All technology sectors are endeavoring to miniaturization with simultaneous performance improvement. That causes an increase of heat flux which is necessary to dissipate from the surface or to exchange in heat exchangers. For example, in the past 30 years, the frequencies of computer microprocessors has increased a thousand times, while the size of these systems and their heat exchange surfaces remained at the same level. This translates into average density of heat generated from 2 to 4.5 MW/m^2 (up to 45 MW/m^2 locally, in small areas). For insulated gate bipolar transistors (IGBT), a heat flux density of 6.5 to 50 MW/m^2 occurs. Heat distribution facilities, in the traditional embodiment occupying entire walls of the premises, are now housed in small boxes. The primary feature that is expected from home ORC micro-power plants is its small size. These are examples of everyday appliances, but there are also high technology industries, aviation, space industries, etc. Poor thermal management is a main drawback on the way of further miniaturization or increase of efficiency. Where conventional and even compact heat exchangers, using single-phase convection are no longer sufficient, researchers' attention is focused on more efficient heat exchange mechanisms such as two-phase flows (boiling/condensing) and the use of mini- and microgeometries (minichannels, minigaps). Because the mechanism of heat transfer during boiling in minigometry has been in the interest of researchers for a long time and is known for its high efficiency, attempts to use it for the construction of highly compact and high-performance heat exchangers are made. This brings new quality, but also generates specific problems: a) relatively high flow resistance, b) flow instability, c) difficulty in achieving even distribution of the fluid within the flow structure, d) very high sensitivity to impurities.

The conceptual work carried out in the Department of Energy and Industrial Apparatus in the Faculty of Mechanical Engineering of Gdansk University of Technology has shown that the problem of unequal distribution of working fluid (maldistribution) may be crucial for the actual heat and flow efficiency of the microchannel heat exchanger and that it may occur at a broader scale than this was assumed in theoretical considerations. The cyclic/pulsed work, that will occur in the case of potential exchanger applications in some reverse thermosyphon solutions, will certainly increase the importance of this issue. The applicant has attempted to identify the subject and intends to devote his dissertation to this subject. The applicant made preliminary studies on the minichannel and minigap geometries, available in his department, to recognize the distribution of working medium in their structures under cyclic conditions, suitable for reverse thermosyphon. Observations led to interesting conclusions, however, due to the limited workshop, they concerned only the adiabatic one-phase flow (without heat transfer) for one working medium (water) and only experimental studies.

The proposed project would be to develop this research program on a broader scale, for different geometries and for different flows (single-phase/two-phase, continuous/pulsed) as well as for fluids other than water (including non-wetting liquids). There is a chance to create a cognitive material focused on core issues related to the operation of heat exchangers, which corresponds to the growing interest of industries such as microelectronics and micropower. In addition, it shows a potential to be visually attractive due to the planned wide use of visualization techniques (fast shutter speed camera, thermography). The applicant assumes the importance of inlet and outlet manifolds to flow distribution, so their optimum shape will be devoted to special attention. In addition to flow issues, contractors will focus on heat transfer and pressure drop, and will attempt to link them together. The mathematical model of an exchanger in the ANSYS environment will be proposed, where the heat transfer during the flow will be coupled to the heat exchanger material, which will make this issue a very original research project. Very likely, the results will find their place in good scientific journals. The project will certainly increase the competency of the applicant and will provide a solid basis for his future doctoral thesis, where he plans to address the issue of heat transfer in detail. It will also be included in a wider research theme, implemented in the Department of Energy and Industrial Apparatus in the Faculty of Mechanical Engineering of Gdansk University of Technology. On the basis of the project, there are also opportunities for interesting laboratory exercises for students of thermo-flow and energy specializations.