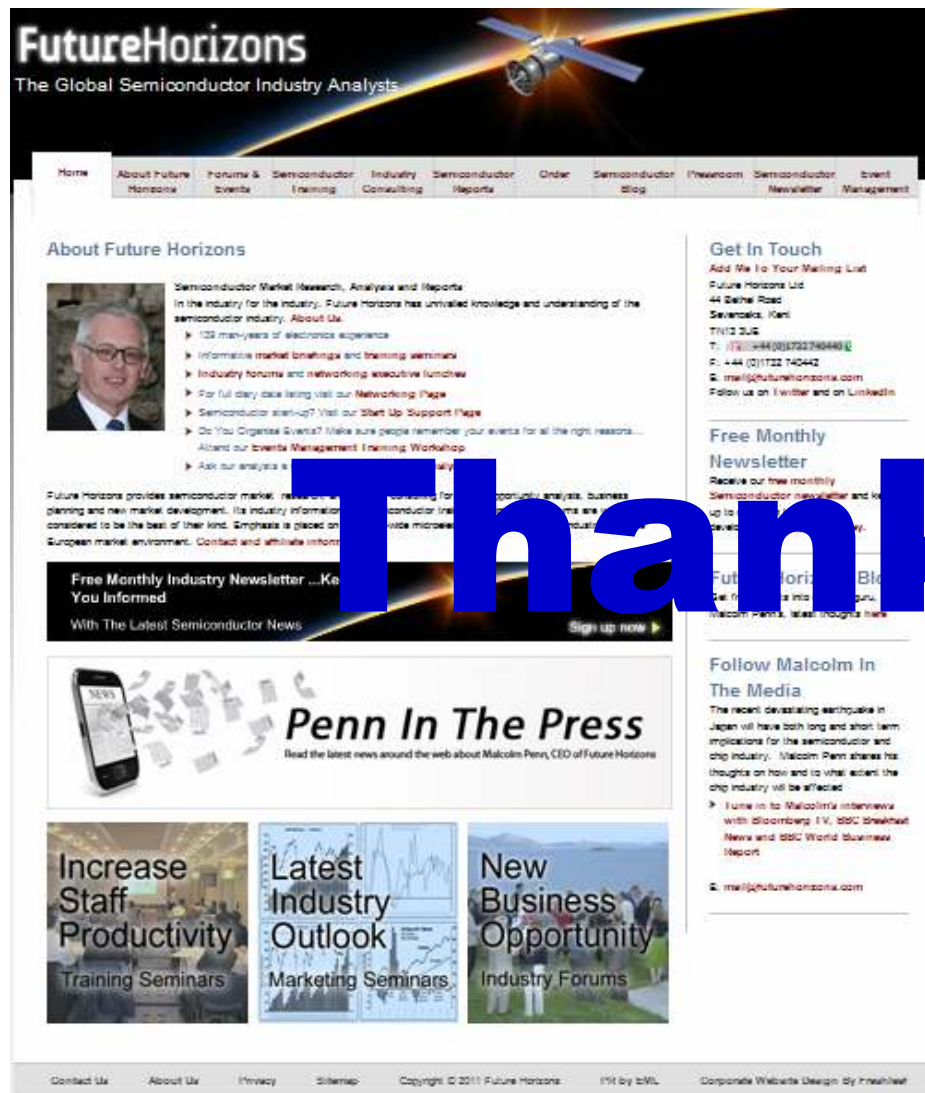
The “Airbus Of Chips” Challenge

***“Chip Production In Europe
Has Halved Since 2001 ...
Get Back To Where We Were”***

- ◆ **Stop Arguing Semantics About ‘Goals’, ‘Targets’, ‘What’s Included’ etc ...
The Message Is VERY Clear – It’s CHIP Production (Not E&M etc)**
- ◆ **The 20% Number Was Chosen To Reflect Europe’s Global GDP Status**
- ◆ **FD-SOI May Help Achieve The Target But It’s Not The Whole Answer**
- ◆ **Firms Have A Social & Economic Responsibility As Well, Especially Given
The 25+ Years (JESSI et al) Generous EU & PA Support ... It’s Payback Time**
- ◆ **450mm Is A Unique Opportunity For Europe’s To Get Back Into Leading-Edge
Volume IC Production At A Stroke; It’s An Intercept Not Catch Up Strategy**



Contact Details – www.futurehorizons.com



Future Horizons Ltd
44 Bethel Road
Sevenoaks, Kent
TN13 3UE, England
T: +44 (0)1732 740440
F: +44 (0)1732 740442
E: mail@futurehorizons.com

Thank You

Regional Offices In The UK & Russia
Affiliates In Europe, India, Israel, Japan,
Russia & USA

Follow us on:
Twitter
Face Book
LinkedIn

E-Mail: mpenn@futurehorizons.com for a copy of this presentation