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**Peter Tuleja, Ing., PhD.**

Technical university in Kosce, Faculty of Mechanical Engineering, Kosice, Slovakia

## VACUUM APPLICATION BY HANDLING TASKS

*Handling tasks which require the gripping across the board extensive and spatially segmented object manipulation ( $O_M$ ) require a specific approach to the design of a suitable gripping effector. This paper describes the individual partial tasks that the designer or engineer must to handle in order to be satisfied with manipulation task the required level of safety and repeatability. Also points out possible solutions to efficient use of compressed air to develop of vacuum..*

**Key words:** compressed air, vacuum, object of manipulation, ejector, suction pad, energy saving

### INTRODUCTION

#### Manipulation task

Automated production is impossible without manipulation tasks. Material handling is specific in that the means allowing its implementation must meet several conditions simultaneously:

- clearly and with guaranteed repeatability grasp object of manipulation ( $O_M$ ) at the taking of;
- safely and without displacement of the gripping mechanism to fix the  $O_M$  throughout the duration of handling tasks;
- clearly and without subsequent displacement impose  $O_M$  in the storage location.

Equipment designed for the fulfillment the handling task is generally referred to as a gripping effector - gripper.

#### Gripper

Designs of gripper as one of the categories so called the end effector consist of different kinematic chains that mediate the transfer of force of actuator (pneumatic, hydraulic, electric) to the destination on the  $O_M$ , therefore determine the grabbing force. Gripping force can act on  $O_M$  in several ways:

- in two or more contact points - two and multilateral gripping, Fig. 1a;
- at one point to the fixed base - passive grasping (without the forces of the added drive - gravitational grip effectors, or the creation gripper forces without an energy source - eg. a passive vacuum gripping);
- at one point without additional support - unilateral grasping.

#### Unilateral grasping

If the gripping force applied to the  $O_M$  only one of the parties without the support of any additional base, we are talking about a unilateral snaps. Representative gripper this category are for example magnetic gripper effectors (electromagnetic or permanent magnet), passive or active suction gripping effectors, adhesive gripping effectors, respectively effectors with mechanical linkage (normally in the form of needles), Fig. 1 [2],[3].

Each of these forms of unilateral grasping it in its own way specific. Attention is drawn to form a vacuum unilateral grasping, grasping the specific active vacuum suction cup.

#### Active vacuum suction cup

Unilateral grasping with the suction cups can be implemented in two ways:

- passive under a vacuum suction cup cuff (usually by applying a mechanical cam or mechanical extrusion part of the volume of atmospheric air from under suction cup), Fig. 2a);
- active by creating the of vacuum suction cup cuff suitable producer (either a vacuum pump or ejector), Fig. 2b).

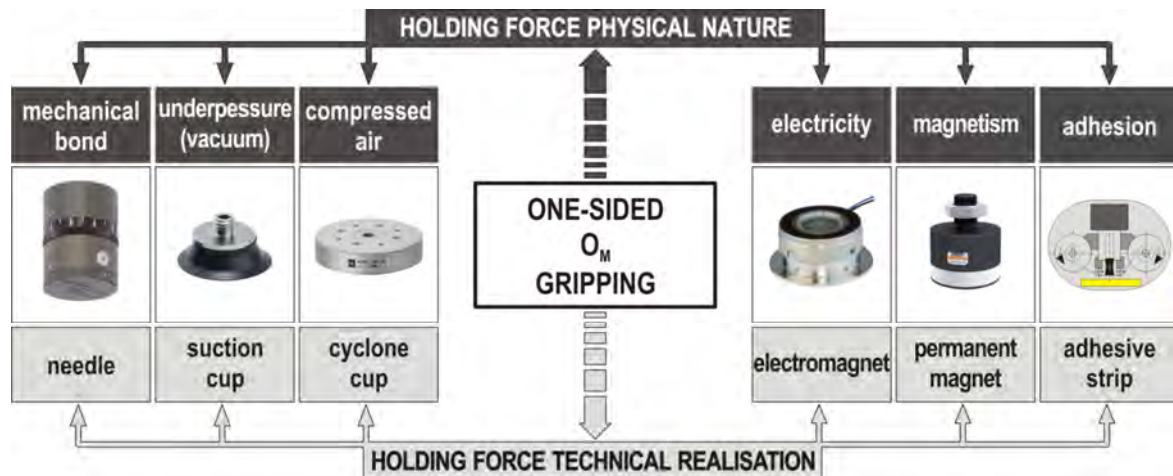


Fig. 1 Form of unilateral grasping

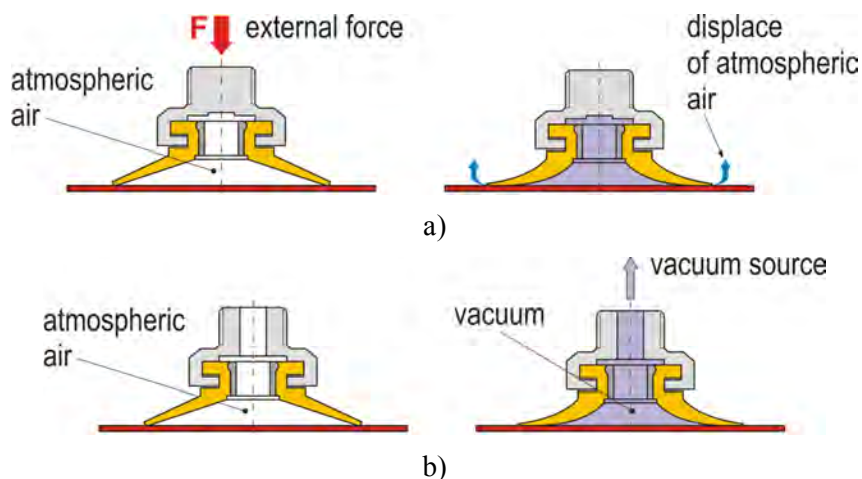


Fig. 2 Passive and active vacuum suction cup

In automated production is the most common form of unilateral grasping active type suction cup, the use of the ejector to create the necessary vacuum prevails over the use of vacuum pumps.

Since for creation of a vacuum in the ejector of compressed-air, the preparation requires considerable energy input, and thus the financial burden of the user should be able to make correct use of circuits for generating of vacuum.

#### The power to create a vacuum

The vacuum in the flow generator of vacuum - in ejector - is developed flow of compressed air through the so called. Venturi tube (Bernoulli modification of the Law on the fluid flow channel). The volume of the flow-through compressed air directly depends on the pressure of the air and the required quality of vacuum, Fig. 3.

It is clear that if we at all costs to develop high-quality vacuum and will you ensure that the pressure conditions in the circuit air consumption will grow and with it the cost of operating the gripping effector suction cup.

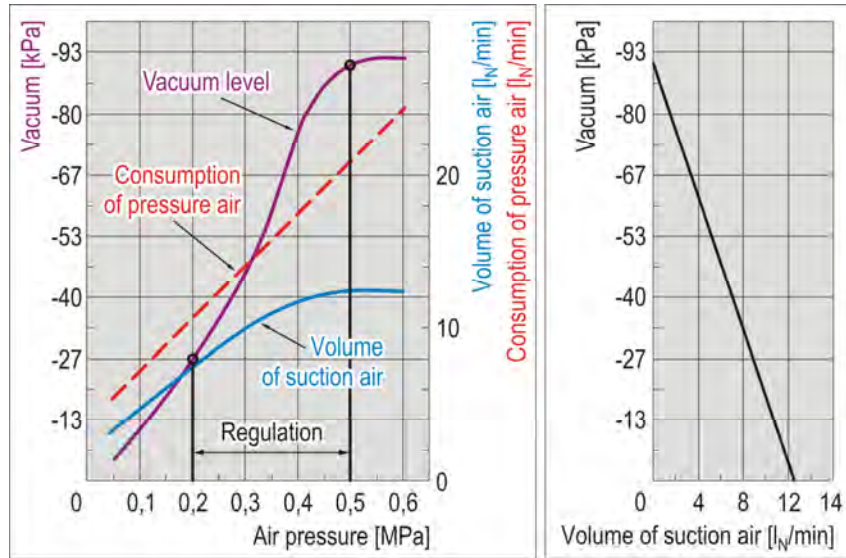


Fig. 3 Characteristic of ejector

Therefore, it is preferable to solve the size the gripping force size of the contact surface of suction cup with OM (size suction cup), than to artificially increase the quality of the vacuum at the expense of air consumption, Fig. 4.

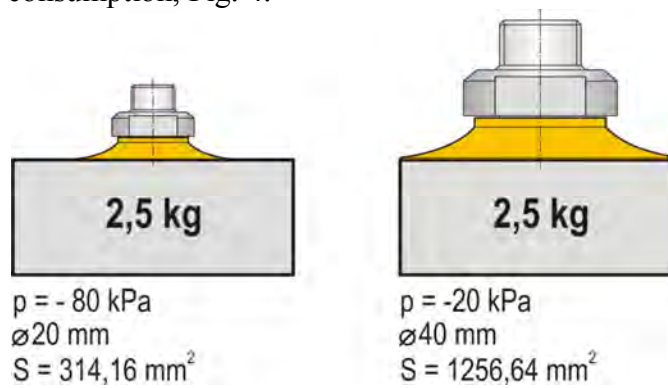


Fig. 4 Ratios of the suction cup

Vacuum saving thus really means a saving of compressed air, that is a fundamental energy (mainly electricity), Fig. 5.

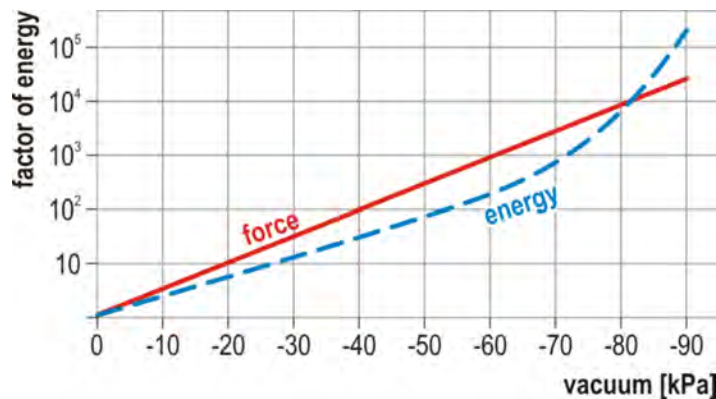


Fig. 5 Factor of energy by vacuum using

**How vacuum save.** First place is needs exactly caculate power things on suction cup with reference to dynamics move handling resources (e.g. robot), fig. 6.

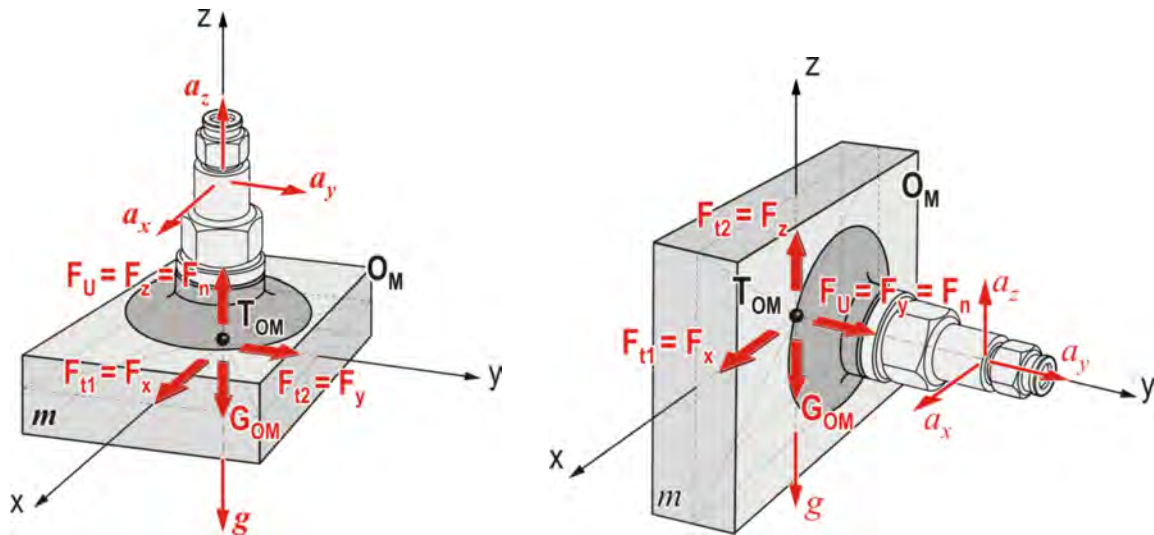


Fig. 6 Force conditions on suction cup in dependency from actuating accelerating

Force calculation would she had be achievement near pressure of compressed air in circuit till max. 0,5 MPA (option the apposite type of ejector and setting of need contact place - dimension and number of suction cups, see too Fig. 3)[1],[2].

By other process is appropriate observe steps indication on Fig. 7.

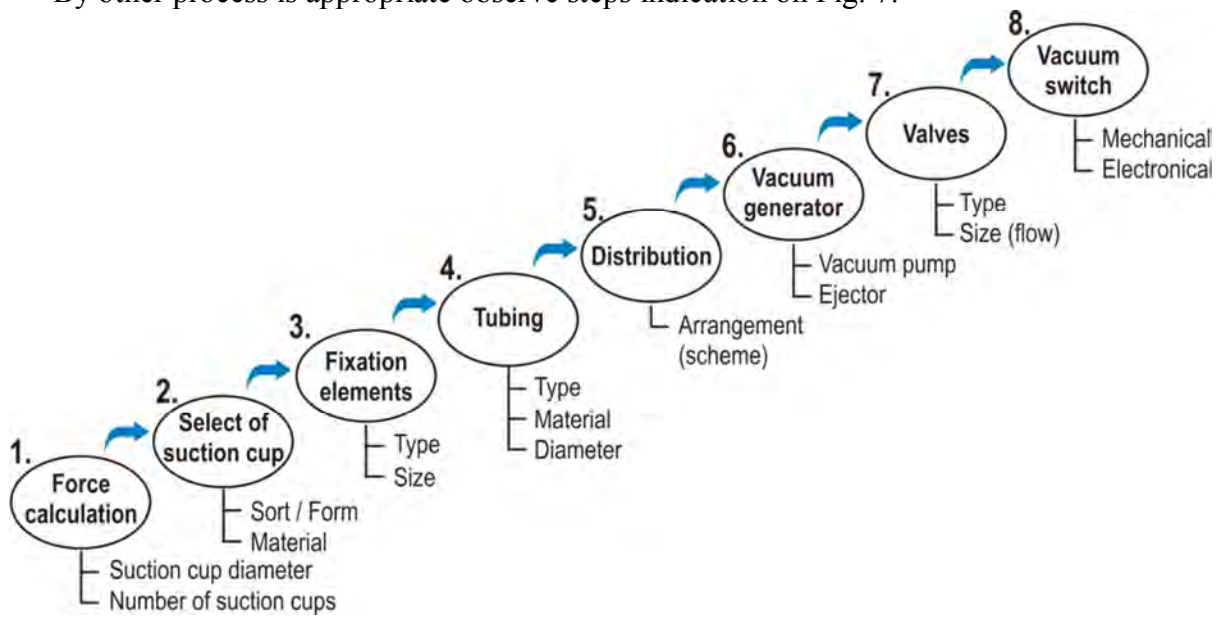


Fig. 7 Sequence by submission of circuit with suction cup

Vacuum in ejector would had not be generating in time full period of operating task (on the proviso that it her character make possible), Fig. 8 [1].

Providing that myself expects ability failure OM in combination several gripping O<sub>M</sub> is needed prevent from leakage thereby unreserved suction cups suitable technical solution, Fig. 9.

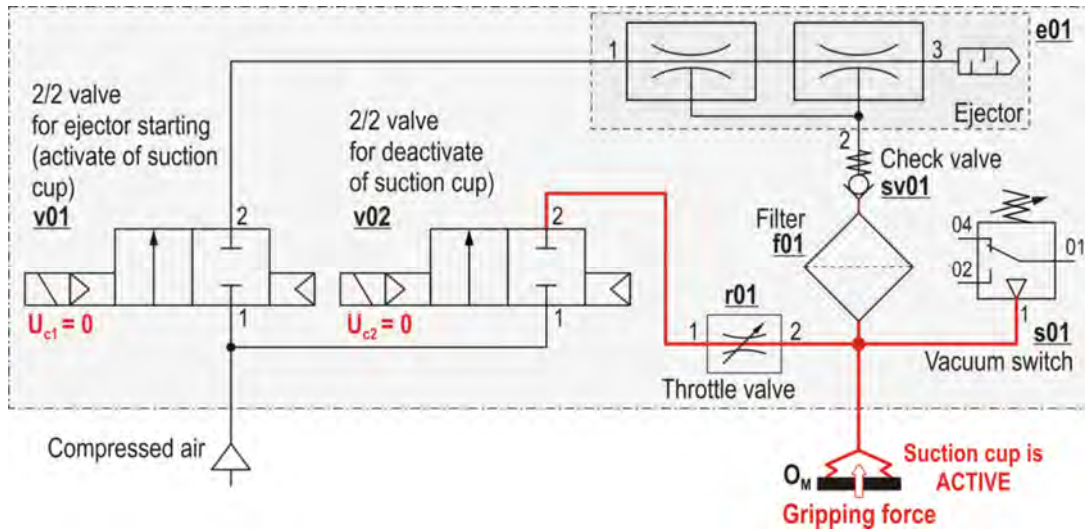


Fig. 8 Compressed air saving by regular structure of circuit

|                            |  |
|----------------------------|--|
| <i>Examples:</i>           |  |
|                            |  |
| <i>Technical solution:</i> |  |
|                            |  |

Fig. 9 Examples and technical solution near suction cup without contact with  $O_M$

Respectable of set-up by circuit with vacuum for solution of handling tasks utilization gripping effectors with unilateral grasp (suction cups) is alone effective mode of retrenchment to operation such solution.

Besides regular options of number and dimension of suction cup along with her another parameters to determine, look like dispose (mapping) suction cups above face of  $O_M$ .

Fundamentals is allocating of suction cups thus, that myself TCP (Tool Center Point) of effector with suction cups got on grounded axle with centre of gravity of  $O_M$ .

By profile multiple and large-scale OM is needs to solve too levelling difference of sheets for contact with suction cup, Fig. 10.

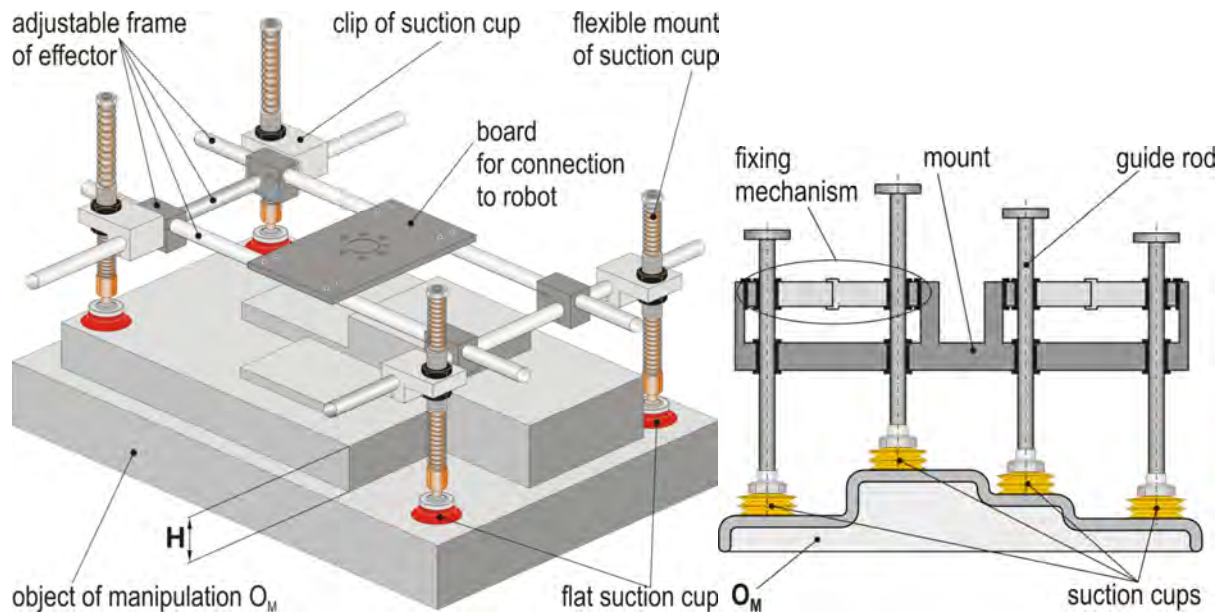


Fig. 10 Spacing solution for suction cups and it's compensating of level difference of the place for contact with suction cup gripper

## CONCLUSION

Performance of indication laws by projection of gripping effector with unilateral grasp by means of suction cup (cups) achieve not only certain and correctly behave of effector, but also large saving of energy expend on set up of compressed air.

## Literature

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*Contribution has arose with advancement of project: Applied research of systems for intelligent manipulation of industrial robot with non-orientable 3D objects / co-resolving with MIA Engineering Ltd., (ITMS: 26220220164).*